Rheinland-Pfälzische Technische Universität Kaiserslautern Landau

Clinical Psychology and Psychotherapy

# Personalising Cognitive Behavioural Therapy for Chronic Pain using person-specific Network Analysis and Single Case Experimental Design

by

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**Abstract**

Cognitive behavioural therapy (CBT) is guideline-recommended for chronic pain, and its moderate effect sizes have been established at the group level. To enhance treatment outcomes, a shift from symptom-focused treatment towards targeting key psychological processes, alongside increasing efforts towards personalisation, have been advocated. The aim of this dissertation was threefold: 1) to develop and evaluate a measurement instrument for the longitudinal assessment of key psychological processes in chronic pain, 2) to derive personalised treatment recommendations based on these assessed processes, and 3) to propose and examine the feasibility and acceptability of an integrative framework combining process-oriented personalisation based on modern research methods for practitioners and individuals seeking treatment.

Across four studies, the comprehensibility, relevance, and initial comprehensiveness of the newly developed item set was evaluated. In an online survey with *n* = 18 practitioners, items showed promising relevance and comprehensiveness. Subsequently, cognitive interviews with *n* = 12 individuals with chronic pain further supported the relevance, comprehensibility, and comprehensiveness and informed the revision of items with ambiguous ratings. The revised items were re-evaluated by *n* = 12 individuals with lived experience of chronic pain and *n* = 12 practitioners. In a fourth online study, *n* = 128 healthy individuals rated the overall comprehensibility of the item set positively with no significant added value of written and audio-visual comprehensibility aids. Overall, findings support the comprehensibility, relevance, and initial comprehensiveness of the item set.

A pilot Ecological Momentary Assessment (EMA) study (six assessments per day over 12 days; *n* = 3 women undergoing treatment) indicated that participant burden was acceptable. In another EMA study (*n* = 68 individuals with lived experience; six assessments per day over 12 days; 4,236 observations), and a subsequent re-evaluation of revised items (*n* = 10 individuals in treatment; six assessments per day over 21 days; 1,253 observations), overall findings supported the reliability of the item set, with four of thirteen process scales missing the threshold for sufficient reliability. Variability analyses yielded mixed results: although all

items met predefined variability criteria, intraclass correlation coefficients were larger than typically expected.

Based on the revised item set, *n* = 22 interdisciplinary clinicians and *n* = 4 psychological pain researchers participated in a group Delphi study design and focus groups to develop a matching matrix linking two CBT modules to each process item. *N* = 15 clinicians from the first Delphi round contributed to the second round. The resulting matching matrix demonstrated robust first-choice module recommendations. Eight out of 23 second-choice module recommendations had to be discussed in the study team. All final decisions were based on the data.

Finally, a proof-of-principle study was designed to study the feasibility and acceptability of an integrative framework combining 1) EMA and 2) person-specific network analysis to derive personalised treatment targets, 3) treatment recommendations for each target based on the matching matrix, and 4) a multiple baseline Single Case Experimental Design to monitor the treatment progress. *N* = 12 therapist-patient dyads completed the proof-of-principle study and participated in semi-structured interviews. The results suggest the procedure to be feasible and acceptable for both practitioners and therapists and revealed specific facilitators and obstacles to be considered in future research.

Taken together, this dissertation combines several innovative methodological approaches to advance the personalisation of CBT for chronic pain. It is among the first to integrate process-orientation, data-informed clinical decision-making, and person-specific network analysis within the context of chronic pain. In the absence of established methodological gold standards, the work provides transparent rationales for key methodological decisions, thereby facilitating future research and replication. Individuals with lived experience, as well as expert clinicians and researchers, were involved across all stages of the research process, contributing to bridging the science-practice gap. The methodological decisions and findings of all studies are discussed in the light of current research. Alternative and complementary approaches are considered, and implications for future research and clinical practice are derived.

## Preface with CRediT-Statements

The dissertation includes three first-authored scientific manuscripts based on six empirical studies and one first-authored study protocol as well as one co-authored scientific manuscript based on the results of the study protocol. The study protocol is published in a peer-reviewed journal (BMJ Open). The manuscript on the psychometric evaluation of the ProCEss item set has recently undergone a Major Review at the *European Journal of Pain*. All other manuscripts, including the co-authored manuscript, have been submitted to peer-reviewed journals.

Following a general introduction, each manuscript is presented in a separate chapter (chapters 2-5), with a comprehensive discussion of the overall results in chapter 6.

Manuscript 1: Hofmann, V. E., Glombiewski, J. A., Prasch, M. F., & Scholten, S. (preprint). Assessing chronic pain processes longitudinally: Validation of the German “Assessing Chronic Pain Processes” (ProCEss) item set. PsyArXiv. https://doi.org/10.31234/osf.io/ruhdf_v3

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Manuscript 3: Hofmann, V. E., Glombiewski, J. A., & Scholten, S. (preprint). Matching cognitive behavioural interventions to psychological processes to personalise chronic pain treatments: a mixed-methods study using Delphi and Focus Groups. PsyArXiv. https://doi.org/10.31234/osf.io/c68de_v2

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## List of Abbreviations

| | |
|---|---|
| ACT | Acceptance and Commitment Therapy |
| AGIST | Algorithm-Guided Intervention Selection Team |
| BC-Tau | Baseline-corrected Tau |
| BF | Bayes Factor |
| CBT | Cognitive Behavioural Therapy |
| cEMA | coverage Ecological Momentary Assessment |
| CPP | Chronic Primary Pain |
| DATA-IN | Dynamic Assessment Treatment Algorithm for Individual Networks |
| DARCI | Duration-Adjusted Reliable Change Index |
| EMA | Ecological Momentary Assessment |
| ICC | Intraclass-Correlation Coefficient |
| mPCS | momentary Pain Catastrophising Scale |
| MSSD | Mean Squared Successive Difference |
| NA | Network Analysis |
| PBAT | Process-Based Assessment Tool |
| PDI | Pain Disability Index |
| PECAN | Perceived Causal Network |
| POINT Pain | Process-Oriented, Individualised, Network-based Therapy for chronic Pain |
| ProCEss | Prozesse Chronischer Schmerzen ErfaSSen |
| QBPDS | Quebec Back Pain Disability Scale |
| RCI | Reliable Change Index |
| RCT | Randomised Controlled Trial |
| RMSSD | Root Mean Squared Successive Difference |
| RoBiNT | Risk of bias in N-of-1 Trials [scale] |
| ROM | Routine Outcome Monitoring |
| SCED | Single Case Experimental Design |
| SUS | System Usability Scale |
| SIM | Single Item Measure |
| TA | Think-Aloud |
| UEQ-S | User Experience Questionnaire |
| VAR | Vector Autoregressive [model] |

| | |
|---|---|
| VP | Verbal Probing |

# Chapter 1: Introduction

Chronic pain is a highly prevalent condition that entails substantial suffering for affected individuals and imposes considerable health-economic and broader societal costs (Deutsche Schmerzgesellschaft, n.d.). In contrast to acute pain, which usually signals damages and leads to adaptive behaviour, chronic pain is recognised as a disease entity in its own right and is associated with a range of additional aversive experiences, for example stress and sleep disturbances (Cohen et al., 2021). This reflects that pain-related disability is commonly accompanied by additional psychological symptoms, such as depressive symptoms, worry, or avoidance behaviours (McCracken & Turk, 2002).

Globally, nearly one third of the population is estimated to experience chronic pain (Cohen et al., 2021). A longitudinal, population-based study conducted across 22 countries on three continents even reported prevalence rates exceeding 40 % (Calvo et al., 2025). In Germany, a recent systematic review and meta-analysis estimated the point prevalence of chronic pain to be approximately 14-22 % (Rometsch et al., 2024). Considering the overall increasing prevalence rates (Calvo et al., 2025) and high prevalence rates of comorbidities in the chronic pain population (Foley et al., 2021; Gore et al., 2012), these figures underscore the substantial burden of chronic pain at both the individual and societal levels.

Chronic pain and its associated impairments in quality of life are generally regarded as amenable to treatment (Cohen et al., 2021). Both national and international guidelines recommend a multimodal treatment approach, with Cognitive Behavioural Therapy (CBT) as the first-line non-pharmacological treatment (Becker & Straßner, 2023; NICE, 2021). The effectiveness of CBT has been demonstrated primarily in nomothetic, i.e., group-based research, with reported effects typically falling within the medium effect-size range (Williams et al., 2020). Extensions of CBT incorporating so-called “third wave” approaches, such as Acceptance and Commitment Therapy (ACT), have not consistently produced the anticipated incremental gains in effectiveness, with reported effect-sizes ranging from small to large (McCracken et al., 2022).

Furthermore, individuals differ substantially in their responses to treatment (McCracken & Turk, 2002; Murillo et al., 2022), and a considerable proportion of patients do not benefit from CBT including ACT as indicated by reported response rates between roughly one and two thirds, corresponding to one to two thirds of non-responders (e.g. MacLean et al., 2023; McCracken et al., 2013; Simister et al., 2018; Vowles & McCracken, 2008; Wetherell et al., 2016) – an observation that is obscured by averaged effect-size estimates. Added to this is the great heterogeneity of chronic pain phenotypes (Breivik et al., 2006; Sundström et al., 2025) that highlights the limited generalisability of nomothetic research findings to individual patients. From a statistical perspective, this issue is closely related to the concept of non-ergodicity. For nomothetic results to be directly applicable at the individual level, each individual would need to be equally representative of the population, implying that variances – and even effect-sizes – are stable over time and invariant across individuals (Gloster et al., 2024; McCracken, 2023; Medaglia et al., 2011; Wright & Woods, 2020). In research involving human behaviour and experience, however, these assumptions are almost always violated (Gloster et al., 2024).

This limits the clinical utility of strictly nomothetic research designs such as randomised controlled trials (RCTs). Although RCTs have undoubtedly contributed significantly to advances in the understanding of mental disorders and their treatment (Hofmann & Hayes, 2019), insight into which specific treatment components are effective, for whom, and through which mechanisms remains scarce.

Against this background, a range of new approaches has been increasingly advocated. Personalising both the assessment and treatment of chronic pain is expected to facilitate a more precise understanding of individual psychopathology and, in turn, to enable more efficient – and potentially more effective – treatment planning (Hayes et al., 2019; Levinson et al., 2024; McCracken, 2023; Scholten, Herzog, et al., 2025; Wright & Woods, 2020). To reduce bias in clinical decision-making, data-informed clinical decision support tools have been proposed to assist clinicians' reasoning processes (Fernandez et al., 2017; Fisher & Boswell, 2016; Kaiser & Laireiter, 2017; Kaiser & Roth, 2022; Lutz, Schwartz, et al.,

2022; Rubel et al., 2018). Finally, there is a growing emphasis on targeting maintaining processes rather than focusing exclusively on symptom reduction (Hofmann & Hayes, 2019; McCracken, 2021, 2023).

Hofmann and Hayes synthesise these developments in a new foundational question for contemporary psychotherapy research: “What core biopsychosocial processes should be targeted with this client given this situation, and how can they most efficiently and effectively be changed? “ (Hofmann & Hayes, 2019, p. 38). The following sections review current empirical findings and outline the remaining challenges in addressing this question.

**Psychological processes of chronic pain and their assessment**

To investigate predictors of pain-related outcomes, both moderator and mediator models have been applied. For instance, within the context of ACT, acceptance, committed action, and values-based action have been found to significantly mediate treatment outcomes, with broader indicators of psychological flexibility demonstrating greater predictive value than more narrowly defined, individual-level measures (Åkerblom, Perrin, et al., 2021). A systematic review and meta-analysis examining moderators and mediators in musculoskeletal pain interventions reported that anxiety and catastrophising mediated effects on pain-related disability, with acceptance and psychological flexibility also showing mediating effects (Murillo et al., 2022). While Broderick and colleagues (2016) identified pain coping style, patients’ treatment expectations, radiographically assessed disease severity, age, and education as relevant moderators for post-treatment outcomes, Murillo and colleagues (2022) reviewed findings regarding moderators to be largely inconsistent.

While some have argued that the identification of moderators and mediators is essential for the advancement of process-based therapy (McCracken, 2023), such models fall short of capturing the complexity that is both theoretically postulated and empirically observed in psychopathology (Hayes et al., 2019). In particular, these models typically do not account for bidirectional or dynamic associations, meaning they can only serve as an interim step toward identifying the “true” mechanisms underlying treatment effects (Hayes et al., 2019).

If moderators and mediators are not equivalent to processes, a clear definition of the term “process” becomes necessary. A commonly used categorisation distinguishes between common versus theory-specific mechanisms of action, which has practical value but is difficult to evaluate because these mechanisms are interacting (Crits-Christoph & Gibbons, 2021). Empirical evidence for theoretically based mechanisms of action in chronic pain is scarce, suggesting that shared mechanisms across psychological treatments be of greater relevance (Burns, 2025).

Hayes and colleagues (2020) propose a set of features that processes should exhibit: processes should be theory-based and consequently enable testable predictions; they are dynamic and can include feedback-loops as well as non-linear associations; they are progressive in that they need to be arranged in a certain sequence to achieve a specific goal; they are context-bound and modifiable; and they are multilevel and can be nested in one another. To date, no chronic pain processes have been identified that fully meet the criteria described by Hayes and colleagues (2020), and it remains unclear what constitutes a specific process.

Against this background, candidate processes can be derived from established psychopathological models (Scholten & Glombiewski, 2025). Such models formalise assumed causal associations that are intended to explain the onset and maintenance of mental disorders. In the context of chronic pain, the fear-avoidance model is among the most established frameworks. The model describes a vicious cycle in which the experience of pain gives rise to catastrophising cognitions and pain-related anxiety, which in turn promote avoidance behaviours (Vlaeyen et al., 2016). Over time, persistent avoidance may lead to physical deconditioning, thereby increasing vulnerability to the experience of pain.

Within this framework, however, it remains unclear how processes should be conceptualised. Specifically, processes could be defined as the individual elements of the vicious cycle, such as avoidance behaviour or catastrophising thoughts, or alternatively as the dynamic associations linking these elements over time. So far, established measurement

instruments like the Pain Catastrophizing Scale (Osman et al., 1997) usually assess specific elements.

Regardless of how processes are conceptualised, they are inherently dynamic (Hayes et al., 2020) and therefore require repeated, longitudinal assessment. Such designs are essential for capturing the temporal dynamics of both psychological processes and pain-related outcomes, which have been largely neglected in traditional assessment approaches (Crits-Christoph & Gibbons, 2021). One prominent method for collecting intensive longitudinal data is Ecological Momentary Assessment (EMA). In recent years, EMA has gained increasing popularity, driven by advances in analytical methods and the widespread availability of mobile digital devices. It is frequently advocated for its high ecological validity, as it enables assessment in individuals' everyday environments and reduces recall bias (Eisele et al., 2021; May et al., 2018; Overton et al., 2023). In chronic pain research, EMA has been increasingly applied as well and has been proposed as a potential new gold standard for the assessment of pain experiences due to its temporal resolution and measurement precision (May et al., 2018; Overton et al., 2023).

In general, EMA can be implemented across a range of timescales, capturing fluctuations occurring over minutes, hours, or days (Eisele et al., 2021). Depending on the research question, assessment schedules may vary from once-daily measurements to multiple assessments per day and may target either momentary experiences or more aggregated states, in so-called coverage EMA (cEMA) (Eisele et al., 2021; May et al., 2018; Stone et al., 2021). Owing to the intensive and repeated nature of EMA, participant burden represents a critical consideration in questionnaire development (Eisele et al., 2021). Consequently, EMA instruments are typically kept brief, often relying on single-item measures (SIMs) or very short scales comprising fewer than three items.

These characteristics render EMA questionnaires particularly vulnerable to measurement error, which is rarely evaluated systematically prior to their application (Dejonckheere et al., 2022). Especially in the context of process-based therapy and chronic pain research, validated measurement instruments suitable for EMA remain scarce. This

might also be due to the lack of gold standards in the development and evaluation of EMA items and scales (Eisele et al., 2021). Notable exceptions include the transdiagnostic Process-Based Assessment Tool (PBAT) (Ciarrochi et al., 2022), which has been proposed for use across different timescales, and the momentary Pain Catastrophising Scale (mPCS) (Frumkin et al., 2023). The PBAT is not specific to chronic pain, but was developed to assess multiple therapeutic processes like values-based behaviour or experiencing an appropriate range of emotions. It was preliminarily evaluated using a machine-learning approach and was found to distinguish between positive and negative processes and to be associated with clinically relevant outcomes such as sadness or lack of social support (Ciarrochi et al., 2022).

The mPCS measures pain catastrophising defined as judging pain and associated problems as significantly worse than necessary (Crombez et al., 2020). It was evaluated in two EMA studies regarding its construct validity as well as reliability and demonstrated overall good psychometric qualities.

Nevertheless, to date, no instrument exists that enables the longitudinal assessment of multiple psychological processes specific to chronic pain. The identification of therapy-relevant processes and the development of suitable assessment instruments constitute essential prerequisites for successful personalisation, as process-based therapy conceptualises such processes as primary treatment targets (Hayes et al., 2020). Accordingly, the first aim of this dissertation was to develop and evaluate a measurement instrument facilitating the longitudinal assessment of key psychological chronic pain processes suitable as treatment targets.

**Identifying targets for psychotherapy**

Assuming that generally suitable therapy-relevant processes have been identified, the subsequent step towards personalised treatment involves determining the most promising intervention target. To this end, assessed processes must be organised within a coherent framework that enables clinicians to identify the most influential or clinically urgent process to address.

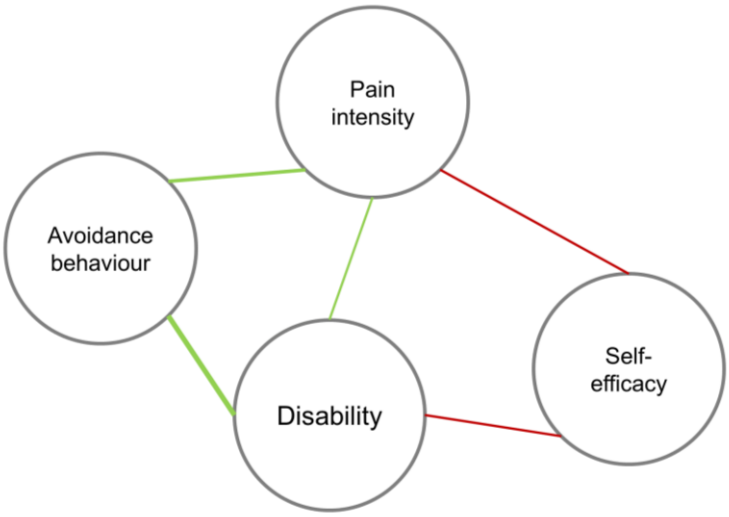
Network theory offers such a framework by modelling structural as well as temporal associations between elements, including psychopathological symptoms or psychological processes (Borsboom, 2017; Bringmann, 2021; Fried & Cramer, 2017). In contrast to traditional latent variable models – common in medical conceptualisations – network theory conceptualises mental disorders as self-sustaining systems of interacting components rather than as manifestations of an underlying disease entity (Hofmann et al., 2016).

Within this framework, networks can be graphically represented to visualise associations. Assessed variables are depicted as *nodes,* which are connected by *edges* representing statistical relationships (Borsboom, 2017; Bringmann, 2021; Fried & Cramer, 2017). In contemporaneous networks, these edges typically reflect undirected partial correlations between variables when all other nodes in the network are controlled for (Fried & Cramer, 2017) (see Figure 1 for an illustrative example).

With sufficient intensive longitudinal data, temporal networks can be estimated to model lagged associations between variables over time (Crits-Christoph & Gibbons, 2021; Fisher & Boswell, 2016; Scholten, Rubel, et al., 2024) (see Figure 2 for an illustrative example). Although such associations do not necessarily imply causality, they provide insight into the average temporal dynamics within the system, i.e. what node or process predicts another (Crits-Christoph & Gibbons, 2021; Fried & Cramer, 2017; Hofmann et al., 2016; Hofmann & Curtiss, 2018; Scholten, Rubel, et al., 2024). In these models, directional edges are represented as arrows, indicating the direction of prediction (see Figure 2). Processes may also exhibit autoregressive effects – that is, self-sustaining dynamics – visualised as loops from a node to itself (see Figure 2).

**Figure 1**

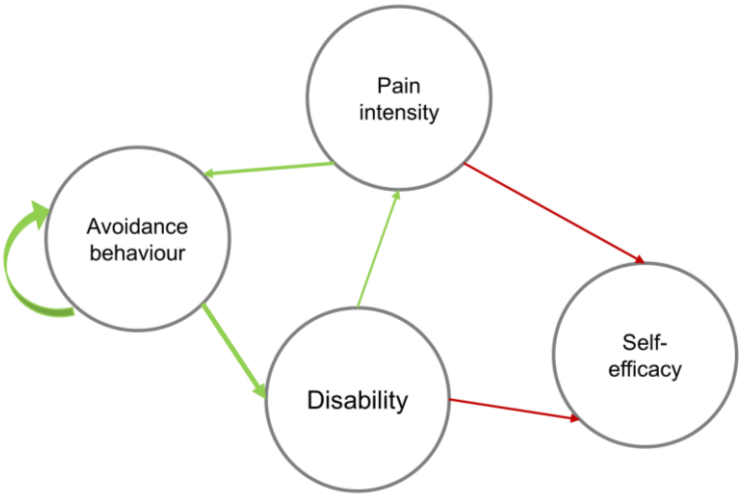
*Exemplary contemporaneous network*




*Note.* Fictitious network not based on actual data; red edges indicate negative associations, green edges positive associations (e.g. higher pain intensity is associated with less self-efficacy and more avoidance behaviour); thickness of edges indicates strength of associations, i.e. the thicker the edge the stronger the association

**Figure 2**

*Exemplary temporal network*




*Note.* Fictitious network not based on actual data; red edges indicate negative associations, green edges positive associations; arrows indicate direction of association (e.g. pain intensity predicts increase in avoidance behaviour and decrease in self-efficacy); loop-like arrow = autoregressive association (i.e. avoidance behaviour sustains itself over time); thickness of edges indicates strength of association, i.e. the thicker the edge the stronger the association

Network theory and the estimation of network models can be applied at both the group and the individual level, thereby enabling the investigation of person-specific process dynamics (Bringmann, 2021). In addition, comorbid conditions can be incorporated into network models, provided that the relevant processes have been assessed (Borsboom, 2017; Hofmann et al., 2016). This seems especially relevant for the chronic pain population, considering the high prevalence of comorbidities in this population (Foley et al., 2021; Gore et al., 2012).

Statistical parameters such as centrality indices allow for the identification of particularly influential nodes within a network (Rubel et al., 2018). In recent applications, strength centrality has most commonly been reported for contemporaneous networks, whereas outstrength centrality has been used in the context of temporal networks (Bringmann, 2021; Fisher et al., 2017; Nemani et al., 2025; Rubel et al., 2018; Scholten et al., 2022; Zhao et al., 2023). Strength centrality represents the sum of a node's connections to all other nodes and thus reflects the overall level of interconnectedness within the network (Wright & Woods, 2020). In contrast, outstrength centrality in temporal networks indicates the extent to which a given node predicts changes in other nodes (Fisher et al., 2017; Rubel et al., 2018).

Prioritising the most central nodes as treatment targets follows the rationale that intervening on the most influential process may destabilise the network most efficiently, thereby inducing broader system-wide change (Rubel et al., 2018). Network theory thus represents a promising framework for personalisation, as it directly capitalises on the intensive longitudinal assessment of psychological processes and allows for the identification of personalised intervention targets.

In clinical contexts, network analysis has been applied in a growing number of studies. Frumkin and colleagues (2019) piloted the feasibility of idiographic psychopathological models developed based on EMA data in a training clinic and compared participants' and therapists' assumptions about symptom associations with the empirically estimated, data-driven networks. They evaluated the feasibility positively, yet observed low

correspondence between subjective assumptions and data-based models. However, the sample did comprise undiagnosed, less disabled participants, thus limiting the generalisability of their findings to purely clinical samples.

Fisher and colleagues (Fisher et al., 2017) examined idiographic dynamics in mood and anxiety disorders using person-specific network analyses in a larger sample. Their findings suggested that positive affect may exert a stronger influence on Major Depressive Disorder and Generalised Anxiety Disorder than the respective core diagnostic symptoms.

In the field of chronic pain, Beeckmann and colleagues (2019) applied network analysis to investigate avoidance-related and activity-engagement networks. Among other findings, they observed that, contrary to assumptions derived from the fear-avoidance model (Vlaeyen et al., 2016), catastrophising did not consistently predict anxiety. Instead, the authors discussed a potential bidirectional association between these variables, consistent with the notion of dynamically interacting processes (Hayes et al., 2019; McCracken, 2023).

Importantly, none of these studies directly selected treatment targets based on the estimated networks. Although they used centrality indices to infer potentially influential processes, there is currently no gold standard specifying which nodes should be prioritised as treatment targets or in what sequence interventions should be implemented. The clinical utility of network models as well as the feasibility of the necessary assessments has yet to be established (Bringmann, 2021) and presents a prerequisite for investing further in these approaches. This dissertation therefore aimed at integrating person-specific network analysis for treatment target selection with specific treatment recommendations, and demonstrating the feasibility and acceptability of this approach for individuals seeking treatment for chronic pain as well as practitioners.

**Personalised, data-oriented treatment indications**

The identification of an appropriate treatment target necessarily precedes the selection of a corresponding intervention. Once a target has been identified, clinicians must determine which therapeutic strategy is most suitable for addressing it. Traditionally, findings from nomothetic research have been disseminated in the form of standardised treatment

protocols for specific syndromes, which are typically evaluated as unified packages what makes it difficult to determine which specific interventions are effective for which underlying process (Cohen et al., 2021; Hayes et al., 2019; Levinson et al., 2024; Murillo et al., 2022).

In so-called dismantling studies, active components of treatment protocols are investigated (Leijten et al., 2021). For example, muscle relaxation does not seem to significantly enhance treatment outcomes of behavioural and cognitive techniques for chronic low back pain (Nicholas et al., 1991). Overall, dismantling studies are rare and their number decreased in the past years, although there is a profound need for identifying active treatment components especially in the emerging field of process-based therapy (Leijten et al., 2021). Summed up, even on the nomothetic level it is unclear what treatment components are beneficial or necessary for positive treatment outcomes.

Given that individual patients often deviate from the average reported in nomothetic studies, clinicians are frequently challenged to personalise treatment, which often leads to the adaptation of, or deviation from, established protocols (Levinson et al., 2024; McCracken, 2023). Personalisation efforts are already reflected in several contemporary developments. For example, novel diagnostic frameworks such as the Research Domain Criteria promote transdiagnostic research grounded in cognitive neuroscience (Walter, 2017), thereby moving beyond traditional categorical systems. Similarly, modular and transdiagnostic treatment approaches, such as the Unified Protocol for emotional disorders (Barlow et al., 2017), aim to increase flexibility compared to rigid, disorder-specific treatment protocols.

More generally, personalised treatment can be operationalised at different levels of specificity. At a relatively broad level, personalisation may involve recommending alternative treatment modalities. For instance, Wester and colleagues (2025) surveyed German psychotherapists on whether they refer patients to forms of psychotherapy other than their own primary orientation (e.g., CBT or psychoanalysis) and found that a majority reported doing so.

In the context of chronic pain, a comparatively low-specificity form of personalisation is reflected in stratified care models, in which patients are allocated to different levels of

treatment intensity based on group-level risk profiles (Scholten & Glombiewski, 2025). However, such approaches do not account for the effects of specific interventions on individual psychological processes.

More fine-grained personalisation approaches in chronic pain treatment often rely on patients' preferences when selecting therapeutic strategies (e.g. Evers et al., 2002; Kerns et al., 2014). Although incorporating patient preferences is consistent with principles of shared decision-making and patient-centred care, such preferences – much like clinicians' judgments based on professional experience and intuitive reasoning – are susceptible to cognitive biases (Lutz, Schwartz, et al., 2022). Routine clinical care based on intuitive clinical judgment has not yielded sufficient treatment outcomes, suggesting a need for data-based support tools to mitigate bias, strengthen the implementation of evidence-based interventions, and support clinicians in making transparent and personalised treatment decisions (Cohen et al., 2021; Lutz et al., 2022).

Beyond the field of chronic pain, several algorithmic decision-support tools have been developed. For example, Fernandez and colleagues (2017) developed an algorithm based on the Unified Protocol for emotional disorders (Barlow et al., 2017) that assigns a priority score to each assessed item, linking a module within the Unified Protocol to each item.

Extending this work, Rubel and colleagues (2018) incorporated person-specific networks to this algorithm. Their approach comprises three steps: first, items are assigned to treatment modules within a predefined matching matrix, with each assignment determined by a panel of clinical experts; second, contemporaneous and temporal networks are estimated at the individual level; and third, an average strength for each module is estimated by multiplying the strength and outstrength centrality of each item with the matching matrix.

Kaiser and Laireiter (2017) introduced a digital platform that assigns a priority value to assessed symptoms and estimates the expected treatment impact when targeting a specific symptom. Similarly, Kaiser and Roth (2022) also developed an algorithm that provides a sequence of modules based on recommendations of a large clinician sample and priority scores.

Fisher and colleagues (2019) subsequently evaluated the algorithm of Fernandez and colleagues (2017) in an open trial and reported encouraging results regarding reductions in depressive and anxiety symptoms. Similarly, Levinson and colleagues (2023) conducted an open trial in the treatment of eating disorders, in which intervention targets were selected based on person-specific network models and linked to corresponding evidence-based treatment modules. The authors observed large improvements in primary outcome measures after one-year follow-up alongside comparatively low dropout rates, supporting the feasibility and acceptability of such data-oriented personalisation approaches in clinical practice.

All such data-driven approaches rest on the assumption that evidence-based interventions are identifiable for any symptom or behaviour and that these interventions are both applicable and effective when delivered in isolation and irrespective of sequencing effects (Fernandez et al., 2017). However, as noted above, treatment protocols are typically evaluated as packages, resulting in limited empirical evidence regarding the effectiveness of stand-alone components – let alone their specific effects on distinct treatment targets (Cohen et al., 2021; Hayes et al., 2019; Levinson et al., 2024; Murillo et al., 2022).

In the field of chronic pain, algorithmic personalisation efforts remain particularly scarce (Mauck et al., 2022). This may reflect the limited availability of sufficiently granular data linking specific interventions to clearly defined psychological processes over time.

In the absence of a sufficiently robust evidence base to fully support data-driven decision-making, systematically drawing on clinical expertise represents a feasible interim strategy to derive personalised treatment recommendations at the level of specific targets. Notably, even the aforementioned algorithmic approaches relied on expert judgment when establishing the correspondence between assessed items and intervention modules (Fernandez et al., 2017; Kaiser & Laireiter, 2017; Rubel et al., 2018).

Although the structured involvement of clinicians and researchers still reflects intuitive judgment that may not necessarily align with purely data-derived recommendations (Fernandez et al., 2017), such procedures offer a pragmatic means of bridging the science-practice gap. Moreover, they may enhance the clinical acceptability of emerging decision-

support tools, thereby facilitating their implementation in routine care (Kaiser & Roth, 2022; Levinson et al., 2024). In this dissertation, process-specific treatment recommendations should therefore be derived from a collaborative approach involving both expert clinicians and psychological chronic pain researchers.

**Evaluating treatment effects**

Once a treatment target has been identified and an intervention selected, the treatment commences and its effects must be systematically evaluated. In contemporary research, RCTs are widely regarded as the gold standard for evaluating treatment efficacy, typically reporting averaged effect sizes at the group level (Mohr, 2024).

However, as outlined above, such aggregated estimates are not necessarily generalisable to the individual patient (Fernandez et al., 2017; Fisher et al., 2017; Fisher & Boswell, 2016). Given the substantial heterogeneity in psychopathological processes across individuals (Wright & Woods, 2020) and especially in chronic pain (Breivik et al., 2006; Sundström et al., 2025), it follows that the evaluation of treatment effects should likewise adopt an idiographic perspective.

Single-Case Experimental Designs (SCEDs) are widely recognised as a method that combines idiographic precision with methodological rigour (Tate et al., 2013), offering a bridge between research and clinical practice (Scholten & Glombiewski, 2025; Vlaeyen & Crombez, 2020). In SCEDs, each individual serves as their own control through repeated assessments and the systematic introduction – and in some designs, withdrawal – of experimental conditions, such as different forms of treatment (Tanious & Onghena, 2021; Tate et al., 2020). Thus, SCEDs offer the opportunity to monitor the treatment process and are proposed to facilitate better clinical decisions (Schemer et al., 2023). Depending on the assessment instruments, they still allow for the aggregation of data and group-based comparisons (Schemer et al., 2023).

Numerous SCED variants exist. For example, multiple baseline SCEDs across participants allow to compare the effect of an intervention on a predefined target by randomising the onset of the intervention for each participant (Morley et al., 2015). Such

designs are especially useful if carry-over effects are expected (Tate et al., 2013), and when an intervention cannot easily be withdrawn (Tanious & Manolov, 2023), as is usually the case in cognitive and behavioural interventions. For a comprehensive overview of the variants of SCED, see Barlow and colleagues (2009), Kazdin, (2019), Morley (2018), or Vlaeyen and colleagues (2020, 2022), and for an overview of possible combinations of SCEDs see Tanious and Manolov (2023).

Likewise, a variety of statistical and visual indices are available for evaluating treatment effects in N-of-1 trials, as summarised by Kininger and colleagues (2025). Visual analysis of plotted data is common in SCED research due to its intuitiveness, but it does not provide statistical parameters and is criticised for vulnerability to biases (Carlin & Costello, 2021; Ferron et al., 2010). It is therefore recommended to combine visual and statistical analyses when interpreting SCED data (Manolov et al., 2014; Morley et al., 2015; Tanious & Onghena, 2021; Vlaeyen et al., 2022). Given the multitude of statistical parameters, a gold standard has not yet been established. Consequently, suitable parameters have to be selected based on the characteristics of any given SCED study (Kininger et al., 2025).

SCEDs have been increasingly applied in recent research, as reviewed by Tanious and Onghena (2021). In the context of chronic pain, Schemer and colleagues (2018) compared CBT with exposure in vivo and found that exposure produced relatively immediate effects, whereas the effects of CBT were smaller and lagged compared with the exposure condition.

Simons and colleagues (2020) used a SCED approach to evaluate graded exposure in youths with chronic pain, reporting that the large majority of participants showed improvement across multiple outcomes at follow-up. Vlaeyen and colleagues (2001) compared graded activity with graded exposure in vivo for individuals with chronic low back pain by randomising the order in which participants received the respective treatment conditions. Improvements were observed exclusively during the exposure treatment, in contrast to the graded activity condition.

Norman-Nott and colleagues (2022) evaluated a digital intervention for chronic pain based on Dialectical Behaviour Therapy and observed improvements across several outcomes, including emotion regulation and coping behaviours. These findings collectively illustrate the utility of SCEDs in chronic pain research and for capturing individual-level treatment effects across diverse interventions.

However, gold standards for the analysis of SCEDs are missing and the absence of such designs in the education of psychologists and psychotherapists (Hayes, 1981; Kazdin, 2019; Vlaeyen et al., 2020) complicates the transfer to routine clinical care. Hence, specific approaches for the application of SCED in research and practice have to be proposed and evaluated with regard to their feasibility and acceptability for practitioners as well as individuals with lived experience in order to generate gold standards for future research.

**Aim of the thesis**

This dissertation aims to develop and preliminarily evaluate a Process-Oriented, Individualised, Network-based Therapy for Chronic Pain (POINT Pain) as an integrated treatment approach. Specifically, the aims of this thesis are threefold: firstly, the longitudinal assessment of clinically relevant processes using EMA should be facilitated. Secondly, personalised treatment recommendations should be derived on the target-level. Finally, the feasibility and acceptability of the integrative framework of POINT Pain should be demonstrated. POINT Pain combines EMA, personalised treatment decisions based on person-specific networks and clinical decision-support tools, and SCED to monitor treatment progress. Both the perspectives of practitioners and individuals with lived experience of chronic pain are to be considered.

The proposed methods entail procedures that are not typical of routine clinical care and may impose additional demands on both patients and clinicians. These include repeated assessments, the regular review and interpretation of incoming person-specific data and novel statistical models such as networks, and the use of assessment software. Prior to addressing methodological refinements or testing clinical effectiveness, it is therefore essential to establish whether such an approach is feasible and acceptable in practice.

Without sufficient feasibility, even a theoretically compelling intervention is unlikely to be implemented in routine care.

To this end, an item set was developed to assess key psychological processes of chronic pain using EMA. The item set was subsequently validated and psychometrically evaluated. Chapter 2 presents two preprints detailing the development, validation procedures, and psychometric findings. The manuscript on the validation has been submitted for publication in *The Journal of Pain.* The manuscript on the psychometric evaluation has been submitted for publication in the *European Journal of Pain* and has undergone a Major Review*.*

Building on the assessment of chronic pain-related processes, the next step involved deriving specific treatment recommendations. Based on the newly developed item set, a matching matrix was constructed in close collaboration with expert clinicians and psychological pain researchers to inform personalised treatment decisions. Chapter 3 includes a preprint detailing the development procedure and resulting structure of the matching matrix. The manuscript has been submitted for publication in *Cognitive Therapy and Research.*

In a proof-of-principle study, the integrated application of the developed item set and matching matrix within the POINT Pain framework was evaluated. Chapter 4 presents the detailed study protocol for this proof-of-principle investigation, which has been published open-access in *BMJ Open.*

Finally, Chapter 5 summarises the findings of the feasibility and acceptability evaluation of the POINT Pain proof-of-principle study. These results are based on qualitative interviews conducted with participating practitioners and participants seeking psychotherapeutic treatment for chronic pain. The corresponding manuscript, to which I contributed as a co-author, has been submitted for publication in *Journal of Consulting and Clinical Psychology*.

# Chapter 2: Assessing psychological chronic pain processes

Please note that all appendices are provided digitally for the printed hardcover versions of this dissertation.

## ProCEss Validation

Hofmann, V. E., Glombiewski, J. A., Prasch, M. F., & Scholten, S. (preprint). *Assessing chronic pain processes longitudinally: Validation of the German "Assessing Chronic Pain Processes" (ProCEss) item set.* PsyArXiv. https://doi.org/10.31234/osf.io/ruhdf_v3

### *Abstract*

Ecological Momentary Assessment (EMA) has become increasingly feasible with technological advances, capturing dynamic fluctuations in symptoms and processes. EMA is ecologically valid and can reduce recall biases. However, there is a lack of thoroughly validated items.

Therefore, the "Prozesse Chronischer Schmerzen ErfaSSen" (ProCEss; engl. „Assessing Chronic Pain Processes") item set was developed for an EMA coverage model, i.e. a broad range of the day shall be captured instead of single momentary experiences. In multiple studies, practitioners ($n$ = 18 + $n$ = 12) and affected persons ($n$ = 12 + $n$ = 12) contributed to establishing content validity through an adapted Discriminant Content Validity Method and Cognitive Interviews. Findings from these studies informed the development of written and audio-visual comprehensibility aids, designed and evaluated in a healthy sample ($n$ = 128) to replace extensive participant instruction procedures.

Across studies, both affected persons and practitioners rated the items positively with regard to comprehensibility and relevance. Feedback of affected persons contributed to item refinement, and the item set was reduced from 29 to 25 items. The evaluation of the comprehensibility aids further supported the comprehensibility of the item set in general.

The ProCEss item set is among the first validated instruments for assessing chronic pain processes using EMA in German. The current study supports its relevance and

comprehensibility. Other forms of validity have to be established in future research, and comprehensiveness might be enhanced by future extensions of the item set.

### *Introduction*

Chronic pain manifests in diverse clinical profiles, making it a multifaceted condition necessitating multimodal therapeutic strategies (Breivik et al., 2006; S. P. Cohen et al., 2021; Sundström et al., 2025). As the therapeutic benefits of Cognitive Behaviour Therapy (CBT) have plateaued at moderate effect sizes (McCracken, 2023; A. C. de C. Williams et al., 2020), the call for process-based and personalised treatment approaches is growing (McCracken, 2020, 2023; Scholten, Herzog, et al., 2025; Scholten & Glombiewski, 2025).

A major challenge lies in identifying therapy-relevant processes. Despite features often attributed to processes – such as theory-based, goal-directed, and progressive (Hofmann & Hayes, 2019) – the precise nature of what constitutes a process remains unclear. For instance, several psychological models have been proposed to explain the onset and maintenance of chronic pain. The fear-avoidance model, for example, posits that fear of bodily harm promotes avoidance behaviours, which in turn contribute to physical deconditioning and increased vulnerability to pain (Vlaeyen et al., 2016). Within this framework, however, it remains ambiguous whether fear and avoidance themselves represent processes, or whether the process is better conceptualised as the association between them. Until specific processes are clearly delineated, the assessment of elements derived from psychological models appears to be a promising step towards a process-oriented approach (Scholten & Glombiewski, 2025).

Given that processes are understood to be non-linear (Hayes et al., 2019; McCracken, 2023) and subject to change over time (*Oxford Advanced Learner's Dictionary at OxfordLearnersDictionaries.Com*, n.d.), their repeated and longitudinal assessment appears essential. Repeated assessments, for instance through Ecological Momentary Assessment (EMA), offer the opportunity to capture dynamic fluctuations in processes while mitigating recall bias and yielding ecologically valid data directly from daily life (May et al., 2018). With the widespread availability of technological devices and user-friendly

applications, the implementation of EMA has become increasingly feasible. Nonetheless, psychometrically validated questionnaires remain scarce, despite existing recommendations on the development and application of EMA instruments (e. g. Eisele et al., 2021). One positive example is the Momentary Pain Catastrophizing Scale (Frumkin et al., 2023). In the German language, thoroughly validated items for the longitudinal assessment of chronic pain processes are currently lacking.

Establishing the validity of newly developed items constitutes an essential first step, particularly in EMA research, where such items are frequently employed as outcome measures (Schemer et al., 2023). According to Boateng and colleagues (2018), content validity testing represents the immediate step following item development. Content validity refers to the extent to which an assessment adequately captures the construct in its entirety and should be established prior to the application of any questionnaire (Johnston et al., 2014; Mokkink et al., 2025). The renowned COSMIN guidelines further distinguish between the relevance, comprehensiveness, i.e. whether all relevant facets of a given process are reflected by the instrument, and comprehensibility of a new scale (Mokkink et al., 2025). Qualitative approaches for the validation of EMA questionnaires are generally recommended (Mokkink et al., 2025; Schorrlepp et al., 2025), for example focus groups or cognitive interviews. For a robust evaluation of relevance, comprehensiveness, and comprehensibility, both experts in the field as well as affected people of the target population should be involved in the validation procedure (Mokkink et al., 2025).

The aim of this study was to develop and validate a German-language item set developed to longitudinally set a broad range of psychological processes relevant for chronic pain. Thereby, personalisation of process-orientation of CBT for chronic pain should be facilitated by enabling the longitudinal assessment of chronic pain processes with an instrument of established psychometric quality.

### *Methods*

The present study focuses on the validation of the item set named *Prozesse Chronischer Schmerzen ErfaSSen* (ProCEss; English translation: assessing chronic pain processes). The

evaluation procedure was preregistered (https://doi.org/10.17605/OSF.IO/9TUQR) and has been approved by the university's local ethics committee (#LEK-501).

The validation of the ProCEss item set was conducted in four successive studies. In the first study, the initial version of the item set was evaluated by practitioners (Hofmann et al., 2023a), focussing on the comprehensiveness and relevance of the items.

In a second study, think-aloud and verbal probing were combined in a cognitive interview study to evaluate comprehensibility as well as comprehensiveness by people with chronic pain (Hofmann et al., 2023b).

Findings from these studies informed a revision of the item set that was re-evaluated by samples of practitioners and people with chronic pain in a third study (Hofmann et al., 2025b), with practitioners focussing on the relevance and comprehensiveness and people with chronic pain on the comprehensiveness of the revised items.

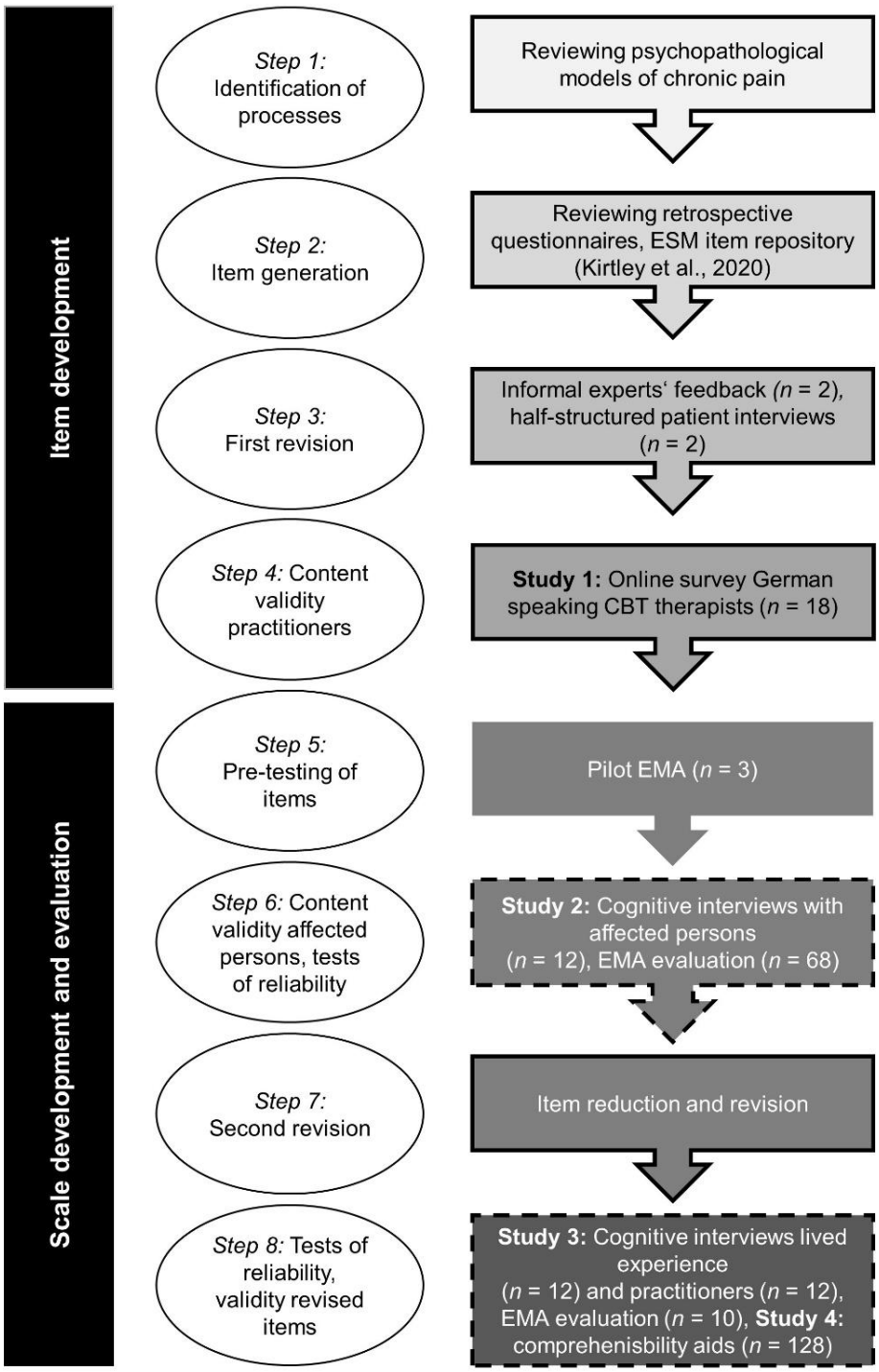
A fourth study was conducted to develop and evaluate written and audio-visual aids to facilitate a shared understanding of the item set (Hofmann et al., 2025a). The utility of both types of aids was pilot tested in an online survey, which received separate approval from the university's local ethics committee (#LEK-591). This study also assessed the comprehensibility of the item set.

An overview of the entire evaluation procedure based on Boateng and colleagues (2018) – from validation to psychometric testing – is provided in Figure 1. The results of the psychometric evaluation are currently available as a preprint: https://doi.org/10.31234/osf.io/pkwxy_v2

**Figure 3**

*Development process of the "Prozesse Chronischer Schmerzen ErfaSSen" (ProCEss) item set*

A




*Note.* Bordered components are reported in the present publication; for dashed components, only qualitative data is reported in the present publication.

**Initial item development.** Established psychological models of chronic pain were reviewed to identify key psychological processes in chronic pain (see Figure 3, Step 1). Additionally, IMMPACT recommendations (Dworkin et al., 2005) as well as resource-oriented processes were taken into account. Consequently, the ProCEss item set includes both theory-based processes derived from psychological models as well as outcome measures. An exact distinction between process and outcome extends beyond the scope of this publication, which is why we refer to “processes” with respect to all items in the ProCEss item set. We do, however, acknowledge the relevance of such a distinction for future research.

All derived processes were subsequently defined based on existing definitions and a lexical approach (definitions are available at the ProCEss repository: https://rptu.de/s/vpcgks). Hence, existing retrospective questionnaires and the ESM Item Repository (Kirtley et al., 2018) were reviewed for suitable items (see Figure 3, Step 2). An overview of all used questionnaires is provided in the supplementary materials (Appendix A1). On this basis, an initial set of items was developed, supplemented with original items when needed. It was refined through consultation with two experienced pain researchers/CBT therapists and two women in psychotherapeutic treatment for chronic pain (see Figure 3, Step 3).

The initial ProCEss item set included 29 items that were assumed to assess the following pain processes: catastrophising (Crombez et al., 2020), avoidance behaviour (Vlaeyen et al., 2016), depressive symptoms (Hasenbring et al., 2009), thought suppression, task persistence, positive affect, acceptance (McCracken & Morley, 2014), values-based behaviour, expectations (Wiech, 2016), pain-related self-efficacy (Nicholas, 2007), sleep disturbances (Cole et al., 2007), self-compassion (Neff, 2003), pain intensity (Dworkin et al., 2005), and pain-related disability. A summary of the complete item development process is provided in the supplemental materials (Appendix A1).

The item set was developed for an EMA coverage model to capture a broad range of experiences (May et al., 2018). The ProCEss item set is assessed on an 11-point scale

(0 = does not apply at all, 10 = completely applies) that is considered intuitively comprehensible and approaches interval scaling (Wu & Leung, 2017).

**Study 1: Practitioners' content validation.** For an initial assessment of the items' relevance and comprehensiveness (see Figure 3, Step 4), CBT therapists practising psychotherapy in Germany were recruited via e-mail. Participants without any treatment experience in chronic pain were excluded. All participating therapists received written information about the study via the online survey and provided informed consent prior to data collection.

***Procedure.*** In an online survey administered via SoSci Survey (Leiner, 2024), therapists were sequentially presented with the 29 items of the initial ProCEss item set, each accompanied by a definition of the corresponding process. The procedure was generally based on the Discriminant Content Validity Method (Johnston et al., 2014), who recommend a sample size of $n$ = 15 to establish a large effect of content validity with this method.

Content validity of each item was first assessed on an 11-point scale (0 = does not capture the construct at all, 10 = captures the construct perfectly), alongside a confidence rating on a separate 11-point scale (0 = completely uncertain, 10 = completely certain). The rating was later simplified, using a dichotomous response as originally proposed by (Johnston et al., 2014) (0 = validity not given, 1 = validity given), together with the same 11-point confidence scale. Furthermore, participants rated the clinical utility of each item on an 11-point scale (0 = not useful at all, 10 = highly useful) as a measure of relevance. A mean rating of > 6 was considered high clinical utility.

***Data Analysis.*** For continuous ratings (11-point scale), scores greater than 0 were multiplied with the corresponding confidence rating and then divided by 10. In cases where content validity was rated as 0 (i.e. validity not given), the associated confidence rating was multiplied by -1 both for the continuous and dichotomous ratings. If in the dichotomous ratings content validity was rated as given, the confidence score remained unchanged. This procedure yielded a combined validity-confidence score ranging from -10 to +10 for both response formats.

Validity of normally distributed items was tested using a one-sample t-test with Bonferroni correction, testing the one-tailed alternative hypothesis of $M > 0$ (i.e. content validity given). Items that were not normally distributed were analysed using a one-sample Wilcoxon signed-rank test, with the alternative hypothesis set at $\mu > 0$.
Content validity was assumed if the test statistic was significant ($p < |.05|$) and positive and was assumed not given if the test statistic was significant and negative. For non-significant results ($p > |.05|$), it was concluded that the sample was too uncertain to determine content validity (Johnston et al., 2014).

Analyses were performed in RStudio (R version 4.5.1) (Posit Team, 2024), using the packages broom (Robinson et al., 2025), DescTools (Signorell et al., 2022), irr (Gamer et al., 2019), openxlsx (Schauberger et al., 2025), psych (Revelle, 2025), rcompanion (Mangiafico, 2025), and tidyverse (Wickham et al., 2019).

**Study 2: Affected persons' content validation.** A total of 12 cognitive interviews (60-120 minutes) (Beatty & Willis, 2007) were conducted in order to obtain detailed insights in the answering process of the item set as well as regarding the comprehensibility of each item (see Figure 3, Step 6). A sample size of $n = 12$ was considered appropriate to achieve data saturation (Guest et al., 2006). Inclusion criteria were sufficient German proficiency as assessed by the female interviewer (MFP; undergraduate psychology student at the time of the study), and experiencing chronic pain for at least six months (excluding headache or migraine; self-report). Exclusion criteria were acute states of psychosis, suicidality, substance abuse, or other circumstances that could hinder the interview process (e.g. severe concentration problems) as assessed by the interviewer. Recruitment took place in local clinical settings, including inpatient clinics, day clinics, and outpatient clinics. Participants were approached face-to-face. All participants received written and verbal study information and provided informed consent.

***Procedure.*** Guided by recommendations from recent validation studies (Boesen et al., 2018; Brod et al., 2023; Luckett et al., 2022; Peterson et al., 2017; Ryan et al., 2012; Van Stiphout et al., 2022; Willis, 2005) a combined think-aloud (TA) and verbal probing (VP)

approach was adopted. TA enabled the spontaneous articulation of thoughts during item completion, while VP supported clarification when participants experienced difficulties or required prompting.

Prior to each interview, participants performed a brief TA practice task to ensure comprehension and sufficient concentration. Participants were instructed to evaluate the 29 items based on chronic pain–related experiences within the preceding two hours to approximate the real-time conditions of EMA assessment. To minimise retrospective bias in cases where no recent pain-related disability had occurred, two predefined anchor situations involving pain were provided as reference points (Van Den Bergh & Walentynowicz, 2016).

The selection of both general and spontaneous probes was guided by the cognitive response process (Willis, 2005). Specifically, the probe: *"Please repeat the statement [item] in your own words"* targeted item comprehension, while the probe *"Was it easy or difficult to respond?"* addressed retrieval and potential interpretation difficulties (Tourangeau, 2018). Optional probes (e.g., *"What does the phrase/word '…' mean to you?"*) were employed to gain further insight into item interpretation when needed.

In addition, participants were asked whether they considered each item consistent with the underlying process definition. This reflects an assessment of comprehensiveness. To support comprehensibility, the researcher provided reformulated process definitions in simplified language (available at the ProCEss repository: https://rptu.de/s/vpcgks). The probes are provided in the supplemental materials (Appendix A2).

All participants were informed about the affiliation of the interviewer who had no relationship to any participant prior to study commencement. The interviews took place in rooms of the respective clinic with only the interviewer and participant present. They were audio-recorded.

***Data Analysis.*** In a first step, all interviews were transcribed using an automatic transcription software program (dr. dresing & pehl GmbH, 2020). The transcripts were not returned to the participants. Subsequent analyses were organised and conducted in Microsoft Excel (*Excel*, 2025).

Subsequently, the transcripts were screened for content-relevant statements, which were identified as item-specific meaning units (“chunks”). These "chunks" were reduced into short paraphrases that retained the central meaning without losing any content by two researchers (MFP, VEH). Both sets of paraphrases were merged and overlapping or redundant paraphrases were removed. Particular attention was given to the paraphrased parts of the general probe: *“Please repeat the statement [item] in your own words”*, as this allowed checking whether people suffering from chronic pain understood and interpreted the item as intended. No additional codebook was created since the allocation of constructs was based on existing construct definitions.

Third, a total of 415 paraphrases underwent randomisation for the subsequent rating process to minimise order effects. The material was divided into three equal segments, resulting in three rating rounds in which the raters allocated each paraphrase to one process of the item set. After each round, interrater reliability was calculated using Cohen’s Kappa (Gwet, 2014), and the researchers refined their rating rules. In each round, the previously rated material was re-rated again.

Additionally, an exploratory analysis was conducted to identify problems in the cognitive response process, i.e. comprehensibility. Identified problems were categorised according to the following criteria: *comprehension*, *question interpretation*, *response interpretation,* and *meaningfulness* (Biernesser et al., 2022).

**Study 3: practitioners‘ and individuals with lived experience’s re-validation.** The first round of cognitive interviews led to the revision of 12 items and the addition of two new items, resulting in a total of 14 items requiring re-evaluation (see Figure 3, Step 7).

For this purpose, *n* = 12 CBT therapists and therapists in training were recruited from local clinics (see Figure 3, Step 8) using flyers, e-mail, or face-to-face approaching for another round of cognitive interviews. In addition, another *n* = 12 individuals with lived experience in chronic pain were interviewed. Inclusion and exclusion criteria were the same as in the first cognitive interview study with people suffering from chronic pain. All

participants received written study information and provided informed consent prior to data collection.

***Procedure.*** All participants received verbal as well as written information on the aim of the study and the affiliation of the interviewers. Interviews took place in practice rooms of the participating psychotherapists, rooms of the respective clinic, or online via Zoom (www.zoom.us). Only the participant and interviewer were present in each interview.

In the therapist interviews, both comprehensiveness and relevance were the primary outcomes of interest. Accordingly, probes were designed to elicit information on comprehensiveness *("Which constructs do you think are assessed with this item?")* and clinical utility *("What therapeutic information does this item convey?")*. In addition, therapists were provided with the construct definitions in professional terminology (available at the ProCEss repository: https://rptu.de/s/vpcgks) and asked to indicate whether each item corresponded to its respective definition (i.e. comprehensiveness). They also rated the clinical utility of each item on an 11-point scale (0 = not at all useful, 10 = highly useful). The probes of the experts' interviews are provided in the supplementary materials (Appendix A3).

The cognitive interviews with psychotherapists were conducted by a female undergraduate psychology student.

The procedure for the participants with lived experience interviews followed the same structure as the previously described cognitive interviews. The cognitive interviews were conducted by a male undergraduate psychology student. The sample constituted a convenience sample.

***Data Analysis.*** Descriptive analyses focusing on the evaluation of fit between each item and its process definition as well as clinical utility as assessed by the practitioners will be reported here. The interviews were conducted, transcribed supported by software (*Amberscript*, 2025; *MacWhisper Mac App | MacTools*, n.d.; *TurboScribe*, n.d.), and prepared by the interviewing undergraduate psychology students. The transcripts were not returned to the participants.

**Study 4: Development and evaluation of written and audio-visual aids.** To enhance the comprehensibility of the item set in an economical manner, written and audio-visual comprehension aids were developed based on the construct definitions in simplified language and people suffering from chronic pain's formulations derived from the first cognitive interview study. The written aids in original German language as well as a preliminary English translation are provided at the ProCEss repository (https://rptu.de/s/vpcgks)**,** while the audio-visual aids are available from the authors upon reasonable request.

***Procedure.*** The study employed a randomised crossover design in a healthy, German-speaking sample. Exclusion criteria were based on age and German language proficiency, excluding individuals younger than 18 years and those with insufficient German skills. Insufficient proficiency was operationalised as scores of $\geq 4$ (i.e., "poor" or "very poor" on a 5-point scale).

All participants were presented with each item set version (i.e., without aids, written aids, audio-visual aids), however the presentation order was randomised to control for order effects. All participants received written study information and provided informed consent within the online survey prior to data collection. The survey was administered using SoSci Survey (Leiner, 2024).

Besides further measures for each item beyond the scope of this publication, overall comprehensibility was assessed once after each completed item set version with the item "How understandable did you find the item set?" (0 = not understandable, 10 = very easily understandable) (Schweizerische Gesellschaft Zum Studium Des Schmerzes, 2025).
The required sample size was determined using GPower (Faul et al., 2007). Assuming a small effect size (f = 0.10) regarding differences in comprehensibility between either of the two aid types and the item set without aids, a total sample of $n$ = 163 was required to achieve a significance level of $\alpha = .05$ and a statistical power of 80 %.

***Data Analysis.*** Data analyses were performed in RStudio (R version 4.5.1) (Posit Team, 2024), using the packages dplyr (Wickham et al., 2023), ez (Lawrence, 2016), ggplot2

(Wickham, Chang, et al., 2025), openxlsx (Schauberger et al., 2025), tidyverse (Wickham et al., 2019), and tidyr (Wickham, Vaughan, et al., 2025).

*N* = 10 outliers and *n* = 2 participants with incomplete data were excluded from the analysis. Since repeated-measure ANOVAs are deemed robust against the violation of normal distribution (Berkovits et al., 2000; Vasey & Thayer, 1987) and sphericity was given according to a Mauchly test, a repeated-measures ANOVA was applied to analyse differences in comprehensibility between the item set versions (no aid, written aid, audio-visual aid).

**Sustainability and Dissemination.** The ProCEss item set represents one of the first instruments designed to assess multiple psychological processes in chronic pain longitudinally. To facilitate dissemination and uptake research and clinical contexts, the items will be made publicly available via the ESM item repository (Kirtley et al., 2018) following publication of the evaluation studies. In addition, they will be hosted in a second, item set-specific repository, where updates (e.g. translations or extensions) will be documented (https://rptu.de/s/vpcgks). Researchers are encouraged to contribute validation and translation efforts to support cumulative development.

### *Results*

**Participants.** The sociodemographic information of all four samples is summarised in Table 1.

**Table 1**

*Sociodemographic information of all samples*

| | **Practitioners' content validation** | **Affected persons' content validation** | **Lived experience re-validation** | **Practitioners' re-validation** | **Aid evaluation** |
|---|---|---|---|---|---|
| **Sample size** | ***N* = 18** | ***N* = 12** | ***N* = 12** | ***N* = 12** | ***N* = 128** |
| **Gender** | 16 female,<br>2 male | 9 female,<br>3 male | 7 female,<br>5 male | 7 female,<br>5 male | 94 female,<br>33 male,<br>1 diverse |
| **Age (years)** | *M* = 40.06<br>(*SD* = 12.36) | *M* = 45.17<br>(*SD* = 14.20) | *M* = 27<br>(*SD* = 9.29) | *M* = 32.67<br>(*SD* = 3.47) | *M* = 26.72<br>(*SD* = 10.61) |
| **Professional experience (years)** | *M* = 10.89<br>(*SD* = 6.88) | N.a. | N.a. | *M* = 4.71<br>(*SD* = 3.27) | N.a. |
| **Number of treated chronic pain patients** | ≥ 10: *n* = 10<br>7-9: *n* = 3<br>4-6: *n* = 4<br>1-3: *n* = 1 | N.a. | N.a. | N.a. | N.a. |
| **Number of students** | N.a. | N.a. | *N* = 8<br>students | N.a. | *n* = 105<br>students |
| **Licensed psycho-therapist** | N.a. | N.a. | N.a. | *N* = 7 yes<br>*N* = 5 no | N.a. |
| **Pain duration (years)** | N.a. | N.a. | *M* = 7.78<br>(*SD* = 7.14) | N.a. | N.a. |

*Note.* N.a. = "not available" means that this data has not been assessed for this sample.

**Study 1: Practitioners' content validation.** Overall, three items ("I thought I cannot stand it any longer" – catastrophising, "I tried not to think about my pain" – thought suppression, "I was tired" – sleep disturbances) yielded non-significant test-results ($p > .05$), indicating that the sample was too uncertain to determine the comprehensiveness of these items. All other 26 items displayed a positive and significant test statistic, supporting the content validity of these items. A detailed summary of all test results, including descriptive

statistics of the continuous validity rating, is provided in the openly available data repository (https://doi.org/10.17605/OSF.IO/YRVCU).

Deviating from the preregistration, Fleiss' Kappa is not reported due to insufficient variability in the data.

With regard to the perceived clinical utility of the items, mean ratings ranged from *M* = 6.00 (*SD* = 2.77) for the item "I was tired" (sleep disturbance) to *M* = 8.78 (*SD* = 1.96) for the item "How much did you feel disabled due to your pain?" (disability). Accordingly, all items except for "I was tired" were judged to possess high clinical utility. The clinical utility of the final item versions is summarised in Table 2.

**Study 2: Affected persons' content validation.** For the main analysis, paraphrases to the verbal probe: "Please repeat the statement in your own words" were assigned to the processes included in the ProCEss item set according to their definition by two independent raters (MFP, VEH) over three rounds. The interrater reliability displayed values of $\kappa = .74$ in the first round, $\kappa = .69$ in the second, and $\kappa = .71$ in the final round. These results can be considered sufficient (Landis & Koch, 1977).

In the last rating, overall 55.90 % of paraphrases were "correctly" assigned to the assumed underlying process by both raters. For the four processes catastrophising (41.86 %), task persistence (28.57 %), values-based behaviour (45.46 %), and pain-related self-efficacy (21.05 %) less than half of the paraphrases were "correctly" identified by both raters. A detailed overview of the rating process (in German language) is provided online (https://doi.org/10.17605/OSF.IO/YRVCU).

Regarding the direct assessment of item-process fit as another measure of comprehensiveness, participants rated 16 of the 29 items as representative of the process definition. Seven items were perceived as not fitting the provided process definition by at least two participants. More detailed results regarding the assessment of construct fit as well as participants' explanations are provided in the supplementary materials (Appendix A4).

The assessment of acceptance posed a particular challenge. Several people suffering from chronic pain argued against the definition, as illustrated by the quote: *"I don't accept the*

*pain; I fight against it. I do something about it".* This finding replicated the informal feedback of women in psychotherapeutic treatment for chronic pain in the development phase, in which the acceptance items were perceived as invalidating.

The item "I was tired" (sleep-disturbances) was associated with exhaustion, one participant even associated it with *"I am tired of life"* which reflects a closeness to passive suicidal thoughts and thus rather a depressive symptom. Again, this observation supported the uncertainty of the practitioners regarding the comprehensiveness of the item "I was tired".

One participant drew attention to the Likert scale, noting that the 0–10 range seemed excessive and that fewer response options would make decisions easier. Especially the avoidance items were interpreted in a dichotomous manner, prompting a revision of these items.

When summarising the criterion of meaningfulness, people suffering from chronic pain demonstrated strong agreement with items assessing catastrophising, depressive symptoms, thought suppression, positive affect, acceptance, and self-compassion, as these items closely reflected their everyday experiences.

**Study 3: Practitioners' and individuals with lived experience's content re-validation.** ***Practitioners.*** When presented the process definition along with the item, practitioners generally rated the fit positively. The least agreement was observed for the item: "I pulled through despite my pain" (task persistence), where seven out of twelve practitioners rated the fit and thus, comprehensiveness as given. Other constructs practitioners associated with this item were resilience, self-efficacy, or self-compassion. Another ambiguous item was: "I was exhausted" (depressive symptoms) that was rated as fitting the according process definition by eight practitioners. Other processes mentioned in this context were avoidance, negative affect, and fatigue. Nevertheless, most practitioners rated the item-process fit of both items positively.

On average, the clinical utility as an indicator of relevance of each item reached the criterion of > 6 on an 11-point scale. Clinical utility ranged between $M$ = 6.33 ($sd$ = 2.57) for the item: "I pulled through despite my pain" (task persistence) and $M$ = 9.36 ($sd$ = 0.79) for

the item: “I trusted myself to be able to do something even though I was in pain” (self-efficacy). Clinical utility of the final item versions is summarised in Table 2.

***Individuals with lived experience.*** Individuals with lived experience in chronic pain rated the item-process-fit as an indicator of comprehensiveness of most items positively. For the three avoidance items (e.g. “I avoided activities that cause pain”), “I was ashamed” (negative affect), and “I pulled through despite my pain” (task persistence), fit was rated positively by all participants. Two participants rated the item “I have told myself that I am not alone with my problems” (self-compassion) as not fitting its process definition. One participant explained: *“This question represents an outwards perspective, but with self-compassion it’s more about how one is treating oneself.”* Overall, most individuals with lived experience rated the content validity of this item positively.

**Study 4: Development and evaluation of written and audio-visual aids.** The general comprehensibility of all three item set versions displayed similar results: On average, the original version without aids was rated with $M$ = 8.89 ($SD$ = 1.63), the version with written aids $M$ = 8.83 ($SD$ = 1.62), and the version with audio-visual aids $M$ = 8.80 ($SD$ = 1.62). Accordingly, the omnibus test revealed no significant differences between either of the three conditions ($F\ (2,250) = .077,\ p = .926,\ \eta^2p = .001$). The detailed results including the assumptions of the repeated-measures ANOVA are provided online (https://doi.org/10.17605/OSF.IO/YRVCU).

**Final item set.** Table 2 summarises the final ProCEss item set in its validated German version as well as a preliminary English translation along with the clinical utility ratings of the practitioners from studies 1 and 3. Please note that all results are only valid for the German version.

**Table 2**

*ProCEss item set final version and relevance*

| **Validated item version** | **Preliminary English translation** | **Relevance (scale: 0-10) *M (SD)*** |
|---|---|---|
| **Katastrophisieren (Catastrophising)** | | |
| Ich habe gedacht: „Es wird nie mehr besser!“ | I thought: „It will never get better!” | n.a. |
| Ich habe gedacht: “Ich halte es nicht mehr aus!“ | I thought: „I can‘t stand it any longer!” | 7.55 (2.22) |
| **Vermeidung (Avoidance)** | | |
| Ich habe Aktivitäten wegen meiner Schmerzen abgebrochen. | I stopped activities because of my pain. | 8.64 (1.23) |
| Ich habe anstrengende Tätigkeiten wegen meiner Schmerzen an jemand anderen abgegeben. | Due to my pain I asked others to do strenuous activities for me. | 8.64 (1.23) |
| Ich habe Aktivitäten, die Schmerzen hervorrufen, vermieden. | I avoided activities that cause pain. | 8.64 (1.23) |
| **Depressive Symptome (Depressive Symptoms)** | | |
| Ich war gereizt. | I felt irritable. | 8.33 (1.65) |
| Ich habe mich schuldig gefühlt | I felt guilty. | 7.61 (2.36) |
| Ich habe mich traurig gefühlt. | I felt sad. | 8.72 (1.57) |
| Ich habe mich antriebslos gefühlt. | I felt listless. | 8.55 (1.00) |
| Ich war erschöpft. | I was exhausted. | 6.45 (1.87) |
| **Akzeptanz (Acceptance)** | | |
| Ich habe versucht, mich mit meinen Schmerzen anzufreunden. | I tried to befriend my pain. | 6.91 (2.16) |
| Ich konnte annehmen, dass der Schmerz mein Leben begleiten wird. | I was able to accept that the pain would accompany my life.* | 8.25 (2.01) |
| **Werteorientiertes Handeln (Values-based behaviour)** | | |
| Ich habe versucht, den Dingen, die mir wirklich wichtig sind [Beispiele], Vorrang zu geben. | I tried to prioritise those things really important to me [examples]. | 8.61 (1.24) |

| **Validated item version** | **Preliminary English translation** | **Relevance (scale: 0-10) *M (SD)*** |
|---|---|---|
| **Erwartung (Expectation)** | | |
| Ich gehe davon aus, dass meine Schmerzen bis zur nächsten Befragung zunehmen. | I assume that my pain will increase until the next survey. | 8.36 (1.51) |
| **Gedankenunterdrückung (Thought Suppression)** | | |
| Ich habe gedacht: „Reiß‘ dich zusammen!“/“Stell‘ dich nicht so an!“ | I thought: „Pull yourself together!”/”Don’t make such a fuss!” | n.a. |
| Ich habe versucht, meine Schmerzen nicht zu beachten. | I tried not to think about my pain. | 8.11 (1.49) |
| **Aufgabenausdauer (Task Persistence)** | | |
| Ich habe trotz meiner Schmerzen durchgezogen. | I pulled through despite my pain. | 6.33 (2.57) |
| **Positiver Affekt (Positive Affect)** | | |
| Ich war trotz meiner Schmerzen gut gelaunt. | I felt cheerful despite my pain. | n.a. |
| **Selbstwirksamkeit (Self-Efficacy)** | | |
| Ich habe mir zugetraut, etwas erledigen zu können, obwohl ich Schmerzen habe. | I trusted myself to be able to do something even though I was in pain. | 9.36 (0.79) |
| Ich war sicher, mein Leben zufriedenstellend führen zu können, obwohl ich Schmerzen habe. | I was sure that I could live my life satisfactorily, even though I was in pain. | 7.60 (2.52) |
| **Selbstmitgefühl (Self-Compassion)** | | |
| Ich habe versucht, freundlich mit mir umzugehen. | I tried to be friendly to myself. | 9.00 (1.24) |
| Ich habe mir gesagt, dass ich mit meinen Problemen nicht allein bin. | I told myself that I am not alone with my problems. | 7.09 (2.00) |
| **Negativer Affekt (Negative Affect)** | | |
| Ich habe mich geschämt. | I felt ashamed. | 8.18 (2.35) |
| **Schmerzintensität (Pain Intensity) (0 = no pain, 10 = maximum pain)** | | |
| Wie stark waren Ihre Schmerzen im Durchschnitt? | How strong was your pain on average? | 7.61 (3.17) |

| Validated item version | Preliminary English translation | Relevance (scale: 0-10) *M (SD)* |
|---|---|---|
| **Beeinträchtigung (Disability) (0 = not at all, 10 = very much)** | | |
| Wie sehr haben Sie sich durch Ihre Schmerzen beeinträchtigt gefühlt? | How much did you feel disabled because of your pain? | 8.78 (1.96) |

*Note.* Relevance ratings are from practitioners of the online survey and practitioners of the second cognitive interview study for revised items, respectively; n.a. = not available because item was not included in practitioner survey nor cognitive interviews; the [examples] of the values item indicate the option to personalise the item with individual examples. *Please note that all English translations are preliminary, and the German version of the Acceptance item does not include the verb “accept” (“akzeptieren”).

***Discussion***

In the present study, the ProCEss item set – developed for a coverage model in EMA – was validated in a multi-step process with respect to comprehensiveness, comprehensibility, and relevance. The relevance of the items was rated high by practitioners, as was comprehensibility in a healthy sample. Regarding comprehensiveness, both practitioners and people with chronic pain rated the fit between the items and their corresponding processes positively.

Suggestions of people with chronic pain informed revisions to the item set as well as the accompanying comprehensibility aids. Additionally, the item set was reduced from 29 to 25 items, thereby decreasing the assessment burden for future participants.

Feedback of participants with chronic pain in the cognitive interviews was highly positive. They described the item set as useful, easy to understand, and closely related to their everyday life. As one participant stated: *“The questions are very comprehensive; there’s something in them for everyone. They also make you think and encourage reflection”.*

At the same time, the cognitive interviews indicated that some people with chronic pain and practitioners interpret certain items differently from the original process definition. This highlights that while the items assess the processes intended, they are not necessarily distinguishing well between processes. Other forms of validity such as discriminant validity

have to be evaluated in future research. This includes research on shifts in item understanding, since comprehension can vary over the course of repeated measures (Palmier-Claus et al., 2011; Schorrlepp et al., 2025). Presently, we recommend the use of the comprehensibility aids to support a shared understanding of the items.

Regarding relevance, the practitioners rated the items positively, as reflected both in the initial validation and the subsequent cognitive interviews. Along with the overall positive feedback of people with chronic pain, the ProCEss item set promises to be a useful tool for both research and clinical practice. The authors attribute this to the fact that all processes included in the item set are based on established psychological models and pain outcome recommendations as well as the combination of burdensome and positive items.

**The challenge of assessing acceptance and context.** A particular challenge presents the valid assessment of acceptance. As Gibby and colleauges (2022) described, acceptance is usually regarded a positive state in psychotherapy, while for people with chronic pain it could also mean resignation or “giving up”. In the present cognitive interview studies, some people with chronic pain seemed angry at the suggestion of accepting their pain, indicating a risk of reactance in response to the items. In other questionnaires like the Pain Solutions Questionnaire (Sielski et al., 2017), acceptance items are often inverted to assess “non-acceptance”. This might better meet people with chronic pain where they are, especially those without prior psychotherapy experience, and reduce reactance or invalidation. However, to reduce the burden in EMA studies it is recommended to use consistent scales (Eisele et al., 2021), which is why the ProCEss item set does not contain any inverted items. Future research should further investigate suitable formulations and involve people with chronic pain more closely in the item development process.

An alternative approach would be the inclusion of idiographic items to complement the item set and tailor it more to individual people with chronic pain (Cooper & Xu, 2023; Sales et al., 2023). This strategy could also help to address the challenge of developing acceptance items that are both valid and non-invalidating for people suffering from chronic pain. Currently, only the values-based behaviour item (“I tried to prioritise things really

important to me") can be personalised with individual examples. Catastrophising and pain-suppressive thoughts present another opportunity for idiographic items, as one practitioner mentioned: *"Measuring catastrophising thoughts seems somehow difficult to me, because not everyone has the same thought."*

Idiographic items might also present a promising option to assess context variables (von Klipstein et al., 2025), for which there is currently no gold-standard. Context variables are currently not included in the ProCEss item set as to include them would have significantly extended its length.

**Strengths and Limitations.** The validation of the ProCEss item set adhered to current recommendations for validating newly developed EMA assessment tools (Schorrlepp et al., 2025). To our knowledge, it represents the first thoroughly validated instrument for assessing a variety of psychological chronic pain processes in a coverage EMA model in German. Qualitative data was analysed by two researchers to reduce the risk of bias during the analysis process. By involving multiple stakeholders in the development process – most importantly people with chronic pain themselves – it was ensured that the items are clearly and mutually understood by all relevant parties in both research and clinical contexts. The predominantly positive feedback from people with chronic pain, together with the high ratings of clinical utility for each item, further support the quality and relevance of the item set. The provision of comprehensibility aids allows for the avoidance of extensive participant instruction procedures while still ensuring a shared understanding of the item set.

From a methodological perspective, the results of the first practitioner validation should be interpreted with caution due to the different rating scales applied. Nevertheless, this limitation may be mitigated by the subsequent cognitive interviews, which produced results consistent with the initial practitioner validation. Furthermore, the results of all reported studies do not provide insight on the discriminant and other forms of validity. Comprehensiveness was assessed in the form of item-process definition-fit, that was rated positively but does not imply a full assessment of all facets of a given process. Future research is needed to investigate the discriminant validity, emphasised by the practitioners' cognitive interviews that

revealed that multiple processes might be associated with several items. The item set should be applicable in a modular fashion so that items can be included or omitted regardless of their “scale”. Extensions of further facets, for example mindfulness regarding self-compassion ( Neff, 2003), or helplessness for catastrophising (Frumkin et al., 2023), as well as completely new processes such as hypervigilance or resting behaviour remain a task for future refinements and will be available at the item set repository (https://rptu.de/s/vpcgks). Re-labelling the included processes might highlight that not all processes are yet covered completely in the ProCEss item set (e.g. “negative appraisal” instead of “catastrophising” or “thought suppression”), presenting another issue for future refinements.

Moreover, the cognitive interviews were conducted with participants possessing high German language proficiency. The sample of individuals with lived experience in the second cognitive interview study was uncharacteristically young and highly educated, highlighting the need for further research to ensure that the item set is also valid and comprehensible for people with chronic pain with lower German proficiency or education levels. Validity can only be assumed for the chronic pain population interviewed in this study (Vogt et al., 2004).

The comprehensibility aids have thus far only been piloted in a healthy, highly educated sample. The pilot study was underpowered to detect a small effect and the aids did not appear to provide additional benefit to the already high comprehensibility of the item set, possibly due to the high education level of the sample. Future research should focus on which and for whom comprehensibiltiy aids are beneficial.

**Conclusion.** To our knowledge, the ProCEss item set represents the first thoroughly validated instrument for assessing a variety of psychological chronic pain processes using an EMA coverage model in German. It comprises 25 items assessing twelve pain-related processes derived from established psychological models (Hasenbring et al., 2009; McCracken & Morley, 2014; K. Neff, 2003; M. K. Nicholas, 2007; Vlaeyen et al., 2016; Wiech, 2016) and IMMPACT recommended pain outcomes (Dworkin et al., 2005). Four studies involving practitioners, healthy participants, and individuals with lived experience support both the relevance and comprehensibility of the item set. The fit between items and

their corresponding processes as a measure of comprehensiveness was likewise evaluated positively by all stakeholders. It can therefore be concluded that the items of the ProCEss item set do measure the intended processes and are well understood both by people suffering from chronic pain and practitioners. However, the items might not distinguish well between processes and do not yet capture all facets of the included processes. Future research should focus on establishing additional forms of validity, involving less educated participants or with less German proficiency, and on considering the inclusion of other relevant processes and process facets to further refine the item set. The findings reported in this study are only valid for the German version of the item set.

We reiterate our invitation to researchers and clinicians to apply, translate, and further evaluate the ProCEss item set, and to contribute resulting data to the ProCEss item set repository (https://rptu.de/s/vpcgks).

**ProCEss Evaluation**

Hofmann, V. E., Glombiewski, J. A., Heider, W., & Scholten, S. (preprint). *Assessing chronic pain processes longitudinally: Psychometric evaluation of the German "Assessing Chronic Pain Processes" (ProCEss) item set.* PsyArXiv. https://doi.org/10.31234/osf.io/pkwxy_v2

Please note that all appendices are provided digitally for the printed hardcover versions of this dissertation.

***Abstract***

**Background.** Ecological Momentary Assessment (EMA) is gaining relevance in contemporary pain research. However, EMA questionnaires are rarely psychometrically evaluated, potentially compromising data quality. This study aimed to develop and evaluate a German item set assessing psychological chronic pain processes for use in EMA, focusing on variability and reliability.

**Methods.** First, the item set was piloted with three people suffering from chronic pain to gather feedback on participant burden and the usability of the data. Second, an evaluation was conducted with a sample of *n* = 68 individuals with lived experience of chronic pain who completed an EMA protocol with six assessments per day over twelve days (4,236 datapoints). Third, revised parts of the item set were preliminarily evaluated in *n* = 10 people suffering from chronic pain over a 21-day EMA period with six assessments per day (1,253 datapoints). Variability was examined primarily using within-person standard deviations and response distributions. Reliability was assessed according to current recommendations for single-item measures (test-retest reliability), two-item scales (Spearman-Brown coefficient), and multi-item scales (McDonald's Omega).

**Results.** Most items and process scales met the predefined criteria for variability and reliability. However, variance was largely attributable to between-person differences. Four out of thirteen scales demonstrated insufficient reliability.

**Conclusions.** This study presents the first psychometrically evaluated German EMA item set capturing a broad range of clinically relevant pain processes. While the findings are

promising, further refinement of several scales and additional psychometric evaluation are warranted.

### *Introduction*

Chronic primary pain is a complex and heterogeneous condition (Breivik et al., 2006; Sundström et al., 2025), and individuals often show markedly different responses to treatment (Gómez-Pérez et al., 2020; McCracken & Turk, 2002; Murillo et al., 2022). At the same time, the generalisation of findings from nomothetic research to individuals has been increasingly criticised for methodological reasons (Gloster et al., 2024; McCracken, 2023). Consequently, personalised, process-based approaches to research and treatment are being advocated (McCracken, 2023; Scholten, Herzog, et al., 2025; Wright & Woods, 2020), drawing on innovative research methods such as Ecological Momentary Assessment (EMA) (May et al., 2018), a Network Approach to conceptualize and study mental disorders (Åkerblom, Cervin, et al., 2021; Borsboom, 2017; Schemer et al., 2023; Scholten et al., 2022), and Single Case Experimental Design (SCED) (Jones & Hurrell, 2019; Vlaeyen et al., 2001).

EMA assesses longitudinal data and enables the examination of dynamic symptom fluctuations essential for approaches such as individual-level network analysis (Bringmann, 2021). It has become increasingly feasible with the widespread use of digital devices and can be implemented in everyday life, thereby enhancing ecological validity and reducing recall bias (May et al., 2018). A systematic review concluded that momentary pain measures are feasible and valid and might become the new gold-standard of outcome assessment (Overton et al., 2023).

Despite existing recommendations for the development of EMA instruments (Eisele et al., 2021; Fritz et al., 2024), formal evaluation is rare, even though establishing the psychometric properties of EMA items is a prerequisite for any subsequent analyses (Palmier-Claus et al., 2011). Simply adapting the instructions to retrospective questionnaires – originally designed to capture between-person differences – is insufficient for individual-

level, longitudinal research and may compromise the validity of the resulting data (Brose et al., 2020).

Beyond validity, reliability represents a key psychometric property and refers to the proportion of observed variance attributable to true score variance rather than measurement error (Eisele et al., 2021). Adequate reliability is a prerequisite for analyses based on EMA data (Bringmann, 2021). However, no gold-standard procedures for estimating reliability in EMA currently exist (Eisele et al., 2021). Moreover, commonly used reliability estimators assume multi-item scales, whereas EMA research frequently relies on single-item measures (SIM) or very short scales to minimise participant burden. These brief measures are particularly susceptible to measurement error (Dejonckheere et al., 2022), underscoring the need for systematic psychometric evaluation of newly developed EMA items and scales. Furthermore, EMA items need to be sufficiently sensitive to capture meaningful temporal fluctuations (Forkmann et al., 2018). Accordingly, item variability constitutes another key psychometric property of EMA measures.

A positive example of a thoroughly evaluated EMA questionnaire in the context of pain is the Momentary Pain Catastrophizing Scale (Frumkin et al., 2023). However, no evaluated EMA items are available in German that capture a broader range of pain processes. The aim of the present study was therefore to develop and evaluate a German-language item set for the longitudinal assessment of clinically relevant pain processes.

### *Methods*

The new EMA instrument was named the “Prozesse Chronischer Schmerzen ErfaSSen” (ProCEss) item set (English: “assessing chronic pain processes”). Its evaluation comprises several preregistrations that are available in the POINT Pain OSF project (doi: 10.17605/OSF.IO/9TUQR) and has been approved by the university’s local ethics committee (#LEK-501).

The present study focuses on the psychometric evaluation of the ProCEss item set, i.e. item reliability and variability. The evaluation procedure comprised a pilot EMA study (see Figure 4, Step 5), an EMA evaluation (see Figure 4, Step 6), and a preliminary assessment

of revised items (see Figure 4, Step 8). The methods of these three studies are described in the following sections.

An overview of the entire evaluation procedure based on Boateng et al. (2018) – from content validation to psychometric testing – is provided in Figure 4. The results of the validation are currently available as a preprint: https://doi.org/10.31234/osf.io/ruhdf_v3

**ProCEss development.** In the absence of established psychological processes of chronic pain, processes included in the item set were derived from reviewing existing psychological models as suggested by Scholten and Glombiewski (2025) and the IMMPACT recommendations concerning relevant pain experiences (Dworkin et al., 2005) (see Figure 4, Step 1). Existing questionnaires and the ESM Item Repository (Kirtley et al., 2018) were subsequently screened for suitable item formulations (see Figure 4, Step 2). A summary of the development process is provided in the supplemental materials (Appendices B1.1, B1.2). Table 3 provides an overview of the processes included in the most recent version of the item set along with the respective models they were derived from and a definition for each process.

To minimise participant burden, the number of items within the ProCEss item set, as well as the number of items per process, was deliberately limited. Consequently, the included processes do not necessarily represent every facet characterizing a specific construct. For example, the current version of the ProCEss item set does not yet include an item assessing the rumination component of catastrophising. Following an extensive qualitative validation procedure (see Figure 4 steps 4, 6, and 8), several items were revised, added, or omitted, resulting in formulations that differ from the original questionnaires from which they were derived.

**Table 3**

*Processes included in the most recent ProCEss item set version*

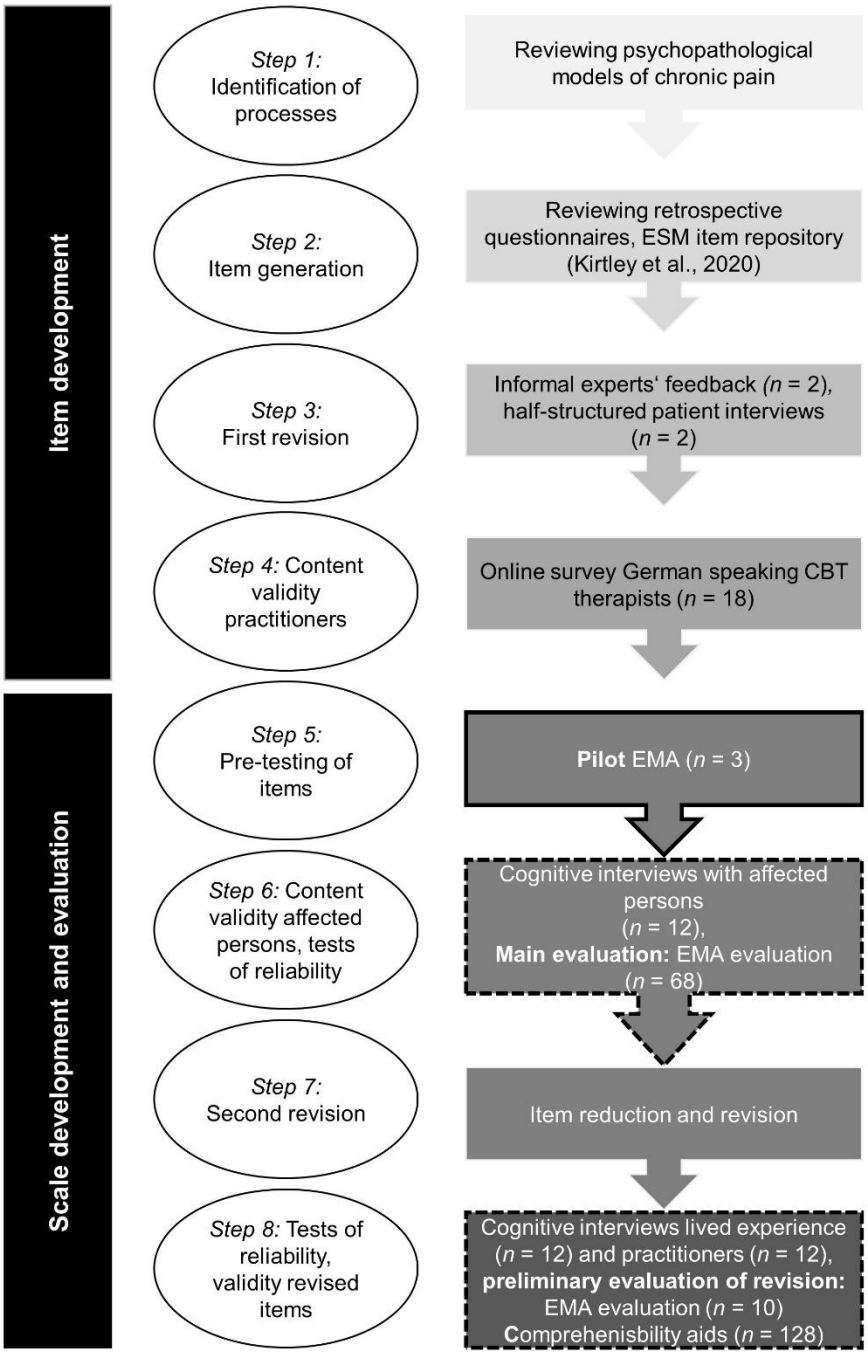
| Process | Model | Definition |
|---|---|---|
| Catastrophising | | Catastrophising describes the tendency to perceive negative aspects of a situation or possible consequences in an excessive manner, and to ruminate about or anticipate them (Dorsch Lexikon der Psychologie, 2021) |
| Avoidance | Fear-Avoidance/Avoidance-Endurance (Hasenbring & Verbunt, 2010; Vlaeyen et al., 2016) | Avoidance constitutes a behaviour aiming at prevention, reduction, or termination of the exposure to certain experiences (in pain context: experience of pain) (McCracken, 2005) |
| Depression | | A depressive episode is marked by subdued mood and listlessness with a reduction of activity. Even in light forms feelings of guilt and thoughts about the own worthlessness can occur (BfArM, 2020) |
| Thought suppression | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Thought suppression denotes a cognitive reactive pattern that forcefully ends the perception of pain or the disruption of daily activities by pain (Hasenbring & Verbunt, 2010; Oxford Advanced Learner's Dictionary, n.d.-c) |
| Task persistence | | Task persistence describes a physical over-activity that can lead to over-use of bodily structures (Hasenbring & Verbunt, 2010) |

| Process | Model | Definition |
|---|---|---|
| Positive affect | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Positive affect marks an emotional state of pleasant mood or feelings that promotes approach oriented behaviour or causes the experience of relaxation, contentment, or serenity (Finan & Garland, 2015) |
| Negative Affect | | Negative affect is a general dimension of subjective distress and unpleasurable engagement that subsumes a variety of aversive mood states, including anger, contempt, disgust, guilt, fear, and nervousness (Watson et al., 1988, p. 1063) |
| Acceptance | Psychological Flexibility(McCracken & Morley, 2014) | Acceptance is an embracing attitude that leads to goal oriented behaviour within the personal frame of control as well as distancing oneself from attempts to control unwanted feelings or unchangeable circumstances (McCracken & Morley, 2014) |
| Values | | Values are subjectively desirable states that influence behaviour. They include beliefs about what is right and wrong and what is important in life (Oxford Advanced Learner's Dictionary, n.d.-d; Spektrum Lexikon der Psychologie, n.d.) |
| Expectations | Predictive Coding (Wiech, 2016) | Expectations describe beliefs about what will happen based on previous experiences and likelihood (Oxford Advanced Learner's Dictionary, n.d.-b; Wiech, 2016) |

| Process | Model | Definition |
|---|---|---|
| Pain intensity | Pain Experience (Dworkin et al., 2005) | Pain intensity reflects the subjective extent of pain (Dworkin et al., 2005) |
| Pain-related disability | | Disability because of pain describes a limitation in movement, senses, and activities most people can do, caused by pain (Crombez et al., 2020; Oxford Advanced Learner's Dictionary, n.d.-a) |
| Pain self-efficacy (Nicholas, 2007) | | Self-efficacy constitutes the belief to be able to handle even difficult situations successfully and to possess the required abilities (Bandura, 1977) |
| | Others | |
| Self-compassion (Neff, 2003; Neff, 2011) | | Self-compassion describes a non-judging understanding for one's own suffering, shortcomings, or failure. It can be divided in the three facets of self-kindness, sense of common humanity, and mindfulness (Neff, 2003; Neff, 2011) |

**Figure 4**

*Development process of the "Prozesse Chronischer Schmerzen ErfaSSen" (ProCEss) item set*




*Note.* Bordered components are reported in the present publication; for dashed components, only quantitative data is reported in the present publication. All N regarding participants, not observations.

The ProCEss item set was developed for the use in a coverage model EMA (cEMA) (Stone et al., 2021, 2023), which means that it is designed to capture a broader timeframe. Accordingly, the items are formulated in past tense and the timeframe participants are to consider is described in the instruction (see Table 4). All items of the ProCEss item set are rated on an 11-point Likert scale to approach interval scaling (0 = does not apply at all, 10 = completely applies) (Wu & Leung, 2017).

**Pilot EMA: Pre-testing of items.** As recommended (Eisele et al., 2021; Forkmann et al., 2018), the item set was piloted with people suffering from chronic pain to evaluate the burden associated with completing the assessment and to examine the comprehensibility of the item (see Figure 4, Step 5). Participants were recruited from the university outpatient clinic based on the primary diagnosis F45.4x (ICD-10; (Bundesinstitut für Arzneimittel und Medizinprodukte (BfArM) im Auftrag des Bundesministeriums für Gesundheit (BMG) unter Beteiligung der Arbeitsgruppe ICD des Kuratoriums für Fragen der Klassifikation im Gesundheitswesen (KKG), 2020)). Exclusion criteria included insufficient German language proficiency (operationalised as a score of $\geq 4$ on a five-point scale, with higher scores indicating lower proficiency), and acute cases of psychosis, substance abuse, or suicidality. Three women suffering from chronic pain participated in a 12-day EMA phase comprising six assessments per day. The assessment was carried out using M-path (Mestdagh et al., 2023), an app that can be installed on the participants' smartphones. M-path required smartphones to use either Android 5.1 or iOS 11.0 as their operating system. Participants received written study information and gave their informed consent prior to enrolment and app installation.

Prior to the EMA phase, all participants attended an individual onboarding session during which the complete item set (excluding distractor items) was reviewed. Participants were first asked to paraphrase each item in their own words, and their responses were documented concurrently by the interviewer (VEH). If a participant's phrasing did not correspond to the definition of the intended construct, the respective construct definition was

provided to ensure a shared understanding of each item. Each onboarding session lasted approximately one hour.

The sampling scheme of the pilot EMA is summarised in Table 4. Items of the same construct were kept together, as recommended to reduce assessment burden (Eisele et al., 2021).

After completing the EMA phase, participants were invited again to a semi-structured interview in which they were provided with a personalised summary of their data (descriptively analysed using Microsoft Excel (*Excel*, 2025)) and asked about their experiences during the EMA period. Responses were documented in real time and subsequently discussed within the research team to identify implications for participant burden. Each post interview lasted approximately one hour.

**Main Evaluation: Testing of variability and reliability.** Focusing on the reliability and variability as essential psychometric criteria, an EMA study with participants suffering from chronic pain was implemented (preregistration: https://doi.org/10.17605/OSF.IO/S4QGP).

In general, the study followed procedures described by Scholten and colleagues (2024) regarding the evaluation of item variability, and Dejonckheere and colleagues (2022) and Forkmann and colleagues (2018) for the assessment of item reliability, as will be described below.

***Sample of the main evaluation.*** The objective of the recruitment process was to generate a sample of 70 valid data sets, based on sample sizes of other EMA evaluation studies. As the methodological design of the current evaluation study is largely based on Dejonckheere et al. (2022), the target sample size of N = 70 was also based on their study. It is evident that other EMA studies which employed a comparable methodological design also utilized smaller sample sizes (see Ben-Zeev et al., 2009 [N = 51]; Chepenik et al., 2006 [N = 57]). A systematic review of the use of EMA in chronic pain research reports an average sample size of N = 62.7 (May et al., 2018).

**Table 4**

*Sampling Schemes of all EMA studies*

| Study | Duration | Assessment frequency | Questionnaire density | Instruction | Reimbursement |
|---|---|---|---|---|---|
| Pilot | 12 days | Six assessments per day, semi-randomised within 12-hour timeframe (usually between 9 a.am and 9 p.m.) | First questionnaire of the day: 29 items + 1 distractor + 1 open-ended question (“Is there anything else you would like to tell us?”) + 1 repeated Single Item Measure (see 2.3.5)<br>Others: 25 items + 1 distractor + 1 open-ended question + 1 repeated Single Item Measure<br>Max. delay 30 minutes<br>Completion time max. 15 minutes total (2-3 minutes per questionnaire) | Considering the past two hours… | 50 € if compliance ≥ 80 % |
| Main evaluation | 12 days | | First questionnaire of the day: 30 items + 1 distractor + 1 open-ended question + 1 repeated Single Item Measure<br>Others: 27 items + 1 distractor + 1 open-ended question + 1 repeated Single Item Measure<br>Max. delay 30 minutes<br>Completion time max. 15 minutes total (2-3 minutes per questionnaire) | Considering the past two hours… | 30 € if compliance ≥ 80 % |

| Study | Duration | Assessment frequency | Questionnaire density | Instruction | Reimbursement |
|---|---|---|---|---|---|
| Preliminary revision evaluation | 21 days | | 25 items + 1-2 idiographic items + 1 distractor + 1 repeated single-item measure<br>Max. delay 30 minutes<br>Completion time max. 15 minutes total (2-3 minutes per questionnaire) | Since the last beep… | 50 € if compliance ≥ 80 % |

*Note.* In the pilot EMA, all four sleep items were only assessed in the first prompt of the day; in the main evaluation, three sleep items were only assessed in the first daily prompt, while “I was tired” was repeated throughout the day; the preliminary revision evaluation did not have different prompt versions.

The recruitment of the total sample took place in two waves (July-September 2024 and January-February 2025). Recruitment was conducted on a nationwide basis in Germany, mainly via online self-help groups and flyers distributed in local healthcare centres.

***Procedure for the main evaluation.*** Participants were screened for in- and exclusion criteria using an online questionnaire on SoSci Survey (Leiner, 2024). Participants received written study information and provided informed consent prior to data assessment and app installation within the online survey. The inclusion criteria were: (1) being of age (≥ 18 years), (2) sufficient knowledge of German (native speaker or self-assessment of at least 3 (*moderate*) on a 5-point scale (1 = *very good* to 5 = *very poor*), (3) self-reported pain symptoms lasting at least six months, (4) a self-reported pain focus outside the head or neck area or migraine, (5) an average pain intensity of at least 1 on an 11-point scale (0 = *no pain* to 10 = *maximally conceivable pain*) in the last 14 days, and (6) disability in at least one of the seven areas of life according to the Pain Disability Index (PDI; Dillmann et al., 2011). The PDI items were recoded dichotomously (1 = *Yes*, 2 = *No*), since no cut-off to discern pathological from non-pathological disability is defined. Consequently, participants whose pain focus was in the head/neck area or who reported no pain or pain-related disability during the past 14 days were excluded from the study. Further exclusion criteria such as acute suicidality, substance abuse, psychosis, or other circumstances endangering the participant were screened in an onboarding session (see below) based on a clinical screening instrument (Margraf & Cwik, 2020). We recognise that people seeking treatment for chronic pain in tertiary pain clinics display heavier pain intensity scores and disability ratings (Nicholas et al., 2019). The broad inclusion criteria intended to account for the heterogeneity of chronic pain while ensuring that participants regularly experienced pain symptoms they could report in an EMA study.

Prior to the EMA phase, an onboarding session was conducted via Arztkonsultation.de (https://arztkonsultation.de), a digital platform specifically designed for video consultations with medical practitioners and psychotherapists, in full compliance with the provisions of the General Data Protection Regulation. During the onboarding process, participants could ask

questions and provided their informed consent again verbally prior to installing the M-path app on their smartphone.

The recruitment was implemented in two assessment waves (see *Sample*). In the first wave, participants provided sociodemographic information in the online screening and completed a short questionnaire demonstration in M-path during the onboarding. In the second wave, participants were made familiar with M-path by assessing their sociodemographic information in M-path during the onboarding session. Each onboarding session took 15-20 minutes. Following the onboarding session, participants completed the 12-day EMA period. Interested participants received a summary of the study's overall results via email. All participants received an incentive of €30 if they completed 80 % of the questionnaire prompts.

**Sampling scheme of the main evaluation.** The sampling scheme and item set order correspond mostly to the pilot study and is summarised in Table 4: The EMA was 12 days long and included six semi-randomised prompts per day. The assessment was implemented using M-path (Mestdagh et al., 2023). Of the 30 process items, six were single-item measures (SIMs). One SIM was repeated at the end of each questionnaire prompt, following protocol 1 described by Dejonckheere and colleagues (2022).

***Compliance Management.*** Sufficient statistical significance can only be achieved if the number of observations is sufficient for the planned analyses (Dejonckheere et al., 2022; Fritz et al., 2024). The total number of observations is determined by two key factors: the sample size and the number of data points generated per person. The latter is significantly influenced by the response rate.

Data collection in real-life situations almost inevitably leads to missed surveys (Fritz et al., 2024). In order to generate valid data that reflects the temporal dynamics of the constructs under investigation as realistically as possible, minimum compliance requirements can be established (Trull & Ebner-Priemer, 2020). However, a gold-standard for setting such a threshold in EMA studies does not yet exist. Some studies aim for a target compliance value at the group level, while others set individual minimum rates for inclusion (M. T. Williams et al., 2021). For group-level analyses, a target value of 80% is generally accepted

(Forkmann et al., 2018). Consequently, this value is adopted as the target value at the group level and was accordingly incentivised.

On the individual level, the literature contains varied criteria, some excluding participants with a response rate below 50% (e.g. Dejonckheere et al., 2019; Heininga et al., 2019; Van Der Gucht et al., 2019), while others set significantly higher thresholds (e.g. 80% [Schiepek et al., 2019]). In this study, an individual minimum rate of 60% is defined as an inclusion criterion for data analysis. The establishment of minimum compliance requirements at both the group and individual levels has been demonstrated to be a useful method of generating valid data that reflects the temporal dynamics of the constructs under investigation as realistically as possible (M. T. Williams et al., 2021).

In order to achieve this objective, several strategies were implemented with the aim of increasing compliance. First, participants were informed in detail about the study design during the personal onboarding interview. Secondly, approximately halfway through the 12-day survey period, the participants received an email containing an interim report on their response rate to date. In instances where further clarification was required on technical matters, additional contact was initiated via email. This approach was also employed to provide motivational support, fostering a sense of engagement and empowerment among the participants. Thirdly, upon attaining a compliance rate of at least 80 %, the participants received a payment of €30. Participating students could choose to receive the financial incentive or course credit if they completed at least 80 % of the questionnaires.

***Analysis.*** All statistical analyses were performed using the software R, version 4.5.1 (R Core Team, 2025). For data management, descriptive and inferential statistical analyses, functions from the packages apaTables (Stanley, 2021), ggrepel (Slowikowski et al., 2024), lavaan (Rosseel, 2012), lme4 (*Lme4 Package - RDocumentation*, n.d.), M-pathr (Mestdagh et al., 2023), openxlsx (Schauberger et al., 2025), psych (Revelle, 2025), semTools (*semTools R Package [Documentation]*, n.d.), and tidyverse (Wickham et al., 2019) were used.

M-path directly gives the compliance rate per person in the app and does not export it as a variable in the dataset, which is why the compliance rates reported in the Results section have been averaged manually based on the compliance rates noted from M-path.

**Variability*:*** Currently, there is no standardised procedure for examining the variability of EMA items. In studies in the field of time-varying network analysis, standard deviation has been used as a pragmatic measure for assessing item variability (Scholten et al., 2022; Scholten, Rubel, et al., 2024). Scholten, Rubel et al. (2024) excluded items with a standard deviation < 0.2 (after min-max scaling) from the data analysis due to insufficient variance. Following this approach, this study also defined a criterion for assessing item variability.

In contrast to the approach of Scholten, Rubel et al. (2024), min-max scaling is not necessary in this context because all items are assessed on an 11-point scale and are therefore directly comparable. Instead, a within standard deviation of ≥1.0 is defined as an indicator of sufficient item variability. This criterion represents a deviation from the original pre-registration (https://osf.io/s4rmn), in which a standard deviation greater than 0.2 was specified. The deviation is due to not using scale normalisation, which makes the selected criterion more stringent.

Additionally, an extra criterion is defined to evaluate the variability of the items, that is that no single response option may comprise more than 80% of all responses across the sample (Scholten et al., 2022).

**Variability calculations:** The standard deviation was calculated within each individual across their individual measurement times. The between-person variance was analysed by calculating random intercepts of an intercept-only model.

Additional to the preregistered analyses and following common recommendations, Intraclass Correlation Coefficients (ICCs) will be reported for each item (Eisele et al., 2021; Overton et al., 2023). The estimation of ICCs was achieved through the implementation of an intercept-only multilevel model, which facilitated an examination of the variance structure across and within individuals. ICCs quantify the proportion of the total variance of a variable that can be attributed to differences between individuals and to fluctuations within an individual (Bolger &

Laurenceau, 2013). In EMA, ICCs ranging between 0.2 - 0.4 are usual (Eisele et al., 2021), i.e. 20-40 % are usually attributable to stable differences between individuals.

Also additional to the preregistration and following the example of other EMA evaluation studies (Forkmann et al., 2018; Frumkin et al., 2023), Root Mean Squared Successive Differences (RMSSDs) will be calculated on the individual level. Mean Squared Successive Differences indicate the variability from timepoint to timepoint in repeated measures (Jahng et al., 2008), and the RMSSD is easier to interpret since it has the same dimension as the originally used scale.

**Reliability:** The reliability of the items is analysed using different methods, depending on the number of items per construct (i.e. test-retest reliability (Dejonckheere et al., 2022), Spearman Brown formula (Eisinga et al., 2013), McDonald's Omega (*ω)* (Forkmann et al., 2018)). Further details are described in the Data Analysis section. Regardless of the method used, reliability was considered sufficient if the respective reliability estimator had a value > .70 (Forkmann et al., 2018; Nunnally & Bernstein, 1994).

**Reliability calculation: Single-item measures (SIMs):** SIMs are analysed applying a test-retest-logic based on protocol 1 by Dejonckheere and colleagues (2022). In this method, the SIM is presented at two timepoints within the same measurement. This is then set in relation to the total variance, which is constituted by both measurements. The fundamental premise underlying this investigation is that the observed discrepancy between the two measurements is exclusively attributable to measurement errors, as the underlying construct has remained relatively stable over the brief interval (Dejonckheere et al., 2022). This results in the following formula:

$$\rho^*_{TRT} = 1 - \left(\frac{E\ (\Delta^2)}{2\sigma^2_{total}}\right) \text{ with } E(\Delta^2) = 2\sigma^2_{\varepsilon}$$

$\rho^*_{TRT}$ = estimated test-retest reliability,

$E(\Delta^2)$ = expected squared difference between test and retest item,

$\sigma^2_{total}$ = total variance of test and retest responses,

$\sigma^2_{\varepsilon}$ = measurement error variance of test and retest responses

In the present study, at least 22 items separated the first and repeated presentation of the SIM, reducing recall effects. On average, each SIM was repeated once per day. Test-retest reliability for SIMs was calculated across the sample, accordingly reflecting a between-person reliability estimate.

**Two-item measures**: The estimation of reliability for scales comprising two items is calculated using the Spearman-Brown formula (Eisinga et al., 2013). The formula assumes that both items measure the same latent construct. It corrects for the tendency to underestimate reliability in short scales (e.g., two-item constructs). This approach is also used by Forkmann et al. (2018) in the evaluation of EMA items. The formula is:

$$\rho_{SB}^{*} = \frac{n \cdot r_{ii}}{1 + (n-1) \cdot r_{ii}}$$

$\rho_{SB}^{*}$ = predicted reliability (Spearman-Brown correction),

$n$ = number of items,

$r_{ii}$ = inter-item correlation

Similar to the test-retest reliability, the Spearman Brown formula is applied across participants and provides a between-person reliability estimate.

**Multiple-item measures:** As recommended (Brose et al., 2020), McDonald's ω is calculated for constructs measured with at least three items. It was calculated separately on the within and between level, based on a one-factorial estimate (group-mean-centred within, person-means between). A multilevel confirmatory factor analysis to extract the reliability parameters was not feasible due to the limited number of items per factor.

**Preliminary evaluation of revised items: Testing variability and reliability.** After the EMA evaluation, the ProCEss item set was reduced to 25 items following the results of the validation procedure. Five items underwent revisions regarding their formulations, three items were summarised to one item, sleep disturbances were omitted from the questionnaire completely due to their different time-scale (being only assessed once per day), and one SIM for negative affect was added to the item set. Therefore, the final ProCEss item set version

was preliminarily evaluated again, repeating the analyses of the main evaluation in a new dataset.

The data for this preliminary evaluation were drawn from the POINT Pain project, in which personalised, network-based CBT is compared with a standardised CBT within a single-case experimental design (for more details, see preregistration: https://clinicaltrials.gov/study/NCT06784141). Participants are adults with chronic pain (primary diagnosis: F45.4x (Bundesinstitut für Arzneimittel und Medizinprodukte (BfArM) im Auftrag des Bundesministeriums für Gesundheit (BMG) unter Beteiligung der Arbeitsgruppe ICD des Kuratoriums für Fragen der Klassifikation im Gesundheitswesen (KKG), 2020)) who complete two EMA phases during their study participation: one prior to commencing personalised CBT and one after completing the full course of therapy. For the present evaluation, only EMA data collected before the personalised CBT phase were analysed, as pain experiences are expected to change during treatment, potentially altering the psychometric properties of the items at the individual level in the post-treatment EMA. As the POINT Pain project is still ongoing, the available dataset for the ProCEss evaluation was limited to $N$ = 10 participants. It is accordingly considered preliminary.

***Sampling scheme of the preliminary re-evaluation.*** The sampling scheme of this EMA study is summarised in Table 4. The EMA was 21 days long and included six semi-randomised prompts per day. Participants received a financial incentive of €50 if they completed at least 80 % of all assessments.

Unfortunately, due to an error in the questionnaire settings, the new SIM assessing Negative Affect was not administered repeatedly. Consequently, test-retest reliability for this item could not be evaluated.

**Exploratory analyses.** In order to explore the ideal timescale with which the ProCEss item set should be applied, descriptive item characteristics as well as the variability indicators regarding within standard deviation, random intercept, and ICCs were calculated again in three subsets: The first subset included a random selection of three datapoints per

day per person, the second included every second datapoint per person, and the third included one random datapoint per day per person.

Additionally, intraindividual standard-deviations were computed per person per item in order to explore response types (e.g. generally low versus generally high variance).

**Sustainability and Dissemination.** The ProCEss item set is among the first tools developed to capture multiple psychological processes in chronic pain using longitudinal assessment. To promote transparency and broad accessibility, the items will be deposited in the ESM item repository (Kirtley et al., 2018) after publication of the evaluation findings. They are also included in an additional, item set-specific repository, which will document future developments such as translations or item extensions (https://rptu.de/s/vpcgks). Contributions from researchers conducting translations or further psychometric evaluations are explicitly welcomed to foster cumulative scientific progress.

### *Results*

**Pilot EMA results.** The three female participants' mean age was 38.67 years (*sd* = 4.64). All participants were White, native German speakers, had completed vocational training, and were employed part-time.

**Burden:** All participants judged the EMA with the ProCEss item set (29 item-version) to be feasible. This impression is supported by high compliance rates of 89 %, 89 %, and 100 %, respectively. Two of the three participants reported benefiting from the EMA through reflection and perceived self-efficacy. One of them additionally reported that she would have preferred to continue the EMA for a longer period.

On the other hand, one participant stated that the EMA phase should not be extended beyond 12 days. She reported becoming bored with the repeated questions towards the end and noted that she spent progressively less time answering them, particularly when feeling stressed. A factor that impeded participation, mentioned by two of the three participants, was the semi-randomised sampling scheme; both expressed a preference for a fixed schedule instead.

Generally, the results support the feasibility of the ProCEss item set for the use in EMA studies.

**Main evaluation results.** Figure 5 provides an overview of the participant flow from recruitment to the final sample, combining both survey waves.

***Sample of the main evaluation.*** The final sample comprised N = 68 individuals (91.2% female), with an average age of *M* = 37.69 years (*SD* = 13.76). The average pain intensity was *M* = 5.50 (*SD* = 1.67). The most frequently reported pain locations were the limbs (55.88 %), joints (51.47 %), back (41.18 %), and neck and head area (39.71 %). Pain exclusively in the head/neck area was an exclusion criterion; therefore, the values given refer exclusively to participants with multiple pain locations.

***Compliance rates of the main evaluation.*** The average compliance on the group-level is an indicator of the quality of the data basis. The final sample – including only participants with a compliance rate of at least 60 % - comprised 68 individuals, with an average response rate of *M* = 86.62% (*SD* = 8.48, Min = 64 %, Max = 100 %). This led to a data base of *n* = 4,236 completed measurement points.

***Variability results of the main evaluation.*** **Variance:** The first criterion for sufficient variability was defined as a within-person standard deviation greater than 1. Within-person standard deviations for the 30-item ProCEss version ranged from 1.30 (depressive symptom: “I felt guilty”) to 2.59 (sleep disturbance: “Last night I woke up too early”). As all sleep-related items were subsequently omitted from the final item set, the largest within-person standard deviation was observed for the avoidance item: “I avoided an activity that causes pain” (*SD* = 2.38). In conclusion, all items met the first variability criterion.

With regard to between-person variance, the standard deviations of the random intercepts per item, based on an intercept-only model, are reported here. They ranged from 1.66 (self-efficacy: “I trusted myself to be able to do something even though I was in pain”) to 2.93 (self-compassion: “I have told myself that I am not alone with my problems”), indicating that considerable between-person variance was present in the dataset. An overview of the

random intercepts per participant as well as per item is provided in the supplementary materials (Appendices B2.1 – B2.3).

**Response distribution:** The second variability criterion specified that no response category of the 11-point Likert scale should account for more than 80 % of all responses across the sample. All items met this requirement. The most frequently selected response category was “0 = completely disagree” for the item: “Due to my pain I asked others to do a strenuous activity for me” (avoidance; 53.90 % of all responses), and for the item: “I felt guilty” (depressive symptoms; 53.71 % of all responses). As shown in Table 5, the full 11-point scale was utilised for each item. An overview of the response distribution for each item is provided in the supplemental materials (Appendix B3).

**Intraclass Correlation Coefficient:** The ICCs support the notion that, although within-person standard deviations met the predefined variability criterion, substantial between-person variance was also present. Only one item fell within the expected range of 0.2-0.4 (Eisele et al., 2021), with an ICC of $\rho = 0.34$ (self-efficacy: “I trusted myself to be able to do something even though I was in pain”). The item with the highest ICC was: “I could accept that there is no solution for my pain” (acceptance), with $\rho = 0.74$. Across the entire item set, this indicates that between 34 % and 74 % of the variance could be attributed to between-person differences. The ICCs for each item are provided in Table 5.

**RMSSD:** As the MSSD assumes equally spaced time intervals (Jahng et al., 2008), and a semi-randomised sampling scheme was employed in this study, the coefficients here should be interpreted with caution. They are presented to facilitate comparison with other EMA evaluation studies (Forkmann et al., 2018; Frumkin et al., 2023). RMSSDs ranged from 0.57 for pain intensity (“How strong was your pain on average?”) to 1.44 for one avoidance item (“Due to my pain I asked others to do a strenuous activity for me”). All RMSSDs were larger than zero. They are summarised along with the other variability and reliability indicators in Table 5.

**Figure 5**

*Flowchart of the main evaluation*

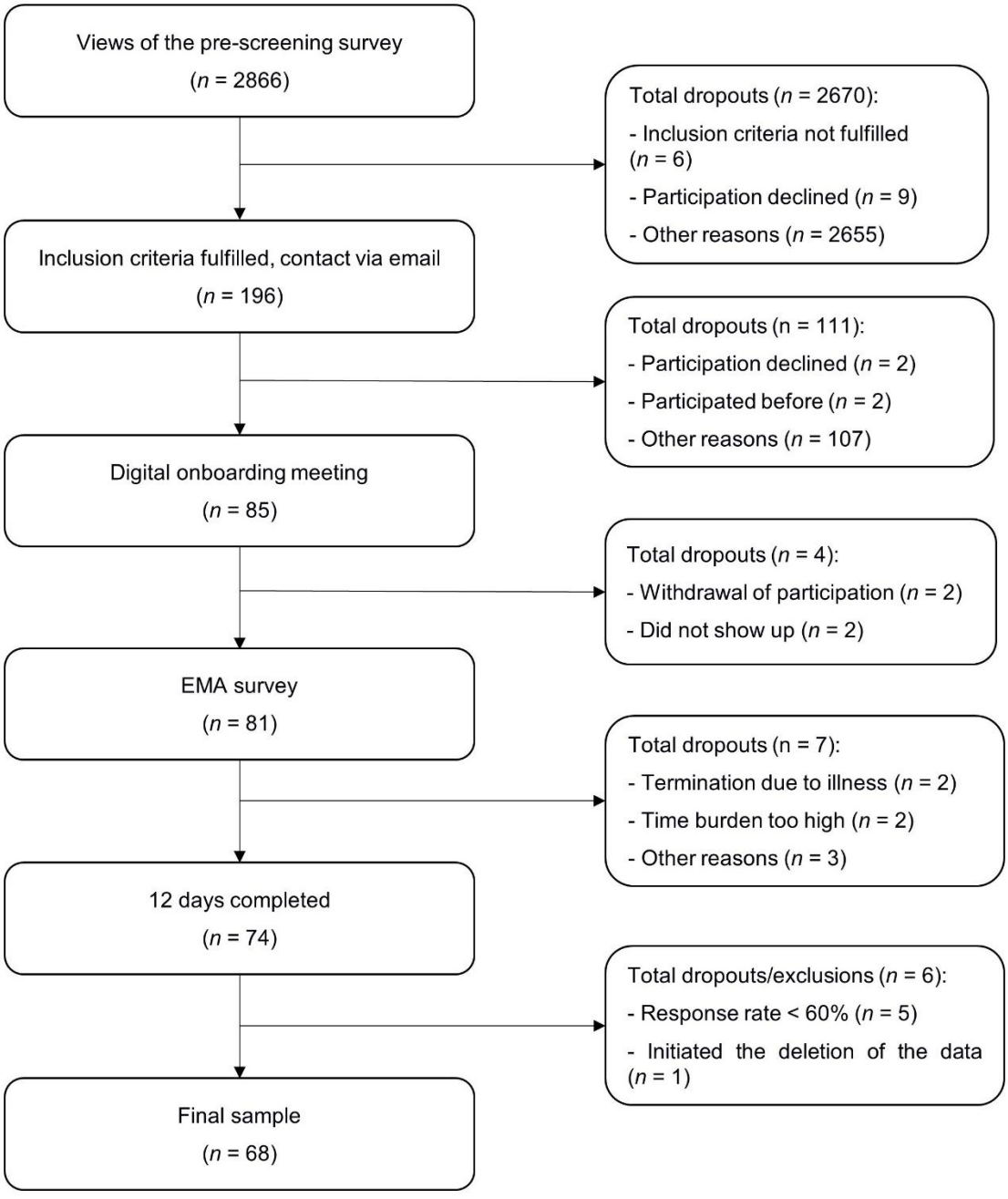


**Table 5**

*Outcomes of the main evaluation*

| Construct/items | *Mean* | *Within SD* | *SD Random intercept* | *Min* | *Max* | *M RMSSD* | *SD RMSSD* | *ICC* | *Reliability* |
|---|---|---|---|---|---|---|---|---|---|
| **Catastrophising** | | | | | | | | | Spearman Brown: 0.79 |
| I thought: “It will never get better!” | 3.16 | 1.76 | 2.40 | 0 | 10 | 2.07 | 1.08 | 0.59 | |
| I thought: “I can’t stand it any longer!” | 2.99 | 1.91 | 2.35 | 0 | 10 | 2.23 | 1.06 | 0.55 | |
| **Avoidance** | | | | | | | | | $\omega_{within}$ = 0.63 $\omega_{between}$ = 0.92 |
| I ended an activity because of my pain.* | 2.35 | 2.05 | 2.04 | 0 | 10 | 2.65 | 1.32 | 0.44 | |
| Due to my pain I asked others to do a strenuous* activity for me. | 3.41 | 1.98 | 2.20 | 0 | 10 | 2.47 | 1.44 | 0.48 | |
| I avoided an activity that causes pain.* | 2.26 | 2.38 | 2.47 | 0 | 10 | 3.01 | 1.27 | 0.48 | |
| **Depressive symptoms** | | | | | | | | | $\omega_{within}$ = 0.71 $\omega_{between}$ = 0.90 |
| I felt irritable. | 2.86 | 1.77 | 2.20 | 0 | 10 | 2.07 | 1.02 | 0.56 | |
| I felt guilty. | 2.02 | 1.30 | 2.36 | 0 | 10 | 1.51 | 1.08 | 0.68 | |
| I felt sad. | 3.10 | 1.94 | 2.12 | 0 | 10 | 2.15 | 0.95 | 0.50 | |
| I felt powerless.* | 3.86 | 2.04 | 2.39 | 0 | 10 | 2.42 | 0.81 | 0.56 | |
| I was exhausted. | 5.70 | 1.95 | 2.39 | 0 | 10 | 2.23 | 0.82 | 0.58 | |

| Construct/items | *Mean* | *Within SD* | *SD Random intercept* | *Min* | *Max* | *M RMSSD* | *SD RMSSD* | *ICC* | *Reliability* |
|---|---|---|---|---|---|---|---|---|---|
| **Thought suppression** | | | | | | | | | $\omega_{within}$ = 0.67<br>$\omega_{between}$ = 0.90 |
| I thought: “Hold on!”* | 3.46 | 2.06 | 2.57 | 0 | 10 | 2.38 | 1.10 | 0.57 | |
| I thought: “Pull yourself together!”* | 2.93 | 1.71 | 2.65 | 0 | 10 | 2.04 | 1.23 | 0.64 | |
| I thought: “Don’t make such a fuss!”* | 2.69 | 1.50 | 2.57 | 0 | 10 | 1.83 | 1.27 | 0.67 | |
| I tried not to think about my pain. | 6.13 | 1.96 | 2.07 | 0 | 10 | 2.55 | 1.15 | 0.49 | |
| **Task persistence** (I pulled through despite my pain.) | 6.75 | 2.07 | 2.09 | 0 | 10 | 2.44 | 1.09 | 0.46 | Test-Retest: 0.75 |
| **Positive Affect** (I felt cheerful despite my pain.) | 5.96 | 1.96 | 1.79 | 0 | 10 | 2.29 | 0.82 | 0.43 | Test-Retest: 0.79 |
| **Acceptance** | | | | | | | | | Spearman Brown: 0.66 |
| I tried to befriend my pain. | 4.15 | 1.68 | | 0 | 10 | 2.12 | 1.09 | 0.67 | |
| I could accept that there is no solution for my pain.* | 3.36 | 1.45 | 2.82 | 0 | 10 | 1.81 | 1.06 | 0.74 | |
| **Values** (I tried to prioritise those things really important to me.) | 7.12 | 1.71 | 2.09 | 0 | 10 | 2.06 | 1.03 | 0.55 | Test-Retest: 0.84 |
| **Expectations** (I expected to experience pain during the next two hours.*) | 5.42 | 1.61 | 2.86 | 0 | 10 | 1.88 | 0.89 | 0.72 | Test-Retest: 0.90 |

| Construct/items | *Mean* | *Within SD* | *SD Random intercept* | *Min* | *Max* | *M RMSSD* | *SD RMSSD* | *ICC* | *Reliability* |
|---|---|---|---|---|---|---|---|---|---|
| **Self-efficacy** | | | | | | | | | Spearman Brown: 0.58 |
| I trusted myself to be able to do something even though I was in pain. | 6.69 | 2.12 | 1.66 | 0 | 10 | 2.63 | 1.24 | 0.34 | |
| I was sure I could lead my life satisfactorily even though I was in pain. | 5.25 | 1.52 | 2.46 | 0 | 10 | 1.87 | 1.11 | 0.66 | |
| **Self-compassion** | | | | | | | | | Spearman Brown: 0.44 |
| I tried to be friendly to myself. | 6.10 | 1.56 | 2.41 | 0 | 10 | 1.93 | 0.86 | 0.67 | |
| I told myself that I am not alone with my problems. | 3.98 | 1.58 | 2.93 | 0 | 10 | 1.91 | 1.11 | 0.73 | |
| **Sleep** | | | | | | | | | $\omega_{within}$ = 0.62 $\omega_{between}$ = 0.88 |
| I was tired. | 6.07 | 1.94 | 2.20 | 0 | 10 | 2.27 | 0.93 | 0.53 | |
| Last night I had problems falling asleep. | 4.35 | 2.45 | 2.73 | 0 | 10 | 0.89 | - | 0.51 | |
| Last night I had problems staying asleep. | 5.38 | 2.58 | 2.53 | 0 | 10 | 1.38 | - | 0.44 | |
| Last night I woke up too early. | 5.11 | 2.59 | 2.67 | 0 | 10 | 1 | - | 0.46 | |
| **Intensity** (How strong was your pain on average?) | 4.77 | 1.36 | 1.96 | 0 | 10 | 1.56 | 0.57 | 0.65 | Test-Retest: 0.92 |
| **Disability** (How much did you feel disabled because of your pain?) | 4.86 | 1.78 | 2.19 | 0 | 10 | 2.12 | 0.66 | 0.58 | Test-Retest: 0.81 |

*Note.* M = Mean, SD = standard deviation, Min = minimum, Max = maximum; items preliminarily translated to English; * items were revised after main evaluation

***Reliability results of the main evaluation.*** **Test-Retest reliability:** For the evaluation of SIM's reliability, a between-person test-retest reliability was calculated. All six SIMs displayed sufficient reliability, ranging between *rel* = 0.75 for the item: "I pulled through despite my pain" (task persistence) to *rel* = 0.92 for the item: "How strong was your pain on average?" (pain intensity). All reliability coefficients are displayed in Table 5.

**Spearman-Brown:** Catastrophising was the only process assessed with two items that reached a sufficient between-person reliability with *rel* = 0.79. Acceptance, Self-efficacy, and self-compassion displayed reliability scores < 0.7, as summarised in Table 5.

**McDonald's ω:** All processes assessed with at least three items displayed better between than within reliability as indicated by McDonald's ω. Thought suppression, Sleep disturbance as well as Avoidance missed the threshold of $\omega > 0.7$ at the within level, while Depressive symptoms just achieved a coefficient of $\omega = 0.71$. Confidence intervals could not be estimated due to numerical instability. All coefficients are summarised in Table 5.

**Results of the preliminary re-evaluation.** The eight female and two male pain people suffering from chronic pain who provided EMA data for the preliminary re-evaluation of the revised items were *M* = 57.60 years old (*sd* = 9.71). They experienced chronic pain since *M* = 9.38 years (*sd* = 12.44), with an average pain intensity of *M* = 6.2 on an 11-point scale (*sd* = 1.03) and an average PDI sum score of *M* = 34.90 (*sd* = 11.74).

Individual compliance rates ranged between 72 % and 97 %, with an average rate of *M* = 86.10 % (*sd* = 9.28 %). This led to a data-base of n = 1,253 data points.

The current version of the ProCEss item set comprises 25 process items assessing fourteen clinically relevant pain processes: Catastrophising (Crombez et al., 2020), Avoidance (Hasenbring et al., 2009; Vlaeyen et al., 2016), Depressive Symptoms, Acceptance (McCracken & Morley, 2014), Values-based behaviour, Expectations (Wiech, 2016), Thought Suppression (Hasenbring et al., 2009), Task Persistence, Self-Efficacy (Nicholas, 2007), Self-Compassion (Neff, 2003; Neff, 2011), Positive Affect (Hasenbring et al., 2009), Negative Affect, Pain Intensity (Dworkin et al., 2005), and Pain Disability. The

German version of the ProCEss item set is provided in the supplemental materials (supplement B4) as well as on the ProCEss repository (https://rptu.de/s/vpcgks).

The following section focuses on the eight revised items.

***Variability results of the preliminary re-evaluation.*** **Variance:** The first criterion for sufficient variability was defined as a within-person standard deviation greater than 1. Within-person standard deviations for the eight revised items ranged from 0.58 (negative affect: “I was ashamed”) to 1.38 (avoidance: “I avoided activities that cause pain”). Four out of eight revised items did not meet this variability criterion (see Table 6).

With regard to between-person variance, the standard deviations of the random intercepts per item, based on an intercept-only model, are reported here. An overview of the random intercepts per participant is provided in the supplementary materials (Appendices B5.1 – B5.4). The latter ranged from 1.67 (avoidance: “I avoided activities that cause pain”) to 3.10 (depressive symptom: “I felt listless”), indicating again that considerable between-person variance was present in the dataset.

**Response distribution:** The second variability criterion specified that no response category of the 11-point Likert scale should account for more than 80 % of all responses across the sample. All items met this requirement. The most frequently selected response category was “0 = completely disagree” for the item: “I was ashamed” (negative affect; 56.46% of all responses), and for the item: “I felt guilty” (depressive symptoms; 54.36 % of all responses). As shown in Table 6, the full 11-point scale was utilised for all items except Expectation (“I expect my pain to get worse until the next beep”). An overview of the response distributions for each item is provided in the supplemental materials (Appendix B6).

**Intraclass Correlation Coefficient:** The ICCs indicate substantial between-person variance. The ICCs of the eight revised items ranged between $\rho = 0.53$ (“I avoided activities that cause pain”, avoidance) and $\rho = 0.89$ (“I was ashamed”, negative affect). This means that between 53 % and 89 % of the variance in the revised items is attributable to between-person differences. The ICCs for each item are provided in Table 6.

**RMSSD:** Again, since a semi-randomised sampling scheme was employed in this study, the RMSSD coefficients should be interpreted with caution. RMSSDs of the revised items ranged between 0.54 for the revised acceptance item ("I was able to accept that the pain will accompany my life") to 1.05 for one avoidance item ("I avoided activities that cause pain"). All RMSSDs were larger than zero. Table 6 summarises the standard deviations of the RMSSD along with the other variability and reliability indicators.

Overall, most items fulfilled the predefined variability criteria, namely sufficient within-person standard deviation and an adequate response distribution. However, four revised items (Negative Affect, Expectation) did not reach the required within-person standard deviation, albeit two of them (Acceptance, Thought Suppression) fell only marginally below the threshold. The remaining four revised items met the variability criterion of a within-person standard deviation > 1 only narrowly. Taken together with the comparatively high ICCs, these findings suggest that the ProCEss item set may not capture intra-individual process dynamics to the extent intended.

***Reliability results of the preliminary re-evaluation.*** **Test-Retest reliability:** Unfortunately, the Negative affect SIM could not be evaluated with regard to its test-retest reliability since it was not repeated in the assessment. The Expectation SIM ("I expect my pain to get worse until the next beep") displayed good between-person test-retest reliability (*rel* = 0.93). All reliability indicators are summarised in Table 6.

**Spearman-Brown:** Acceptance displayed sufficient between-person reliability with *rel* = 0.79. For Thought Suppression, the reliability index dropped significantly in comparison to the main evaluation (*rel* = 0.02).

**McDonald's ω:** Both processes assessed with at least three items display better reliability at the between than the within level as indicated by McDonald's ω. While Depressive symptoms reach the threshold for sufficient reliability at the within level ($\omega$ = 0.72), Avoidance misses that criterion scarcely ($\omega$ = 0.66). Table 6 summarises all descriptive, variability, and reliability indices of the revised items.

**Table 6**

*Outcomes of the preliminary re-evaluation*

| Construct/items | *Mean* | *Within SD* | *SD Random intercept* | *Min* | *Max* | *M RMSSD* | *SD RMSSD* | *ICC* | *Reliability* |
|---|---|---|---|---|---|---|---|---|---|
| **Avoidance** | | | | | | | | | $\omega_{within}$ = 0.66 |
| | | | | | | | | | $\omega_{between}$ = 0.94 |
| I ended activities because of my pain.* | 2.70 | 1.04 | 2.07 | 0 | 10 | 1.29 | 1.01 | 0.72 | |
| Due to my pain I asked others to do strenuous activities for me.* | 2.41 | 1.05 | 2.08 | 0 | 10 | 1.26 | 0.94 | 0.71 | |
| I avoided activities that cause pain.* | 2.81 | 1.38 | 1.67 | 0 | 10 | 1.70 | 1.05 | 0.53 | |
| **Depressive symptoms** | | | | | | | | | $\omega_{within}$ = 0.72 |
| | | | | | | | | | $\omega_{between}$ = 0.88 |
| I felt irritable. | 2.86 | 1.18 | 2.37 | 0 | 10 | 1.24 | 0.63 | 0.76 | |
| I felt guilty. | 2.02 | 0.85 | 2.56 | 0 | 10 | 0.91 | 0.63 | 0.85 | |
| I felt sad. | 3.10 | 1.51 | 2.68 | 0 | 10 | 1.36 | 0.62 | 0.71 | |
| I felt listless* | 5.61 | 1.18 | 3.10 | 0 | 10 | 1.24 | 0.68 | 0.85 | |
| I was exhausted. | 5.70 | 1.23 | 2.87 | 0 | 10 | 1.35 | 0.76 | 0.82 | |
| **Thought suppression** | | | | | | | | | Spearman Brown: 0.02 |
| I thought: “Pull yourself together!”/”Don’t make such a fuss!”* | 4.71 | 0.95 | 3.00 | 0 | 10 | 1.12 | 0.75 | 0.88 | |
| I tried not to think about my pain. | 6.13 | 1.02 | 2.57 | 0 | 10 | 1.26 | 0.63 | 0.84 | |

| Construct/items | *Mean* | *Within SD* | *SD Random intercept* | *Min* | *Max* | *M RMSSD* | *SD RMSSD* | *ICC* | *Reliability* |
|---|---|---|---|---|---|---|---|---|---|
| **Acceptance** | | | | | | | | | Spearman Brown: 0.79 |
| I tried to befriend my pain. | 4.15 | 0.97 | 1.68 | 0 | 10 | 1.16 | 0.67 | 0.72 | |
| I was able to accept that the pain will accompany my life.* | 5.62 | 0.95 | 2.18 | 0 | 10 | 1.10 | 0.54 | 0.82 | |
| **Expectations** (I expect my pain to increase until the next prompt.*) | 2.85 | 0.65 | 2.28 | 0 | 8 | 0.78 | 0.73 | 0.87 | Test-Retest: 0.93 |
| **Negative Affect** (I felt ashamed.*) | 1.79 | 0.58 | 2.66 | 0 | 10 | 0.66 | 0.79 | 0.89 | - |

*Note.* * Revised items; M = Mean, SD = standard deviation, Min = minimum, Max = maximum; items preliminarily translated to English

Regarding reliability, the SIMs in particular demonstrated satisfactory performance. Overall, most processes showed adequate reliability, with the exception of Self-efficacy and Self-compassion. The revisions to the Avoidance and Depressive Symptoms processes yielded only marginal improvements, whereas Acceptance reached acceptable reliability following revision. In contrast, the revised Thought Suppression scale exhibited virtually no reliability, indicating a need for further investigation of its validity.

**Explorative results.** Three subsets including a random selection of three datapoints per day per person (2,430 datapoints), every second datapoint (2,136 datapoints), and one random datapoint per day per person (819 datapoints) were exploratively analysed to investigate the relevance of assessment timescales for the psychometric properties of the item set. The analyses revealed negligible differences on all indicators. This means that means, within standard deviations, random intercepts, and ICCs did not meaningfully differ from the original results. Therefore, all timescales (i. e. six, three, or one assessment per day) seem to lead to similar results, and none of these timescales can clearly be prioritised over the others. The results for the three subsets are provided in the supplemental materials (Appendices B7.1-B7.3).

In order to explore intraindividual variability patterns, the standard deviation was calculated per participant. A visual inspection of the results implied that there are some participants who display medium to high variability on most of the ProCEss item set, while others display very low standard deviations on most items. Most participants, however, displayed standard deviations $\geq 1$ across the item set. The intraindividual standard deviations are provided in the supplemental materials (Appendices B8.1-B8.4).

### *Discussion and Conclusions*

The present study evaluated the ProCEss item set with regard to variability and reliability. A pilot study indicated good feasibility, participant acceptance, and manageable burden. The main evaluation indicated that most items showed adequate within-person variability, supporting the sensitivity of the ProCEss item set to reflect temporal dynamics. However, a substantial proportion of variance was attributable to between-person differences, with most

ICCs exceeding the typical EMA range. Reliability was good to acceptable for most ProCEss items. In particular, the SIMs demonstrated satisfactory performance. For multi-item measures, between-person reliability was consistently higher than within-person reliability. These findings suggest that, although the measure performs adequately, certain items and scales may require further refinement to fully capture the intended psychological processes.

**Discussion of variability.** A substantial proportion of variance was attributable to between-person differences. Methodological factors may partly explain this pattern, including the semi-randomised sampling scheme violating RMSSD assumptions (Jahng et al., 2008), and the cEMA model increasing susceptibility to recall bias (Eisele et al., 2021; Stone et al., 2023). Similar findings have been reported for the momentary Pain Catastrophising Scale (Frumkin et al., 2023). As observed in the pilot study, some participants reported boredom during participation, which may contribute to reduced within-person variability through careless responding that has been found to promote neutral responses (Wang et al., 2024). However, response start points were randomised to minimise such effects. Alternatively, lower variability may reflect psychopathology-related factors in chronic pain, including potentially more rigid behavioural patterns. While psychological factors are not inherently pathological in chronic pain (Eccleston, 2001), reduced flexibility as observed in chronic pain patients (Krypotos et al., 2022) may limit temporal fluctuations in EMA data. Blanchard and colleagues (2023) discussed a similar phenomenon in burnout syndrome, where they reflected that greater psychopathology might lead to less fluctuations.

Determining optimal sampling frequency remains challenging, as timescales may vary across processes and individuals (Frumkin et al., 2019; Wright & Woods, 2020). In the present data, exploratory artificial reduction of sampling frequency revealed negligible effects on variability, suggesting that sampling frequency did not explain the observed ICC patterns.

The findings highlight the need to further examine the sensitivity to change of the ProCEss item set. Some items, such as “I was sure I could lead my life satisfactorily even though I was in pain”, may reflect more stable attitudes rather than momentary states. The

temporal dynamics of the items should therefore be investigated both theoretically and empirically.

**Discussion of reliability.** Overall, most processes showed good to acceptable reliability. Between-person reliability for multi-item measures was consistently higher than within-person reliability, likely due to limited within-person variability and the small number of items typical of EMA scales (Nezlek, 2017).

Thought Suppression showed a marked decrease in between-person reliability after revision. This may reflect the combination of two literal thought items (“Pull yourself together/Don’t make such a fuss”) with a more abstract cognitive process. The low reliability may also indicate a validity issue, as the item “I tried not to think about my pain” was adapted from the Avoidance-Endurance-Questionnaire (Hasenbring et al., 2009), where it is associated with task persistence. Future research should examine convergent and discriminant validity and consider potential restructuring of these scales.

Self-Efficacy and Self-Compassion require further investigation. Items within these scales may be heterogeneous, as they were intended to capture different facets of the respective constructs. Both were assessed using two-item scales, for which a more liberal reliability threshold of .60 has been proposed (Yang et al., 2022), yet neither scale reached this criterion. Future research should examine item loadings using multilevel confirmatory factor analysis as another psychometric criterion as well as to establish the expected within- and between-person reliability (Yang et al., 2022).

Psychometric properties may change over time (Fritz et al., 2024), highlighting the need to assess additional properties such as measurement invariance. Given the heterogeneous nature of chronic pain (Breivik et al., 2006; Sundström et al., 2025) and the fact that the processes were derived from multiple psychological models, not all items may be relevant for every participant. Even in individual-level research, standardised instruments are required to enable data aggregation and meta-analytic synthesis (Morley et al., 2015). If the ProCEss item set were further personalised, with individually relevant items administered modularly, psychometric properties may differ. Accordingly, assessing reliability of SIMs in

each application may be advisable, as reliability is sample-dependent and may vary across individuals and time (Brose et al., 2020; Stone et al., 2023).

**Recommendations for users of the ProCEss item set.** We do not recommend calculating scale sum scores, as this would result in a loss of relevant information (Pena Loray et al., 2025). In line with this, the processes included in the ProCEss item set may not yet be fully captured by the current items and should not be considered complete representations of latent constructs.

Sleep problems are common for chronic pain syndromes and should be considered in assessment and treatment (Mathias et al., 2018). The original ProCEss item set included sleep-related items, which were removed in the current version to reduce burden and due to their differing time scale, which may complicate analyses. However, in the main evaluation they showed good between-person and sufficient within-person reliability using a more liberal criterion (> .60; Nezlek, 2017; Yang et al., 2022). We therefore encourage their use where appropriate, despite their exclusion from the core item set.

**Strengths and Limitations.** The ProCEss item is the first German EMA instrument to assess a broad range of clinically relevant pain processes. Its development followed current best-practice recommendations (Eisele et al., 2021; Fritz et al., 2024) and involved individuals with chronic pain across multiple stages, from initial feedback to pilot testing and evaluation. Content validity of the item set has been established (see preprint: https://doi.org/10.31234/osf.io/ruhdf_v3), and the main evaluation included a reasonably large and diverse sample with compliance rates consistent with those reported in EMA research (May et al., 2018; Ono et al., 2019). The preliminary revision study showed high compliance and included patients with confirmed chronic pain diagnoses. The semi-randomised sampling scheme may have reduced response bias (Stone et al., 2023).

Overall, the findings are promising, although several issues indicate the need for further refinement and evaluation of the ProCEss item set. First, especially the revised items should be evaluated in a larger sample, as they were only examined in a small cohort of $n$ = 10 participants. Given that sample size is generally more critical for statistical inference than

the number of measurement occasions (Oleson et al., 2022), the extended EMA period in the revised study cannot sufficiently compensate for the limited sample size. At the same time, findings from psychometric evaluations are sample-dependent (Brose et al., 2020; Stone et al., 2023), limiting their relevance for individual-level applications.

Second, the limited within-person variance requires further investigation, particularly with respect to timescales and alternative sampling strategies, including fixed or momentary EMA designs. A fixed sampling scheme may also reduce participant burden, as suggested by the pilot phase.

Third, reliability could not yet be established for the Negative Affect SIM. As the target sample size in the main evaluation was slightly underachieved and chronic pain status was based solely on self-report, re-evaluation in a clinical sample is warranted.
Multilevel analyses did not converge in the main and preliminary evaluations of the ProCEss item set. This is a notable limitation, as multilevel modelling is considered gold standard for EMA data (Castro-Alvarez et al., 2025; Nezlek, 2017). Future research should aim to enable more robust multilevel analyses of the item set.

**Directions for future research.** Future research should further refine, extend, and evaluate the ProCEss item set. Future work may consider estimating variability and reliability at the individual level, as has been recommended due to the sample-dependency of psychometric estimators (Brose et al., 2020).

Similarly, if items are to be administered independently rather than as scales, future research should examine the reliability of all ProCEss items at the single-item level, effectively treating each as a standalone SIM.

Some psychometric properties remain to be examined, including sensitivity to change, measurement invariance, and the item set's capacity to capture processes dynamically over time. Several processes, such as thought suppression, acceptance, or catastrophising also include evaluative or regulatory components that may not be sufficiently salient in real-time assessment. Although the ProCEss item set was administered using a cEMA approach, whereby participants reflected on a recent time window rather than the

exact moment, the process labels may require refinement to better reflect their momentary operationalisation (e.g. “pain-related worry” instead of “catastrophising”). This raises questions regarding construct validity and highlights the need for further refinement and extension of the item set.

**Conclusion.** The ProCEss item set is to the best of our knowledge the only psychometrically evaluated German EMA instrument assessing a broad range of chronic pain processes. Most scales showed adequate reliability and variability, although a substantial proportion of variance was attributable to between-person differences. Exploratory findings did not indicate a clearly preferable sampling timescale. Future research should examine subgroups with differing variability patterns (e.g. based on treatment experience) and further psychometric properties, including sensitivity to change and measurement invariance. Individual-level psychometric evaluation and a more modular structure allowing selection of personally relevant items may further support individual-level applications. Overall, the ProCEss item set represents a promising tool for EMA-based assessment of chronic pain processes.

## Chapter 3: Generating reliable treatment recommendations

Hofmann, V. E., Glombiewski, J. A., & Scholten, S. (preprint). *Matching cognitive behavioural interventions to psychological processes to personalise chronic pain treatments: an adapted group Delphi study with clinical and science experts.* PsyArXiv. https://doi.org/10.31234/osf.io/c68de_v2

Please note that all appendices are provided digitally for the printed hardcover versions of this dissertation.

**Abstract**

**Background.** Cognitive Behavioural Therapy is guideline-recommended for the treatment of chronic pain with well-established efficacy. However, treatment effects remain moderate. Recent efforts to enhance outcomes focus on process-orientation and personalisation. Intuitive personalisation approaches are vulnerable to biases. As the data base for purely data-driven algorithms in chronic pain remains insufficient, input from clinical and scientific experts appears to be a necessary interim step that may also help bridging the science-practice gap.

**Methods.** In this group Delphi study, a Matching Matrix linking cognitive behavioural modules to specific treatment targets was developed using an adapted group Delphi technique and online surveys. 22 clinicians selected two modules per target in the first Delphi round consisting of five separate groups. 15 clinicians contributed to the second round via an online survey. Their recommendations were validated by a focus group of four chronic pain science experts.

**Results.** For all 23 targets, two modules could be matched based on the assessed data. Eight out of 46 matches required discussion within the study team. Especially the first-choice modules appear well-founded.

**Conclusion.** The presented Matching Matrix is a first step towards the development of a broader evidence base for data-informed clinical decision-making in the treatment of chronic pain. The described method provides a transparent, replicable procedure for future extensions.

## Introduction

Chronic pain is a highly heterogeneous condition, requiring interdisciplinary and multimodal treatment approaches (Breivik et al., 2006; Cohen et al., 2021; Sundström et al., 2025; Turk, 1990). Among psychological treatments, cognitive behavioural therapy (CBT) is recommended by multiple guidelines (Becker & Straßner, 2023; National Institute for Health and Care Excellence [NICE], 2021). However, treatment effects at the group level remain moderate (Vlaeyen & Crombez, 2020; A. C. de C. Williams et al., 2020), and even seemed to become smaller with improving meta-analytic methods (McCracken, 2023). Given the heterogeneity of chronic pain syndromes and the substantial variability in individual treatment responses (McCracken & Turk, 2002; Scholten, Herzog, et al., 2025), it is plausible that nomothetic, group-based research might not adequately capture individual treatment effects (Gloster et al., 2024). Accordingly, personalised treatment and research approaches targeting disability-maintaining processes are increasingly advocated (Bartels et al., 2022; Finan & Garland, 2015; McCracken, 2023; Murillo et al., 2022; Scholten, Herzog, et al., 2025; Turk, 1990; Vlaeyen & Morley, 2005).

### *Definition of terms*

The terms “processes of change” and “mechanisms of change” are often used interchangeably. While mechanisms of change are commonly defined as mediating pathways that explain how an intervention leads to changes in outcomes (Ehring et al., 2022; Kazdin, 2007), Hayes and colleagues conceptualize processes of change more broadly as dynamic, potentially non-linear phenomena that may operate across multiple levels of analysis (Hayes et al., 2020). Furthermore, processes of change should be theory-based and modifiable. However, while this framework specifies characteristics that processes should exhibit, it does not provide a clearly delineated set of processes themselves. In the present study, processes were derived from established psychological models of chronic pain (Scholten & Glombiewski, 2025), for example avoidance behaviour as described in the fear-avoidance model (Vlaeyen et al., 2016). Accordingly, the processes used in this study are

theory-derived constructs that have been proposed to contribute to the maintenance of pain-related disability and other burdensome pain-related experiences.

In the present study, these processes are not assumed to represent isolated causal mechanisms but are used to derive clinically meaningful treatment targets for personalised intervention selection. Thus, we use the term *process* when referring to general psychological processes and their assessment, while the term *treatment target* denotes a specific process selected in the context of treatment and clinical decision-making. All treatment targets are therefore process-based. More specifically, treatment targets represent clinically actionable manifestations of broader psychological processes, for example asking others to take over a strenuous task (target) as a specific manifestation of avoidance behaviour (process).

Following our previous definition (V. E. Hofmann et al., 2024), an *intervention* is embedded within a *treatment module* that provides structure to its implementation, including preparation, execution, and consolidation. A treatment module extends beyond the isolated delivery of an intervention. For example, exposure in vivo may involve preparatory elements that establish treatment rationale and commitment (e.g., creating a movement hierarchy), the intervention itself (e.g., behavioural exposure), and procedures intended to consolidate treatment effects (e.g., self-management goals).

To link treatment modules to predefined treatment targets in a transparent and reproducible manner, a Matching Matrix is required. A Matching Matrix therefore does not encompass the full clinical decision-making process and does not determine which treatment target should be prioritised. Rather, it supports the selection of a treatment module once a target has been identified. In contrast, an algorithm encompasses the broader clinical decision-making process, including both target selection and treatment module indication (Hofmann et al., 2024).

***Personalisation strategies***

In routine clinical practice, therapists already personalise treatment because recommendations derived from nomothetic averages frequently do not fit individual patients

(Levinson et al., 2024). CBT therapists therefore rely on case conceptualisations and flexible adaptations of treatment protocols – an approach that calls the utility of protocols into question (McCracken, 2023). Moreover, clinical judgments underlying case conceptualisations are prone to cognitive biases and limited reliability (Lutz, Schwartz, et al., 2022; Scholten, Herzog, et al., 2025). Modular treatment frameworks, such as the Unified Protocol for emotional disorders (Barlow et al., 2017), offer an alternative to rigid protocols.

Process-based therapy has been proposed as an advancement to evidence-based practice in order to directly address processes of change instead of mere symptoms (Hofmann & Hayes, 2019). However, evidence is not yet sufficient to delineate process-intervention matches.

In parallel, data-informed decision-support systems that integrate clinical expertise into their statistical models have been proposed to address limitations of intuitive clinical judgement (Burger, Ralph-Nearman, et al., 2022; Levinson et al., 2024).

Across psychotherapy research, support-tools have been developed to match interventions to targets (e. g. Fernandez et al., 2017; Kaiser & Roth, 2022; Rubel et al., 2018). For mood and anxiety disorders, the algorithm developed by Fernandez and colleagues (2017) demonstrated promising effects (Fisher et al., 2019). However, evidence for the superiority of such algorithms over usual clinical decision-making remains scarce. Crucially, such approaches presuppose clearly specified links between interventions and the psychological processes they are intended to change. In the absence of structured and empirically grounded target-intervention mappings, decision-support systems risk reproducing intuitive or heuristic decision-making rather than improving upon it.

Idiographic and process-focused approaches have been proposed across clinical domains to complement nomothetic models by emphasising within-person change and mechanism-based decision-making (Fisher & Boswell, 2016; Levinson et al., 2024). Such approaches have shown promise in other heterogeneous conditions, including depression (Fisher et al., 2019) and eating disorders (Levinson et al., 2023). Both studies underscore the need for frameworks that systematically link interventions to treatment targets.

### *Personalisation in chronic pain treatment*

In chronic pain research, structured approaches to matching interventions to treatment targets remain particularly underdeveloped (Mauck et al., 2022). Existing personalisation strategies in chronic pain illustrate this limitation in different ways. Stratified care models assign patients to different treatment intensities based on group-level risk profiles (Scholten & Glombiewski, 2025) and have shown modest benefits in low back pain (Foster et al., 2014; Hill et al., 2011). However, recent meta-analytic evidence suggests limited advantages over usual care (Chiodo & Haley, 2024). In addition, stratified approaches do not specify how particular interventions affect individual processes.

More highly personalised treatments for chronic pain, often based on patients' preferences, have also shown encouraging results (Åsenlöf et al., 2005, 2009; Evers et al., 2002; Ferwerda et al., 2017; Gasslander et al., 2022; Kerns et al., 2014; van Koulil et al., 2010). At the same time, preference-based personalisation remains vulnerable to bias and does not ensure that selected interventions are optimally aligned with the most relevant treatment targets for a given individual. Robust moderators of treatment effects have yet to be identified in chronic pain research (Murillo et al., 2022), while traditional mediation and moderation models may be ill-suited to capture complex, non-linear, and reciprocal processes (Hayes et al., 2019).

### *Current study*

Taken together, this raises several key questions for personalised psychotherapy: In the absence of a comprehensive empirical evidence base, how can personalised treatment decisions be improved? Which psychological processes should be assessed, which interventions are best suited to address them, and how should interventions be systematically matched to treatment targets?

One approach to addressing the gap between intuitive and data-based decision-making is the systematic involvement of clinicians in the development of decision-support tools. In other clinical contexts, expert-informed approaches have been used to formalise intervention–target relationships and guide treatment selection (Bartels et al., 2022; Burger,

Ralph-Nearman, et al., 2022; Kaiser & Roth, 2022; Mauck et al., 2022). Involving science experts may further help bridge the science–practice gap. The present study therefore aimed to develop a Matching Matrix that assigns two CBT modules to psychological chronic pain–related processes by combining using a group Delphi approach (Niederberger et al., 2024).

## Methods

In this section, the overall design of the present study will be summarised. The study was preregistered (https://doi.org/10.17605/OSF.IO/MNUQA) and approved by the university's local ethics committee (#LEK-589). Informed consent as well as all data were assessed online using the platform SoSci Survey (Leiner, 2024). Patients as well as the general public have not been involved in the study's conceptualisation. Reporting standards are provided in the Appendix (C1) using the DELPHISTAR protocol (Niederberger et al., 2024).

### *Design*

The aim of the present study was to develop a Matching Matrix assigning two CBT modules ("first choice" and "second choice") to 23 treatment targets (i. e. items assessing facets of chronic pain processes, see Study Materials). To bridge the science-practice gap and bring in multiple perspectives, the development process was designed to take place in close collaboration with clinicians as well as science experts. For this purpose, the Delphi technique represents a suitable method.

The Delphi technique is used to survey experts in the field, usually across multiple rounds, in order to facilitate the development of consensus, or at a minimum increase agreement (Boulkedid et al., 2011; Niederberger et al., 2024; Powell, 2003; Trevelyan & Robinson, 2015). The following approach was implemented in the present study:

A group Delphi approach was adopted, whereby separate groups of clinicians were invited to openly discuss and provide anonymous responses to an online survey (Niederberger et al., 2024). Following common recommendations, the number of Delphi rounds was set a priori to two (Diamond et al., 2014; Trevelyan & Robinson, 2015), resulting

in Study phases 1 and 2. In Study phase 3, a focus group was conducted with science experts to cross-validate the results of the Delphi groups.

***Sample***

For study phases 1 and 2, clinicians from inpatient and outpatient settings were included. As recommended (Vogt et al., 2004), we aimed to conduct five groups, with an overall target sample size of *n* = 25. Clinicians were recruited via the university outpatient clinic and local inpatient clinics with dedicated pain treatment units. In inpatient clinics, the whole practitioner team was invited to participate, therefore different professions are represented.

Only participants who agreed to be contacted again in phase 1 were invited to the second Delphi round (phase 2).

For the science expert focus group (phase 3), we aimed for a sample size of *n* = 5. Science experts were contacted via e-mail based on their expertise in chronic pain as well as (personalising) CBT interventions.

In Delphi studies, expertise is usually used as an inclusion criterion (Powell, 2003; Trevelyan & Robinson, 2015). However, the concept of expertise remains poorly defined (Baker et al., 2006). Therefore, relevant indicators for clinical expertise were retrieved from relevant literature (Baker et al., 2006; Hill et al., 2017; Kurniawan et al., 2023; Overholser, 2010), assessed via self-report, and will be reported in detail in the sample description, in accordance with recommendations (Trevelyan & Robinson, 2015). These indicators for example included years of professional experience, number of treated chronic pain patients, or self-ratings of eM-pathic skills for clinicians, and taking part in national and international collaborations and self-rated communication skills for science experts.

Knowledge of CBT interventions and having treated at least one chronic pain patient were defined as inclusion criteria. These criteria allowed the inclusion of different professions whilst ensuring the necessary knowledge to match CBT interventions to specific treatment targets. CBT knowledge was assessed on a 7-point scale (1 = no knowledge, 7 = in-depth

knowledge). Participants who indicated knowledge below 4 (“basic knowledge”) were excluded from analyses.

Since expertise was assessed anonymously in the online survey, participants were not excluded from participating in the group Delphi procedure, but their data was excluded before analyses. The conducting researcher (VEH) did not observe a negative influence of excluded participants on the discussion process.

### *Procedure*

The complete study procedure is summarised in Figure 6. All assessments took place between January and March 2025.

**Phase 1: clinicians first Delphi round.** The aim of *phase 1* was to develop an initial Matching Matrix based on clinicians’ recommendations. As selection criterion, a majority of clinicians recommending the same module for the same treatment target was set.

*Phase 1* represents the first Delphi round and was conducted in separate groups to develop an initial Matching Matrix based on clinicians’ recommendations. Discussions were conducted separately in five groups, with each round building iteratively on the previous one. All groups were conducted and moderated by the first author (VEH), a female licensed psychotherapist (CBT) employed at the university as a PhD student. She did not partake in the open discussion, but kept track of time, answered questions regarding targets or modules, and moderated the discussion ensuring that all participants felt comfortable to speak. She also ensured that the discussion remained on the topic and ensured that arguments were not based on misunderstandings or incorrect information. In two groups, participating clinicians worked at the university outpatient clinic, therefore knowing the conducting researcher (VEH). Otherwise there was no personal contact between the conducting researcher and participants prior to or after conduction. Licensed psychotherapists and physicians received continuing education credits for their participation.

Each group took between 60 and 90 minutes. Face-to-face groups took place in the university outpatient clinic and local inpatient clinics, online groups were conducted via the platform Zoom (https://www.zoom.com/). The format of the groups depended on the

capacities of the clinics and the interviewer. Only participating clinicians and the conducting researcher were present during conduction.

All groups followed the same structured procedure: Firstly, informed consent was obtained via an online survey. This survey followed the approach described by Kaiser and Roth (2022) and allowed for anonymous responses. The clinicians were informed regarding the affiliation of the conducting researcher as well as the aim of the study project. Second, sociodemographic data and self-reported expertise indicators were assessed in the online survey. Third, each item of the ProCEss questionnaire was presented and the clinicians were asked to select their first and second choice CBT module for each item. The clinicians were instructed to imagine a patient presenting for an initial assessment session whose most promising target process was represented by the item currently displayed. For positively worded items (e. g. self-efficacy), the clinicians were asked to imagine a patient with low scores, with the therapeutic goal being to strengthen this process. This *first rating* was made anonymously in the survey. Fourth, in the first group, the clinicians were instructed to discuss their selections. From the second group, the two most frequently selected modules per item were presented. The clinicians were invited to provide arguments in favour of as well as against the presented module choices and could suggest and justify other options. Fifth, clinicians provided a *second rating* that was later used for analyses as it was considered to reflect the more informed decision.

**Phase 2: clinicians second Delphi round.** The aim of *phase 2* was to assess the agreement of the clinicians with the Matching Matrix developed based on phase 1. As selection criterion, a mean agreement of >5 on a 7-point scale (0 = do not agree at all, 6 = completely agree) for each target-module match was set.

*Phase 2* represents the second Delphi round. It was conducted online and could be completed by clinicians over a period of two weeks. Study information was provided in written form with the invitation email as well as in the online survey to download. The clinicians gave their informed consent in the online survey.

After providing sociodemographic and expertise information, the clinicians were presented with the results of phase 1 one match at a time. If the same module had been selected most frequently as both first and second choice, the next most frequently selected module was presented as the second option. In the event of a tie between modules for either the first or second choice, all tied modules were displayed, and participants were asked to rank them. They also had the option to provide written comments. These qualitative comments were used in cases that did not meet the pre-defined selection criteria to complete the matching matrix.

**Phase 3: science expert focus group.** The aim of *phase 3* was to validate the clinicians' selections by a focus group with psychological science experts. The primary criterion for final module selection in this group was majority agreement for each target-module match. If no clear majority emerged for a given target in phase 2, the decision could be overruled by the focus group of science experts. That means, a module was considered accepted if a majority was reached *either* among the clinicians *or* among the science experts, or among both. Since the science experts were not participating in the previous phases, this phase was not considered another Delphi round.

Study information was provided in written form via email prior to the session. All science experts gave verbal consent to the recording of the discussion.

The science experts received the same theoretical introduction as the clinicians in phase 1. Recording began after this introduction, when the science experts were presented with the results of the clinicians' ratings of phase 1. They were invited to discuss potential contraindications for the selected modules and to specify under which conditions the second-choice module might be preferable to the first-choice module. The recorded discussion was transcribed by a research assistant also present in the meeting for qualitative assessment of the discussion. The transcript was not returned to the participants. The qualitative comments transcribed were used in cases that did not meet the pre-defined selection criteria to complete the matching matrix.

Following the discussion of each target-module match, science experts completed an online survey in which they indicated their agreement with each target-module match on a dichotomous scale (agreement vs. disagreement), regardless of the position of the module as first or second choice. They also provided sociodemographic and self-assessed expertise indicators (see Study Materials). The science experts' focus group took 90 minutes.

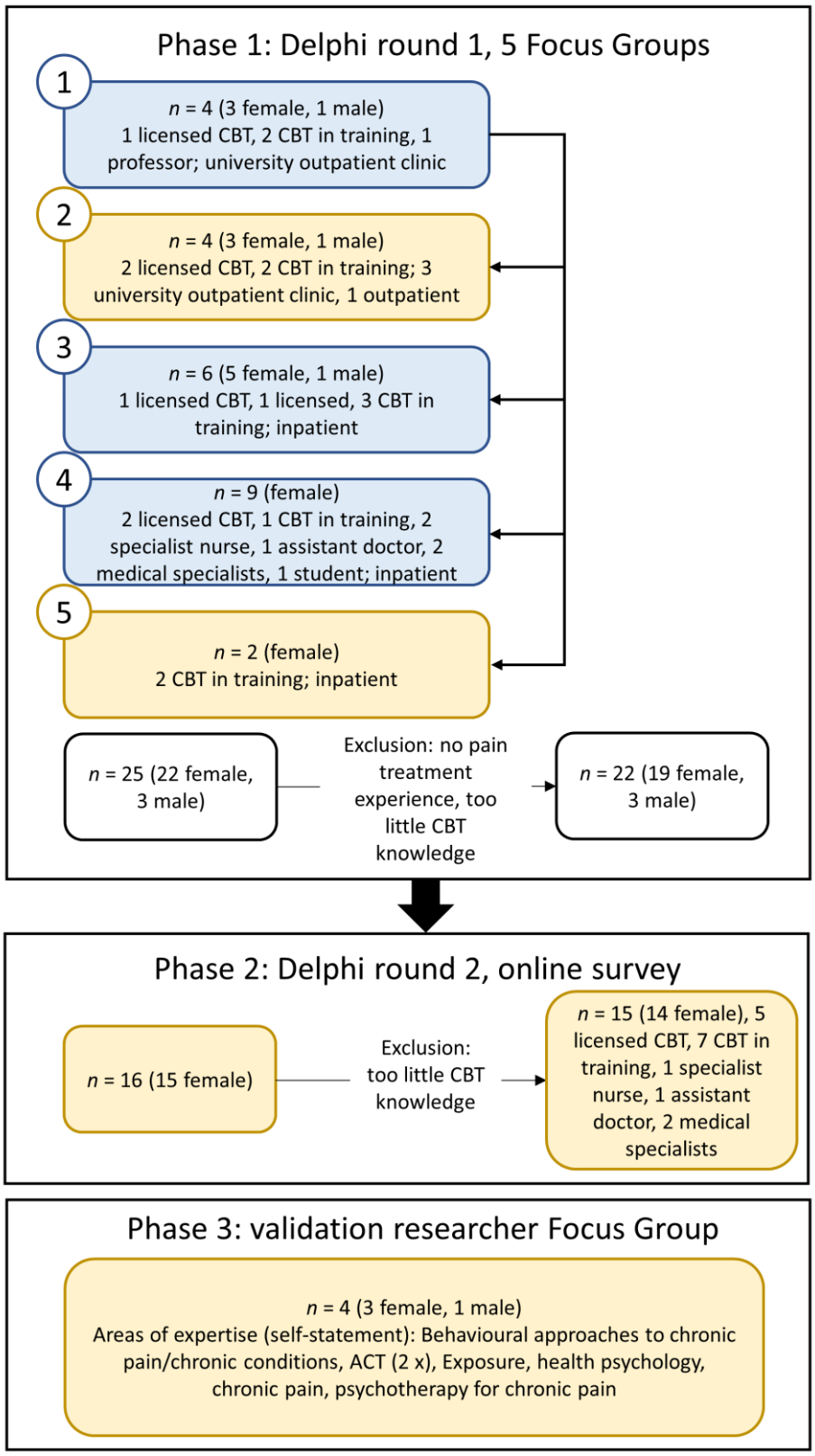
### *Study Materials*

**Treatment Targets.** The set of potential targets was based on the German "Prozesse Chronischer Schmerzen ErfaSSen" (ProCEss; English: "Assessing chronic pain processes") item set. The ProCEss item set has been qualitatively validated (Hofmann, Glombiewski, Prasch, et al., 2026) and demonstrates overall sufficient psychometric properties (Hofmann, Glombiewski, Heider, et al., 2026). Of the ProCEss item set, 23 items assessing specific manifestations of the processes catastrophising, avoidance behaviour, depressive symptoms, acceptance, values-based action, expectations, thought suppression, task persistency, positive affect, negative affect, self-efficacy, and self-compassion, were used in this study (for items, also see Table 8). The original German version of the ProCEss item set as well as relevant evaluative data can be found on the ProCEss repository (https://rptu.de/s/vpcgks).

**CBT Modules.** Regarding the treatment modules, nine CBT interventions were extracted from established treatment protocols for chronic pain. These were: Exposure in vivo, Relaxation, Activity and Rest (adapted version of Pacing), Cognitive module, Attentional Control, Activating Resources, Acceptance, Values-based action (for short: Values), and Self-Compassion. A brief description of each module including the protocol references is provided in the Appendix (C2).

**Figure 6**

*Current study procedure*




*Note.* Blue = face-to-face, yellow = online; each focus group in phase 1 was presented the cumulative results of all previous focus groups.

### *Analysis*

All analyses were carried out using R Studio (R version 4.4.1) (Posit Team, 2024), using the following packages: dplyr (Wickham et al., 2023), forcats (Wickham & RStudio, 2023), ggplot2 (Wickham, Chang, et al., 2025), openxlsx (Schauberger et al., 2025), stringr (Wickham, Posit Software, et al., 2025), tidyr (Wickham, Vaughan, et al., 2025), tidyverse (Wickham et al., 2019), and writexl (Ooms & McNamara, 2025).

The majority of clinicians recommending the same module (selection criterion of phase 1) was calculated as frequencies with which each module was recommended per target after group discussion.

As preregistered, the Gibbs-Martin Index was calculated to quantify variability in clinicians' selections (Gibbs & Martin, 1962). Given that participants could choose from nine predefined CBT modules, the index could range from 0 to 0.89. The closer the index is to 0, the fewer categories are selected – indicating a clearer consensus. Conversely, values approaching the upper limit suggest more evenly distributed selections across modules, reflecting lower agreement. The index was calculated across all item-module matches for the first and second rating and separately for the first and second choices, resulting in four indices (first rating – first choices, first rating – second choices, second rating – first choices, second rating – second choices).

## Results

### *Samples*

In the first Delphi round (phase 1), $n$ = 25 clinicians participated in five focus groups. Three clinicians were excluded from the final analyses: two participants reported no prior treatment experience with chronic pain patients, and one rated their CBT knowledge below "basic knowledge". This resulted in a final sample size of $n$ = 22.

The sociodemographic and expertise characteristics of all three samples are summarised in Table 7. A more detailed overview of those variables is provided in the Appendix (C4).

23 clinicians were contacted via e-mail to participate in phase 2. 16 of them (69.57 %) completed the online survey for the second round. One participant was excluded due to insufficient CBT knowledge, resulting in a final sample-size of *n* = 15. Reasons for not participating in this phase are not known. A more detailed overview of the sociodemographic and expertise information is provided in the Appendix (C5). The sample was compared to the sample of phase 1 with regard to all expertise indicators, as well as age, gender, secondary school qualification, and professional affiliation. No significant differences were found between the two samples on any of these variables.

Four out of the five contacted pain science experts participated in the online focus group. The four participating science experts thankfully agreed to be named. They were: Prof. Dr. Julia Glombiewski (JAG), Prof. Dr. Lance McCracken, Prof. Dr. Katja Boersma, and Dr. Marlies den Hollander. Further details on the sociodemographic and expertise variables are provided in the Appendix (C6).

**Table 7**

*Sociodemographic and expertise variables of all three phases*

| | **Clinicians Phase 1** | **Clinicians Phase 2** | **Science experts Phase 3** |
|---|---|---|---|
| **Final sample size** | 22 | 15 | 4 |
| **Age (years)** | *M* = 38.35 (*sd* = 12.52) | *M* = 37.73 (*sd* = 12.87) | *M* = 52.75 (*sd* = 6.50) |
| **Gender** | Female = 19<br>Male = 3 | Female = 14<br>Male = 1 | Female = 3<br>Male = 1 |
| **Licensed psychotherapist** | Yes = 8<br>No = 9 | Yes = 5<br>No = 7 | N.a. |
| **Specialisations*** | None = 15<br>Yes = 7 | None = 10<br>Yes = 5 | ACT = 2<br>CBT = 1<br>CBT license, Supervisor = 1<br>Licensed psychologist (Sweden) = 1 |

| | Clinicians Phase 1 | Clinicians Phase 2 | Science experts Phase 3 |
|---|---|---|---|
| **Setting*** | | | N.a. |
| Outpatient | 4 | 4 | |
| University outpatient clinic | 10 | 6 | |
| Day clinic | 3 | 1 | |
| Inpatient | 14 | 9 | |
| Other | 2 (Uni) | 0 | |
| **Number treated pain patients** | 7 x 3-10<br>3 x 11-20<br>2 x 21-50<br>10 x > 50 | 5 x 3-10<br>1 x 11-20<br>3 x 21-50<br>6 x > 50 | N.a. |
| **Ethics complaint** | No = 21<br>Yes = 1 | No = 14<br>Yes = 1 | N.a. |
| **Professional experience in years** | 11.36 (10.04) | 11.20 (10.65) | 26.75 (4.50) |
| **Scale: 1-7** | ***Mean (SD)*** | ***Mean (SD)*** | ***Mean (SD)*** |
| **EM-pathic skills** | 6.27 (0.83) | 6.47 (0.64) | N.a. |
| **Flexibility** | 5.77 (0.87) | 5.80 (0.78) | N.a. |
| **Self-reflection** | 5.86 (0.94) | 5.93 (0.59) | N.a. |
| **Pain treatment skills** | 5.05 (1.25) | 5.00 (1.00) | N.a. |
| **CBT knowledge** | 5.68 (0.72) | 5.60 (0.63) | 6.75 (0.50) |
| **Patient feedback** | 6.18 (0.73) | 6.20 (0.41) | N.a. |
| **Colleague feedback** | 6.14 (0.56) | 6.00 (0.38) | 5.50 (0.58) |
| **Student feedback** | N.a. | N.a. | 6.00 (0.82) |
| **Self-initiated continuing education** | N.a. | N.a. | 6.75 (0.50) |
| **National collabs.** | N.a. | N.a. | 6.50 (1.00) |
| **International collabs.** | N.a. | N.a. | 6.00 (1.41) |
| **Communication-skills** | N.a. | N.a. | 5.25 (0.50) |

*Note.* * multiple selection possible; N.a. = “Not available” means that the variable has not been assessed in this sample; ACT = Acceptance and Commitment Therapy; CBT = cognitive behavioural therapy; collabs. = collaborations

### *Results of phase 1: clinicians first Delphi round*

For the first 23 first-choice selections, 66.40 % of recommendations met the criterion of a simple majority. In three cases, exactly 50 % of clinicians selected the same module as their first choice. Only for one target did the first-choice module fall short of a simple majority, with 45.46 %.

Regarding the second-choice selections, the criterion of a simple majority was met for 46.84 % of the 23 targets. Agreement in percent for both the second as well as the first rating and majority outcomes for both the first and second ratings are provided online on OSF (https://doi.org/10.17605/OSF.IO/MKY3C).

In all four instances (first rating – first choice, first rating – second choice, second rating – first choice, second rating – second choice), the Gibbs-Martin Index was 0.5, indicating a moderate consensus among clinicians across items, with some preference patterns emerging alongside notable distributional spread. Accordingly, no differences from the first to the second rating and between first and second choices in the variability of clinicians' recommendations could be detected.

### *Results of phase 2: clinicians second Delphi round*

Regarding the mean agreement rating of > 5 on a 7-point scale, all first-choice modules met this threshold. Among the second-choice modules, three did not meet this selection criterion. A detailed breakdown of all agreement scores as well as the ranking of unclear choices is provided online (https://doi.org/10.17605/OSF.IO/MKY3C).

### *Results of phase 3: science expert focus group*

Regarding the primary criterion of this focus group – namely, a majority agreement (i. e. > 2) – the criterion was met for 31 out of 46 target-module matches (67.40 %). 22 target-module matches received unanimous agreement from all science experts.

### *Explorative Results*

**Frequency of module choices.** Figure 7 illustrates the frequency with which the nine CBT modules were selected as first or second choices in the clinicians' rating after discussion in phase 1. It is noteworthy that "third-wave" modules such as Self-Compassion,

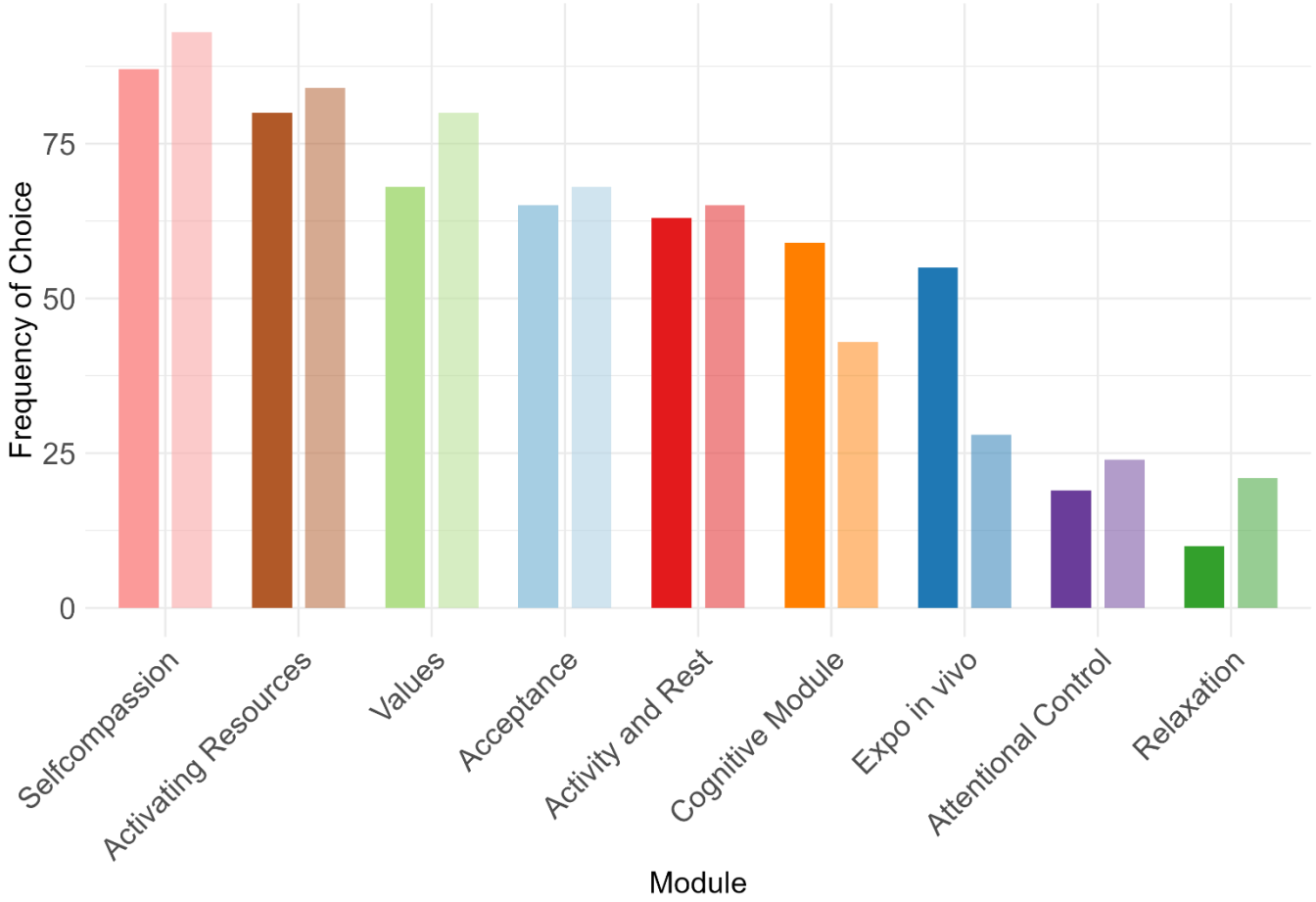
Acceptance, and Values were selected considerably more frequently than “classical” CBT modules like Attentional Control or Relaxation. This trend was also explicitly noted by several clinicians, who reported choosing “third-wave” modules more frequently in the study context than they typically do in routine clinical practice, where Attentional Control and Relaxation are more commonly applied. Notably, all nine modules were selected at least once, suggesting the overall clinical relevance and perceived applicability of the pre-selected module pool.

**Agreement shift from first to second rating.** Another noteworthy observation concerns changes in agreement in the clinicians’ recommendations before and after the discussion in phase 1. These two ratings can themselves be interpreted as separate rounds, with the second rating reflecting a more informed decision following group discussion. For the first-choice modules, agreement increased in 18 instances and remained unchanged in two. In three instances, agreement decreased from the first to the second rating. Overall, the agreement regarding the first-choice modules increased from 56.72 % before to 66.40 % after discussion.

For the second-choice modules, agreement increased after group discussion for 18 targets and remained unchanged in three instances. In two instances, agreement decreased from the first to the second rating. Overall, agreement regarding the second-choice modules increased from 38.34 % before to 46.84 % after group discussion. Agreement percentages from the first and second rating are provided online (https://doi.org/10.17605/OSF.IO/MKY3C).

**Figure 7**

*Frequency of module choices by clinicians in phase 1 in absolute numbers*




*Note.* Transparent/lighter bars represent second-choice recommendations

**Data saturation.** In qualitative research, anticipating the point of data saturation is crucial for planning the number of rounds, focus groups, and overall sample size. In this study, module choices were descriptively summarised based on the most frequently selected options after each group of phase 1 (https://doi.org/10.17605/OSF.IO/MKY3C). For eight out of 23 items, both the first- and second-choice modules were already clearly established following the first focus group. For an additional five targets, the first-choice module (but not the second-choice) was determined after the first group. Only one item showed a change after the fifth focus group, resulting in a tie. Overall, this descriptive analysis suggests that for the majority of items, module preferences were established within the first one to three focus group sessions, with only minor changes occurring during the final two groups.

## Overall Results

The final Matching Matrix is presented in Table 8. Of all 46 target-module matches, 21 (46.65 %) fulfilled all three primary criteria: a majority of clinicians in phase 1, a mean agreement of > 5 in phase 2, and a majority of science experts in phase 3. For an additional 17 matches (36.96 %), at least one majority – either among clinicians or science experts – was present, and these matches were therefore also included in the final matrix. Of these 17 matches, there were two that were included despite missing two criteria. The remaining eight target-module matches (17.39 %), all of which involved second-choice modules, were subject to discussion within the study team. These were selected based on the frequency of module selections in phase 1 and the qualitative comments from both phases 2 and 3. The study team consisted of three female psychologists, one licensed psychotherapist and PhD (SS), one licensed psychotherapist and PhD student (VEH), and one psychotherapist in training and PhD student. A detailed summary of the final Matching Matrix, including the fulfilment of each phase criterion and the rationale for decision on the eight discussed items is provided in the Appendix (C7).

**Table 8**

*Full Matching Matrix*

| Target (preliminary English translation) | First Choice | Second Choice |
|---|---|---|
| I thought: „It will never get better!" | Cognitive Module | Activating Resources |
| I thought: "I can't stand it any longer!" | Self-Compassion | Cognitive Module |
| I stopped activities because of my pain. | Exposure in vivo | Activity and Rest |
| Due to my pain, I asked others to do strenuous activities for me. | Exposure in vivo | Values |
| I avoided activities that cause pain. | Exposure in vivo | Activity and Rest |
| I felt irritable. | Self-Compassion | Acceptance |
| I felt guilty. | Cognitive Module | Self-Compassion |
| I felt sad. | Activating Resources | Values |
| I felt listless. | Activating Resources | Activity and Rest |
| I was exhausted. | Activity and Rest | Relaxation |
| I tried to befriend my pain. | Acceptance | Values |
| I was able to accept that the pain would accompany my life. | Acceptance | Values |
| I tried to prioritise those things really important to me. | Values | Activating Resources |
| I assume that my pain will increase until the next survey. | Cognitive Module | Attention Control |
| I thought: "Don't make such a fuss!"/"Pull yourself together!" | Self-Compassion | Cognitive Module |
| I tried not to think about my pain. | Attention Control | Acceptance |
| I pulled through despite my pain. | Activity and Rest | Self-Compassion |
| I felt cheerful despite my pain. | Activating Resources | Values |
| I trusted myself to be able to do something. | Exposure in vivo | Activating Resources |
| I was sure that I could live my life satisfactorily, even though I was in pain. | Values | Activating Resources |
| I tried to be friendly to myself. | Self-Compassion | Cognitive Module |

| Target (preliminary English translation) | First Choice | Second Choice |
|---|---|---|
| I have told myself that I am not alone with my problems. | Self-Compassion | Activating Resources |
| I felt ashamed. | Cognitive Module | Self-Compassion |

*Note.* Please note that all targets are preliminarily translated to English by non-native speakers. They have only been validated and psychometrically evaluated in German language yet.

**Discussion**

The aim of this mixed-methods study was to develop a structured Matching Matrix linking two CBT modules to individual, chronic pain-related processes, thereby addressing a central challenge in personalised psychotherapy: how to support clinical decision-making in the absence of robust, component-level empirical data. Using a group Delphi approach with clinicians and a focus group with science experts, a complete matrix covering 23 target processes was generated. Notably, first-choice module selections showed high robustness, as all first-choice selections met the predefined criteria and required no further discussion by the study team. This suggests that clinicians and science experts share a substantial degree of implicit agreement regarding core intervention–target relationships in chronic pain treatment.

In contrast, eight of the 23 second-choice modules required additional discussion within the study team, as they did not meet the obligatory criteria. This may reflect the broader framing of second-choice modules as “alternatives”, potentially encouraging clinicians to consider a wider range of options and thereby reducing consensus. These findings support the idea that there may be multiple viable intervention strategies for addressing a given target process (Scheidegger et al., 2023), reinforcing the idea that personalised treatment should accommodate flexibility rather than enforce singular solutions.

Across both science experts and clinician groups, “third-wave” CBT modules (e. g. Self-Compassion, Acceptance) were more frequently selected and received higher agreement. This may reflect their perceived relevance for chronic pain, where acceptance-based and contextual approaches are widely regarded as particularly suitable. At the same

time, this tendency could reflect cognitive biases – such as availability or recency effects due to recent training experiences. In the case of science experts, this may in part be explained by selection bias, as two of the four participants reported specific expertise in Acceptance and Commitment Therapy. A more systematic documentation of the arguments underlying module selection would have allowed for a deeper examination of these influences and represents an important direction for future research.

Interestingly, various modules were selected for items of the same process. This observation supports the notion that discernible facets of the same process may require different treatment approaches, and that using for example sum scores of processes assessed with multiple items might result in loss of therapy-relevant information (Pena Loray et al., 2025). More broadly, these results echo ongoing debates regarding mechanisms of change in psychotherapy. While it seems unlikely that specific interventions only affect one target at a time (Henry et al., 2022), understanding the differential effects of theoretically distinct interventions remains a key challenge for improving CBT (Cohen et al., 2023). Emerging evidence questions the existence of strictly intervention-specific mechanisms (Burns, 2025), suggesting that selecting modules for isolated targets may be overly simplistic. Future work may therefore benefit from identifying efficacy profiles that capture patterns of effects across multiple interacting targets.

Data saturation within the clinician sample may have been reached prior to the fifth clinician group. From a resource-oriented perspective, fewer groups could therefore be sufficient for developing a Matching Matrix of this kind. The focus group of science experts proved to be useful for validating the clinicians' selections, with 17 of the final target-module matches being supported by at least one majority criterion.

In most cases, agreement between clinicians in phase 1 increased from first to second rating. This might reflect a tendency to agree with the previous focus group, the results of which were presented after the first rating, enhanced by the prompt to deliver arguments in favour with these recommendations. Cases in which agreement decreased could be explained by especially empathetically made arguments against the previous

results that did not occur very often. However, both these explanations are based on the impression of the conducting researcher (VEH). Future research should consider transcribing the arguments provided so that agreement shifts can be analysed more systematically.

From a clinical perspective, personalised psychotherapy rarely involves a single intervention in isolation. Rather, treatment decisions unfold iteratively, requiring clinicians to determine not only *which*, but also *when* to apply an intervention (Fisher & Boswell, 2016). Although the present Matching Matrix does not prescribe a fixed intervention sequence, it is compatible with such an iterative approach by supporting repeated target selection and module assignment across treatment phases. Future research should examine how such matrices can be integrated into longitudinal treatment planning, including the determination of meaningful endpoints of the intervention and the treatment in general.

While the present matrix does not replace empirical effect estimates, it provides a formalised representation of expert knowledge that can serve as a foundation for future data-driven refinement. Importantly, the challenge of evidence-based personalisation in the absence of sufficient empirical data is not unique to chronic pain, but reflects a broader issue in psychotherapy research, where the aspiration for personalised treatment often outpaces the available evidence base. Consequently, both the Matching Matrix itself as well as the detailed description of the development process present valuable starting points for future research on personalised CBT within and beyond the context of chronic pain.

### *Strengths and Limitations*

This study adhered to current recommendations for systematic and structured clinician surveys (Kaiser & Roth, 2022), employing a collaborative framework to enhance the acceptability of the resulting matrix (Levinson et al., 2024) as well as its ecological validity, and predefining methodological procedures in accordance with established guidelines (Diamond et al., 2014; Trevelyan & Robinson, 2015). In response to common criticisms of Delphi studies, indicators of clinical expertise were assessed following relevant recommendations (Baker et al., 2006; Boulkedid et al., 2011; Hill et al., 2017; Overholser,

2010) and transparently reported alongside consensus in the form of percentage agreement (Diamond et al., 2014).

A further strength of the present study lies in the composition of the expert samples. The literature recommends heterogenous samples involving experts from diverse professional backgrounds and settings (Baker et al., 2006). Furthermore, such an approach reflects the multimodal treatment reality of chronic pain. In this study, a minimum level of expertise was ensured, while still allowing for a broad range of professional roles and clinical experience. As such, we consider the clinician sample to be well suited to the study objective, with the results likely to be both ecologically valid and reasonably reliable. The inclusion of psychological science experts complemented the clinician perspective by introducing a more theoretical and research-informed viewpoint. Taken together, these two expert groups may contribute to bridging the science-practice gap – an effect that could be amplified by bringing science experts and clinicians into direct discussion. Additionally, both the number of focus groups (Vogt et al., 2004) and the sample sizes in the Delphi rounds (Baker et al., 2006) followed established methodological recommendations.

From an epistemic perspective, the present study should be understood as an interim step between intuitive clinical judgement and fully data-driven decision-support systems. It reflects clinician and researcher recommendations. While previous research suggests a likely mismatch between clinical judgement and data-oriented decision-making tools (Fernandez et al., 2017), collaboration with clinicians appears to be a necessary interim step to generate robust data for algorithmic approaches. The method used to create the present Matching Matrix is replicable, and applying the Matching Matrix in psychotherapy research will allow studying module-specific effects on clearly defined treatment targets.

However, patients have not been included in this study project, which should be considered in future studies. It is yet unclear how algorithmic decision guidelines such as this Matching Matrix can be incorporated in an interactive, shared-decision making process (Wester et al., 2025), that is and should be the gold-standard in clinical practice. Especially as long as evidence for algorithmic decision-tools is scarce, additional information such as

patients' preferences should be included (Wester et al., 2025). In this study, such additional information was considered regarding contraindications for certain interventions and were discussed in the researcher focus group. We advise users of the Matching Matrix to reflect if any adverse effects are anticipated when following the recommendations for any individual patient, and of course to obtain informed consent.

The use of a predefined pool of CBT modules introduced a top-down element to the procedure, potentially omitting relevant interventions (e. g. problem-solving). The same holds true for the predefined set of process items. However, earlier, unpublished study projects had shown that, in the absence of a predefined module pool, discussions became overly broad and unmanageable within the given timeframe.

Some clinicians reported potential framing effects or the tendency to project personal clinical experience onto the items, since they were presented without contextual case vignettes. One promising alternative to mitigate this limitation could be to reverse the selection logic – asking clinicians to identify the most relevant target processes for specific modules, rather than selecting modules for processes. Another possibility would be the use of personas to guide the discussion process (Bartels et al., 2023).

From a methodological perspective, potential order effects cannot be ruled out, as randomisation of item presentation was not feasible. Future studies should consider randomising the order of items or modules. Moreover, due to time limitations, the discussions among clinicians and science experts were relatively brief and should be regarded as thought prompts rather than in-depth deliberations.

Since no transcripts of the focus groups in phase 1 were made, more detailed insights regarding agreement and disagreement of the clinicians cannot be reported. The option to leave comments in phase 2 was used by few clinicians as well. Future research should incorporate a more systematic assessment and analysis of qualitative data.

Additionally, allowing more extensive discussions in future work may facilitate clearer consensus-building and potentially lead to greater convergence among participants.

## Conclusion

In the present study, a mixed methods approach including Delphi technique and focus groups was applied in close collaboration with practicing clinicians as well as renowned pain science experts that resulted in a matrix linking CBT modules of first and second choice to 23 chronic pain processes. By formalising intervention–target relationships, the present Matching Matrix addresses a central bottleneck in personalised psychotherapy: the absence of structured guidance when empirical evidence is incomplete. The procedure used to develop this Matching Matrix is replicable, suitable to bridge the science-practice gap, and can guide future efforts to personalise psychotherapy, also beyond the context of chronic pain.

Several key questions remain to be answered, including which processes are most suitable as therapeutic targets, how they can best be assessed, and which interventions are most effective in addressing them. Ultimately, the aim of research in this area should not be to replace clinicians, but to support them in making evidence-based, personalised decisions (Levinson et al., 2024; Lutz, Schwartz, et al., 2022; Wester et al., 2025). The present study may serve as an interim step towards a more data-based clinical decision process. A stronger empirical basis is urgently needed to predict the effects of particular methods on defined target processes (Cohen et al., 2023; Murillo et al., 2022) and to determine the usefulness of specific targets versus more complex efficacy profiles in the absence of intervention-specific mechanisms of action (Burns, 2025).

## Chapter 4: An integrative framework of personalised CBT for chronic pain

Hofmann, V. E., Glombiewski, J. A., Kininger, F., & Scholten, S. (2024). How to personalise cognitive-behavioural therapy for chronic primary pain using network analysis: study protocol for a single-case experimental design with multiple baselines. *BMJ Open, 14*(12). https://doi.org/10.1136/bmjopen-2024-089319

Please note that all appendices are provided digitally for the printed hardcover versions of this dissertation.

### Abstract

**Introduction:** Cognitive-Behavioural Therapy (CBT) is an effective treatment for Chronic Primary Pain (CPP), but effect-sizes are small to moderate. Process-orientation, personalisation, and data-driven clinical decision-making might address the heterogeneity among persons with CPP and are thus promising pathways to enhance the effectiveness of CBT for CPP. This study protocol describes one approach to personalise CBT for CPP using network analysis.

**Methods and analysis:** A Single-Case Experimental Design (SCED) with Multiple Baselines will be combined with Ecological Momentary Assessment (EMA). Feasibility and acceptance of the study procedure will be demonstrated on a sample of $n$ = 12 adults with CPP in an outpatient clinic. In phase A, participants complete 21 days of EMA, followed by the standard diagnostic phase of routine clinical care (phase B). Person-specific, process-based networks are estimated based on EMA data. Treatment targets are selected using mean ratings, strength, and outstrength centrality. After a second, randomised baseline (phase C), participants will receive one out of ten CBT interventions, selected by an algorithm matching targets to interventions, in up to ten sessions. Finally, another EMA phase of 21 days will be completed to estimate a post-therapy network. TAU-U and Hedges' g are used to indicate individual treatment effects. Additionally, conventional pain disability measures (PDI, adapted QBPDS) are assessed prior, post, and three months after phase C.

**Ethics and dissemination:** Ethical considerations were made with regard to the assessment-induced burden on the participants. This proof-of-concept study may guide

future studies aiming at personalisation of CBT for CPP as it outlines methodological decisions that need to be considered step-by-step. The project was approved by the local ethics committee of the psychology department of University Kaiserslautern-Landau (#LEK-457). Participants gave their written informed consent prior to any data assessment and app installation. The results of the project will be published, presented at congresses, and relevant data will be made openly accessible via the Open Science Framework (OSF).

**Note:** The case example described in this study protocol (Mrs. Algae) is fictitious and does not represent any real case or data.

## Introduction

Dolores Algae, 60 years old, is one of around 30 % of people worldwide living with Chronic Primary Pain (CPP) (Cohen et al., 2021), seeking treatment to relief her pain in her right arm and hand. In the absence of a sufficient somatic diagnosis, Mrs. Algae is diagnosed with persistent somatoform pain disorder (*ICD-10 Version:2019*, n.d.), or somatic symptom disorder with predominant pain (*Diagnostic and Statistical Manual of Mental Disorders | Psychiatry Online*, n.d.). In accordance with national and international guidelines, she is being referred to Cognitive-Behavioural Therapy (CBT) (Cohen et al., 2021; Deutsche Schmerzgesellschaft, n.d.; NICE, 2021). That way, Mrs. Algae and her therapist can expect a small to moderate effect on her symptoms (McCracken, 2023; Morley et al., 2015; Vlaeyen & Crombez, 2020; Williams et al., 2020).

Despite evolving research methods, the observed effects of CBT on CPP did not increase (McCracken, 2023). One plausible explanation is that results of nomothetic studies on group-level – such as from Randomised Controlled Trials (RCTs) – might not be applicable to individuals like Mrs. Algae (Fernandez et al., 2017; McCracken, 2023; Vlaeyen & Crombez, 2020). For valid nomothetic inference, the data must be “ergodic”, i.e., the same statistical model must hold at both group- and individual levels, and the assumption of stationarity must hold (Adolf & Fried, 2019; Gloster et al., 2024; Medaglia et al., 2011; Molenaar, 2004). In other words: A group and its components (i.e. participants) have to be homogenous regarding the effect, and there is no variability over time. In human sciences,

these assumptions are almost never met (Fisher et al., 2018; Gloster et al., 2024). As the CPP population is characterized by an especially noticeable heterogeneity, generalisations to the individual might not only be invalid, but the observed averaged effects could be impaired by idiographic differences in the effect (Breivik et al., 2006; Gómez-Pérez et al., 2020; McCracken, 2023).

So, how could Mrs. Algae's treatment be improved? Bartels et al. (2022) argue that person-centred and behavioural interventions are necessary for sustained benefits of CPP treatment across different outcomes. This agrees with calls for a paradigm-shift in the treatment of CPP (McCracken, 2020, 2021, 2023): Mrs. Algae's treatment should be tailored to her individual circumstances, focusing on therapy-relevant processes instead of mere symptoms (Cohen et al., 2021), an approach emerging for the treatment of mental illness in general (Hofmann & Hayes, 2019; Wright & Woods, 2020). Process-oriented therapy could facilitate the understanding of mechanisms of change, the dissemination of evidence-based strategies, and provide an alternative, more plausible model for aetiology and treatment response than focusing on symptoms and syndromes alone (Hofmann & Hayes, 2019).

***New methods for process-orientation and personalisation***

The requested paradigm-shift requires precise and testable models that allow to link treatment procedures to psychological changes (Vlaeyen & Crombez, 2020). Unfortunately, current models are rather vague about specific, especially temporal, interactional pathways, or the pathways prove to be more complex than proposed (Edwards et al., 2016; Wideman et al., 2014).

In addition, CBT usually consists of standardised treatment protocols containing several interventions that are applied consecutively to all patients, assuming that within the protocol there will be a suitable method for everyone. By breaking down evaluated treatment protocols into treatment modules, they can be used and tested independently without the necessity to develop entirely new interventions (Delgadillo & Lutz, 2020). We define "module" as the application of a specific intervention, including the necessary psycho-education, motivation, and consolidation. As in clinical practice therapists already select

single interventions out of protocols for personalising purposes (McCracken, 2023), they should be evaluated separately regarding effectiveness and functional associations with therapy processes (Hofmann & Hayes, 2019).

Supposing that separate modules exist, Mrs. Algae's therapist would plan therapy by selecting and prioritising one or several modules. To avoid cognitive biases, Mrs. Algae's data should inform the clinical decision-making process (Lutz, Schwartz, et al., 2022; Scholten et al., 2022). A promising approach to personalisation, process-orientation, and data-driven decision-making could be the combination of Ecological Momentary Assessment (EMA), person-specific network analysis, and Single Case Experimental Design (SCED) (Schemer et al., 2023).

EMA allows the longitudinal assessment of relevant processes during the patients' daily lives and reflects inter- and intraindividual variation over time (Lutz, Schwartz, et al., 2022; Wright & Woods, 2020). It is ecologically valid, reduces recall bias, and fulfils the requirement of repeated, systematic measures of SCED as well as of time-varying network analysis (Bentley et al., 2019). There are helpful guidelines to the implementation of EMA in general (Eisele et al., 2021) as well as in clinical (Palmier-Claus et al., 2011), and even pain-specific contexts (May et al., 2018; Stone et al., 2021).

Network analysis on the other hand can model interactive processes and could support personalised and data-driven clinical decision-making (Borsboom, 2017; Bringmann, 2021; Hofmann et al., 2016). Person-specific networks graphically depict interrelated phenomena, describing each recorded symptom, construct, or process as "node", and the links between them as "edges". Temporal relationships between two measurement timepoints can be mapped using autoregressive statistical methods and depicted as arrow-shaped edges in the network; contemporaneous correlations can be estimated using the residuals of the temporal relationships and are represented as line-shaped edges, i.e. representing relations within a measurement window (Bringmann, 2021; Fisher et al., 2018; Fried & Cramer, 2017; Hofmann et al., 2016). Contemporaneous edges can be interpreted as undirected partial correlations or conditional dependencies, while temporal edges

represent predictive, directed relationships over consecutive timepoints. Both models can used complementary (Scholten, Rubel, et al., 2024).

Person-specific networks can guide clinical decision-making by delivering statistical, so-called centrality parameters on the relative importance of each node within the network (Fisher et al., 2017; Hofmann et al., 2016). For contemporaneous and temporal networks there are different parameters, and the information generated from both can complement each other (Scholten et al., 2022). An overview of the different centrality parameters can be found for example in Hofmann and colleagues (2016) or Hofmann and Curtiss (Hofmann & Curtiss, 2018). In contemporaneous networks, strength centrality equals the sum of the edges' weights of a certain node, giving insights on the overall strength of associations of this node with the others (Fisher et al., 2017; Wright & Woods, 2020). In temporal networks, outstrength centrality shows the degree to which one node predicts other nodes (Fisher et al., 2017). Centrality parameters are already used in order to interpret person-specific networks (Bringmann, 2021), as central nodes are thought to convey information on linked nodes as well (Hofmann & Hayes, 2019), and might thus be promising, data-driven treatment targets. Levinson et al. (2023) successfully used centrality parameters to personalise the treatment of eating disorders.

Several research groups developed algorithms to match interventions (like exposure in vivo or relaxation) to assessed symptoms (like avoidance or pain intensity) (Fernandez et al., 2017; Kaiser & Laireiter, 2017; Kaiser & Roth, 2022). Applied to Mrs. Algae's treatment, this procedure would lead to treating the most promising target first with one specific intervention. Later on, Mrs. Algae's network could be assessed again, ideally leading to a new target and recommended intervention. The sequence of interventions plays an essential role when it comes to personalised treatment (Fisher & Boswell, 2016).

Finally, SCEDs offer a practical and cost-effective opportunity to evaluate the effectiveness of personalised interventions on the individual level (Scholten, Schemer, et al., 2024), thus overcoming the problem of non-ergodicity (Bentley et al., 2019; Morley, 2018; Morley et al., 2015) and ethical issues of waitlist controls (Gómez-Pérez et al., 2020). In

contrast to RCTs, Mrs. Algae would become her own control by being assessed multiple times in various study phases: Experimental control is achieved by manipulating the treatment onset (independent variable), for example by randomising the length of Mrs. Algae's baseline phase, and assessing the targeted therapy process repeatedly (dependent variable) (Tanious & Onghena, 2021; Tate et al., 2020). This experimental control poses a significant advantage over uncontrolled case studies (Kazdin, 2019), and the frequently repeated measures ensure internal validity and statistical power (Bentley et al., 2019).

SCEDs are advocated as a potential bridge between research and clinical practice (Barlow et al., 2009; Barlow & Hersen, 1973; Berg et al., 2024; Hayes, 1981; Kazdin, 2019; Tate et al., 2020; Vlaeyen et al., 2022; Vlaeyen & Crombez, 2020), have already been applied in several clinical studies (Blackwell & Holmes, 2010; Curreri et al., 2022; Gorczynski et al., 2014; Hague et al., 2015; Halldorsson & Salkovskis, 2017; Hicks, 2019; Ramaiya et al., 2018; Roberts-Collins, 2016), and are starting to play an increasingly important role in the field of CPP (Gómez-Pérez et al., 2020; Jones & Hurrell, 2019; Morley et al., 2015; Schemer et al., 2018; Vlaeyen et al., 2001). SCEDs can be methodologically evaluated using the Risk of Bias in N-of-1 Trials Scale (RoBiNT) (Tate et al., 2013, 2015). For an overview of different SCEDs as well as their specific advantages and limitations, see Barlow and colleagues (2009), Kazdin (2019), Morley (2018), or Vlaeyen and colleagues (2020, 2022). A helpful guide to combined designs can be found in Tanious and Manolov (2023). Tanious and Onghena (2021) systematically reviewed current literature on applied SCEDs regarding designs and application of reporting guidelines.

**Objectives**

The present proof-of-concept study represents one of the first attempts to evaluate the feasibility and acceptance of a procedure that aims to combine EMA, network analysis, and SCEDs. Data will be collected in an EMA before the start of treatment and the data will be used to estimate person-specific networks. The networks will be used to guide data-driven clinical decision-making regarding treatment target and intervention using an algorithm.

Patients and therapists are involved to evaluate the procedure using SCEDs. Evidence on the effectiveness of this personalised procedure will be explored.

### *Research Questions*

(1) We assume that the implementation of the process-oriented, individualised, network-based therapy for CPP (POINT Pain) is feasible for and accepted by patients as well as therapists. Both aspects are operationalised as mean ratings > 3 on a 5-point Likert scale and > 1 on a 7-point Likert scale (-3 to +3) in a feasibility and acceptance questionnaire, as well as positive feedback in a semi-structured qualitative interview (see Methods section).

(2) Furthermore, we expect POINT Pain to lead to a significant improvement during the intervention phase compared to the baseline phase, i.e. a decreasing score in the individual treatment target derived from the person-specific network (see Adapted Algorithm). This will be analysed visually on the one hand (trend, level) and supported by statistical parameters on the other (see SCED evaluation).

## Methods and Analysis

The procedure of the POINT Pain project has been preregistered on ClinicalTrials (https://clinicaltrials.gov/study/NCT06179784).

### *Design*

An ABA'C Multiple Baseline Design is chosen to evaluate the effectiveness of POINT Pain in an outpatient setting. Multiple Baseline Designs can be used across participants, behaviours, or settings (Tanious & Manolov, 2023; Tate et al., 2020), thereby replicating potential treatment effects. In Multiple Baseline Designs across participants, a baseline for each participant is assessed, while the treatment onset for each participant varies (Morley et al., 2015). Unlike other forms of SCEDs, the treatment in Multiple Baseline Designs is not withdrawn once introduced (Tanious & Manolov, 2023). Ferron and colleagues (2009, 2010) discuss the application of Multiple Baseline Designs in detail.

Firstly, a baseline assessment (A) is conducted over a period of 21 days six times per day using EMA. The waking hours of the participants (presumably between 9am and 9pm) are divided into six equally spaced time intervals and questionnaire prompts are presented

semi-randomised within each interval. After completion of phase A, a person-specific network is estimated.

Secondly, a diagnostic phase (B) is initiated. Phase B will comprise three weekly sessions, including a first interview, biographical anamnesis (i.e. exploration of relevant biographical background like early attachment or learning experiences), and functional analysis (obligatory in Germany for a CBT case conceptualisation, i.e. analysis of maintaining factors within a pre-defined, representative, individual problematic situation). At the end of phase B, participants will be asked to indicate which five to six items from the EMA questionnaire they deem to be the most personally relevant. The selection is used to complement item selection for the person-specific network. For the following assessments, up to two idiographic items can be formulated and added to the questionnaire to increase compliance. The assessment protocol is changed to three assessments per week, two during the week and one on the weekend. Prompts are semi-randomised during the same times of day as during the EMA. This assessment mode is continued throughout all following phases.

Thirdly, a second baseline (A') is assessed. Its length will be randomised across participants (Multiple Baseline Design) between one and three weeks. During phase A', study therapist, supervisor, and a researcher of the study management meet for the so-called Algorithm-Guided Intervention Selection Team (AGIST). The process of the AGIST is depicted in figure 8 and has the following structure:

1. The study therapist verbally presents the information of the diagnostic phase, i.e. results of the (biographical) anamnesis and functional analysis, to the supervisor. Neither study therapist nor supervisor have knowledge of the person-specific networks and algorithm yet.

2. As a result, study therapist and supervisor develop a mutual understanding of the case conceptualisation.

3. Supervisor and study therapist review ten available treatment modules (see table 9).

4. Based on this review, they select three modules that are considered the most suitable for the case at hand.

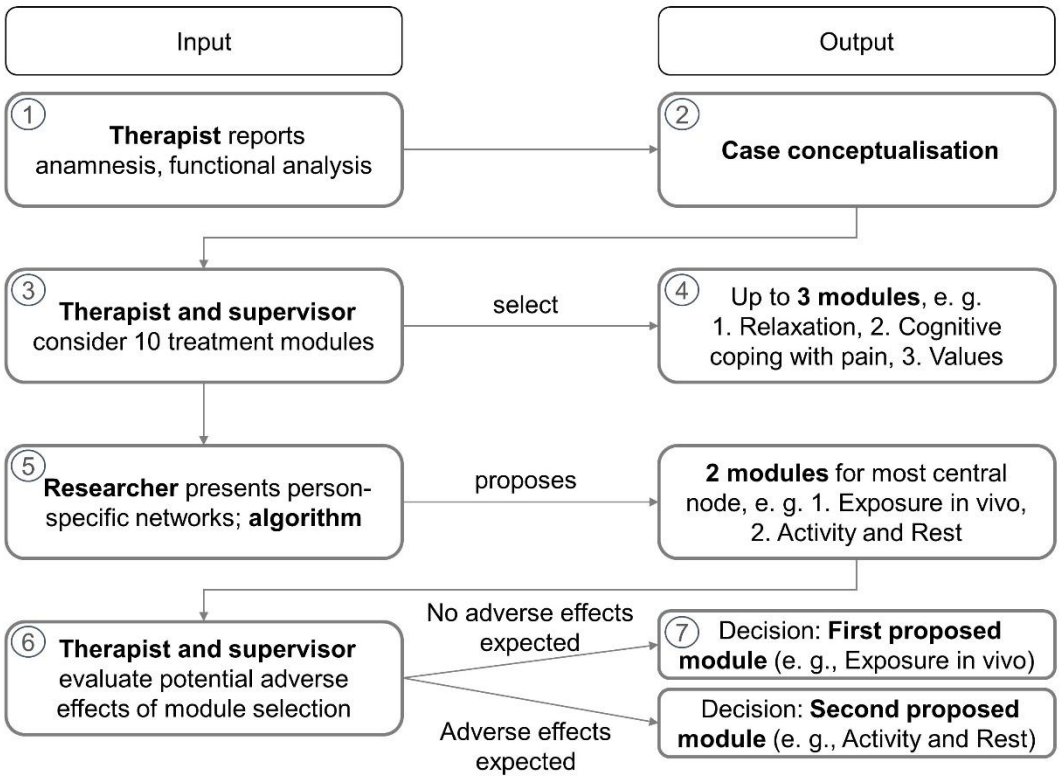
5. The researcher presents the person-specific networks as well as the according result of the algorithm to the supervisor and study therapist. The algorithm always proposes two modules for each case, based on the averaged centrality of both person-specific networks (see Patient Allocation and Adapted Algorithm).

6. Supervisor and study therapist reflect if adverse effects are to be expected for the first recommended module of the algorithm.

7. Supervisor and study therapist decide on the first algorithm option if no adverse effects are expected, otherwise the second option will be applied.

**Figure 8**

*Process of the Algorithm Guided Intervention Selection Team*




Subsequently, the intervention phase (C) is realised. Sessions 1 + 2: All participants receive psychoeducation, including motivational aspects. Sessions 3 - max. 12: The selected intervention is carried out until significant improvement is reached (see SCED evaluation) and maintained over at least two weeks, or until a maximum of ten intervention sessions has

been conducted. The two-week criterion was chosen to ensure that the observed effect was not an outlier (e.g., due to holidays or other exceptional circumstances) while remaining within pragmatic time limits, given the maximum therapy duration of ten sessions and subsequent EMA phase.

In a post intervention phase, participants will receive two monthly booster sessions for monitoring purposes, while they undergo two additional weeks in SCED mode. Afterwards, another EMA phase of 21 days and six assessments per day will be implemented. Follow-up will take place three months after the last session of phase C. The sampling-scheme is summarised in the Appendix (D1; also available as table 1 on OSF: https://osf.io/8xujc/?view_only=c05ad626aa064f6b83d771bfbea0e43e). We also rated the study design on the RoBiNT scale (Appendix D2, also available as table 2 on OSF: https://osf.io/8xujc/?view_only=c05ad626aa064f6b83d771bfbea0e43e) (Tate et al., 2013, 2015). Overall, we reached a conservative rating of 18 (out of 30 possible) points. We fell short on the design as participants do not start assessment concurrently, as well as blinding, which is always hard to achieve in psychotherapy studies. The present study does not contain further replication of the treatment effect, but further research will be planned based on the results. For capacity reasons, the research team also functioned as study therapist in at least four cases, compromising the scores for blinded assessors as well as treatment fidelity.

***Participants***

In the context of SCEDs, each individual is analysed separately, thus, a sample of $n = 1$ would be sufficient. Regarding the qualitative outcomes (feasibility, acceptance), it can be assumed that a sample of twelve will lead to a saturation in obtainable answers (Guest et al., 2006; Turner-Bowker et al., 2018). Thus, we aim for a sample of $n = 12$ adult patients with CPP: (1) to evaluate whether the study procedure is feasible and accepted by patients as well as their therapists, and (2) to monitor clinically significant change within each individual SCED.

Patients will be recruited via the waiting list of the university's outpatient clinic, contacting licensed physiotherapists and physicians as well as inpatient clinics, and via various media (e.g. newspaper articles, radio). For patients recruited via the waiting list, screening for suitability will take place during the first consultation at the outpatient clinic. Other patients will be screened per telephone. Recruitment for the project began at 9th of November 2023 and was completed at 18th of June 2024. As of the date of submission, 15 participants were enrolled in the project. Three dropouts lead to a current sample-size of $n = 12$. Data collection is currently ongoing and is expected to be completed in March 2025. The current [as of 8th of August 2025] recruitment status is depicted in the Appendix (D3, also available as figure 1 on OSF: https://osf.io/8xujc/?view_only=c05ad626aa064f6b83d771bfbea0e43e).

Therapists (licensed CBT therapists or in advanced CBT training) will be recruited via the outpatient clinic.

***Inclusion and exclusion criteria***

Inclusion criteria are at least 18 years of age, having access to a smartphone (from Android 5.1 or iOs 11.0), main diagnosis of CPP (ICD-10: F45.4x) (*ICD-10 Version:2019*, n.d.), and subjective pain-related disability. Exclusion criteria are acute conditions of comorbid disorders (substance abuse, psychosis, dangerous underweight, suicidality), migraine, headache, or neck pain as only or primary issue, illiteracy, insufficient German knowledge, and physical inability to visit the weekly sessions. German knowledge is assessed via self-report on a 5-point Likert-scale if German is not the first language, with higher values indicating less German knowledge. Insufficient German knowledge is operationalised as values of 4 or higher (i.e. "bad" or "very bad"). If language barriers are observed throughout the first two assessments with the researcher, participation in the study is carefully reflected within the study management and will be discussed transparently with the participant. Participants cannot parallelly take part in another psychotherapy study or have an ongoing psychotherapy or similar treatment. Main diagnosis and comorbid disorders

are determined using the German Brief Version of the Diagnostic Interview for Mental Disorders (Mini-DIPS) (Margraf & Cwik, 2020).

***Randomisation***

As described above, the daily timepoints of the EMA as well as dates and times of the SCED assessments will be semi-randomised within fixed intervals. Additionally, the duration of the second baseline (A') will be randomised between one and three weeks.

***Patient allocation***

Patients will be allocated to one out of ten interventions (see intervention section) according to their treatment target. The treatment target is selected by modelling the six items with the highest mean value in phase A plus up to two subjectively relevant items (asked in phase B) in the person-specific network.

An adapted version of the Dynamic Assessment Treatment Algorithm for Individual Networks (DATA-IN) is used to select the treatment target (see analysis section for further details) (Rubel et al., 2018). For all items modelled, strength centrality of the contemporaneous, and outstrength centrality of the temporal network will be averaged, and the item with the highest average score will be selected as treatment target.

The target was used in combination with a matching matrix. It matches two treatment modules to each item of the EMA questionnaire. The matching matrix was constructed following the procedure described by (Kaiser & Roth, 2022). Briefly, a sample of German-speaking CBT therapists and psychotherapists in advanced training participated in an online survey. They were asked to select up to two most appropriate treatment modules (see table 9) for each item of the EMA questionnaire. Based on their responses, a matching matrix was created, assigning two modules to each item using confirmatory factor analysis. A more detailed description can be found in the preregistration: https://doi.org/10.17605/OSF.IO/BNFWY.

This process of identifying the target based on the person-specific network and assigning treatment modules is referred to as the algorithm.

In the decision-making process (AGIST), study therapist and supervisor are presented the person-specific network, the resulting personal treatment target, and the two intervention choices according to the matching matrix (see above), all of which are analysed before the AGIST by a researcher of the project (see Data Analysis). Supervisor and study therapist can overrule the algorithm's recommendation only if adverse effects are anticipated (e.g. exposure in vivo with existing red flags). The same intervention will be carried out throughout phase C if no adverse effects or non-response over several weeks is observed. Only in case of adverse effects or lasting non-response can the participant be allocated to another intervention, which will be discussed in supervision.

***Intervention***

Ten therapy modules were derived from evaluated CBT protocols that are commonly used in practice and comply to present guidelines. The interventions, their respective goals, and exemplary content are summarised in table 9 (also available as table 3 on OSF: https://osf.io/8xujc/?view_only=c05ad626aa064f6b83d771bfbea0e43e).

If Mrs. Algae took part in the POINT Pain project and went through the first baseline and diagnostic phase, her data might suggest avoidance behaviour as the treatment target, whereupon the algorithm prescribes exposure in vivo as the preferred intervention. As all interventions are constructed in modules, they follow the same structure: At first, an individual explanation model is developed with each patient, considering the person-specific network (e.g. fear-avoidance model for Mrs. Algae) (Hasenbring et al., 2009; Hasenbring & Verbunt, 2010; Vlaeyen & Crombez, 2020). Furthermore, the treatment rationale is deduced from the model and network, and consent for the implementation of the respective module is obtained. After a short diagnostic phase (e.g. observing Mrs. Algae's behaviour, developing a movement hierarchy with her), the selected intervention is applied (e.g. Mrs. Algae lifts a water box into her car boot). Finally, successes and newly developed strategies should be consolidated and transferred to self-management goals (Mrs. Algae could take on the weekly shopping). The number of sessions to be used for each module segment is not specified to allow for personalisation. In addition, it is left to the therapist to convey the intervention in

double or single sessions (single session = 50 minutes). The intervention ends either after ten sessions or if a significant treatment effect is observed over a period of two weeks. The end of the therapy phase (C) will always be discussed in supervision.

Before administering the intervention and interpreting the networks, all study therapists participated in a workshop on SCED and person-specific network analysis. This ensures that therapists have basic knowledge about the study design and the interpretation of the networks as well as competence in implementing the interventions. Regular supervision enables the timely discussion of specific difficulties in the treatment process (at least every fourth therapy session). All therapists gave their consent to participate in the study and adhere to the procedure.

**Table 9**

*Pre-defined intervention pool of POINT Pain*

| **Module name** | **Goal** | **Exemplary working unit(s)** | **Adapted from** |
|---|---|---|---|
| Exposure in vivo | Correcting beliefs and reducing the recurrence of fear of movement, enhancing activity levels by reducing avoidance behaviour | Developing a movement hierarchy by fear level<br>Performing movements of the hierarchy without avoiding or protection | Nicholas et al. (2003) |
| Relaxation | Reducing stress and tension that could aggravate pain experience | Practicing breathing techniques, Progressive Muscle Relaxation etc. | (Kleinstäuber, Bleichhardt, et al., 2018; Kleinstäuber, Thomas, et al., 2018; Nicholas et al., 2003) |
| Activity and rest (based on pacing) | Balancing activity and rest to enhance flexibility and feelings of control | Activity protocol<br>Activity and rest plan<br>Short practices (e.g. stretching) | Main et al. (2015), Nicholas et al. (2003) |

| Module name | Goal | Exemplary working unit(s) | Adapted from |
|---|---|---|---|
| Cognitive coping with pain | Reducing rigid, dysfunctional thought patterns<br>Building flexible, functional thought patterns | Thought protocol<br>Cognitive restructuring<br>Metacognitive techniques (e.g. labeling) | Kleinstäuber, Bleichhardt, et al. (2018), Kleinstäuber, Thomas, et al. (2018), Nicholas et al. (2003) |
| Attention control | Enhancing coping with pain, enhancing level of functioning | Anti-pain diary<br>Distraction alphabet | Kleinstäuber, Bleichhardt, et al. (2018), Kleinstäuber, Thomas, et al. (2018), McCracken (2005), Nicholas et al. (2003) |
| Activating resources | Relief, balancing inconvenient and pleasant experiences | Positive diary<br>Reflecting on healthy areas in the body | Kleinstäuber, Bleichhardt, et al. (2018; Kleinstäuber, Thomas, et al. (2018) |
| Acceptance | Regaining mental resources, relief | Peace treaty with oneself<br>Disengaging from thoughts | McCracken (2005) |
| Values-based action | Enhancing quality of life, regaining control | Prioritising values<br>Reviewing life | McCracken (2005) |
| Sleep | Enhancing subjective sleep quality and recovery | Stimulus control<br>Imaginary practices (e.g. happy place) | Binder et al. (2020), Nicholas et al. (2003) |
| Self-compassion | Enhancing well-being and feelings of self-worth | Self-compassion break<br>Letter to oneself | Germer & Neff (2013, 2019) |

***Measures***

**EMA Questionnaire.** Although methods of EMA are becoming more popular as technologies and statistical methods evolve, psychometrically evaluated questionnaires for processes relevant to CPP available for the use in EMAs are rare, especially in German language. At the same time, items of evaluated retrospective questionnaires cannot be

applied in EMAs as they do not reflect the necessary variability over time (Forkmann et al., 2018).

Another challenge is the decision which variables to assess in the EMA to adequately reflect the heterogeneity of the CPP population and derive a meaningful explanation model. A pilot study was conducted to develop a set of items that reflects relevant processes in CPP (preregistration: https://doi.org/10.17605/OSF.IO/S4RMN). The resulting items, related processes and their definition, and underlying models of the questionnaire are summarised in table 10 (also available as table 4 on OSF: https://osf.io/8xujc/?view_only=c05ad626aa064f6b83d771bfbea0e43e). All items displayed sufficient content validity scores in the pilot study and will be further evaluated qualitatively regarding the patients' perspective (preregistration: https://doi.org/10.17605/OSF.IO/SU9P4) as well as quantitatively in a more comprehensive evaluation study (preregistration: https://doi.org/10.17605/OSF.IO/S4QGP).

To ensure the understanding of each item's wording, an onboarding appointment takes place before the beginning of phase A. In that appointment, the EMA questionnaire is discussed in detail.

**Data collection.** For all assessments, the software M-path (https://M-path.io/landing/) will be used. The app is installed on the participants' smartphones during the pre-test appointment, using a pseudonym as identifier, and a sociodemographic questionnaire as well as the secondary and disability outcome measures will be assessed in the presence of the study management to ensure functioning and settings of the app. From then on, participants receive prompts for the assessment directly on their smartphone, independent from their study appointments. Participants can view their own questionnaire results via the dashboard of the M-path app. Therapists can view the data only of their own patients in a researcher/practitioner dashboard on computers.

Regarding treatment fidelity, video recordings of each therapy session will be carried out for objective data. Additionally, therapists self-report the applied treatment module after each therapy session, using M-path as well. Two undergraduate students independent from

the study procedure will analyse the video data based on the procedure described by Leeuw and colleagues (2009) as well as the self-report data. As the treatment comprises four phases, four recordings per participant will randomly be selected and independently rated by both students.

**Table 10**

*Constructs and items assessed in the EMA questionnaire ordered by associated psychopathology models*

| **Process** | **Model** | **Definition** | **Item(s)** |
|---|---|---|---|
| Catastrophising | | Catastrophising describes the tendency to perceive negative aspects of a situation or possible consequences in an excessive manner, and to ruminate about or anticipate them (Crombez et al., 2020; Dorsch Lexikon der Psychologie, 2021) | I thought that it will never get better. |
| | | | I thought that I cannot go on any longer. |
| Avoidance | Fear-Avoidance/ Avoidance-Endurance (Hasenbring & Verbunt, 2010; Vlaeyen & Linton, 2000) | Avoidance constitutes a behaviour aiming at prevention, reduction, or termination of the exposure to certain experiences (in pain context: experience of pain (McCracken, 2005) | I stopped an activity because of my pain. |
| | | | Due to my pain I asked others to do a strenuous activity for me. |
| | | | I avoided at least one activity that caused pain. |

| Process | Model | Definition | Item(s) |
|---|---|---|---|
| Depression | | A depressive episode is marked by subdued mood and listlessness with a reduction of activity. Even in light forms feelings of guilt and thoughts about the own worthlessness can occur (World Health Organization, n.d.) | I felt sad. |
| | | | I felt lifeless. |
| | | | I felt guilty. |
| | | | I felt irritable. |
| Thought suppression | | Thought suppression denotes a cognitive reactive pattern that forcefully ends the perception of pain or the disruption of daily activities by pain (Hasenbring & Verbunt, 2010; Oxford Advanced Learner's Dictionary, n.d.-c) | I thought: "Hold on!" |
| | | | I thought: "Pull yourself together!" |
| | | | I thought: "Don't make such a fuss!" |
| | | | I tried not to think about my pain. |
| Task persistence | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Task persistence describes a physical over-activity that can lead to over-use of bodily structures (Hasenbring & Verbunt, 2010) | I went on despite my pain. |
| Positive affect | | Positive affect marks an emotional state of pleasant mood or feelings that promotes approach oriented behaviour or causes the experience of relaxation, contentment, or serenity (Finan & Garland, 2015) | I felt cheerful. |

| Process | Model | Definition | Item(s) |
|---|---|---|---|
| Acceptance | Psychological Flexibility (McCracken & Morley, 2014) | Acceptance is an embracing attitude that leads to goal oriented behaviour within the personal frame of control as well as distancing oneself from attempts to control unwanted feelings or unchangeable circumstances (McCracken & Morley, 2014) | I tried to live with my pain. |
| | | | I could accept that there is no solution for my pain. |
| Values | | Values are subjectively desirable states that influence behaviour. They include beliefs about what is right and wrong and what is important in life (Oxford Advanced Learner's Dictionary, n.d.-d; Spektrum Lexikon der Psychologie, n.d.) | I tried to prioritise those things important to me [individual examples]. |
| Expectations | Predictive Coding (Wiech, 2016) | Expectations describe beliefs about what will happen based on previous experiences and likelihood (Oxford Advanced Learner's Dictionary, n.d.-b; Wiech, 2016) | I expected to experience pain in the upcoming two hours. |
| Pain intensity | Pain Experience (Dworkin et al., 2005) | Pain intensity reflects the subjective extent of pain (Dworkin et al., 2005) | How strong was your pain during the past two hours (on average)? |
| Pain-related disability | | Disability because of pain describes a limitation in movement, senses, and activities most people can do, caused by pain (Crombez et al., 2020; Oxford Advanced Learner's Dictionary, n.d.-a) | How much did you feel disabled because of your pain during the past two hours? |

| Process | Model | Definition | Item(s) |
|---|---|---|---|
| Pain self-efficacy (Nicholas et al., 2003) | Others | Self-efficacy constitutes the belief to be able to handle even difficult situations successfully and to possess the required abilities (Bandura, 1977) | I was confident I could get things done despite being in pain. |
| | | | I was confident I could live a fulfilling life despite my pain. |
| Sleep disturbance (Cole et al., 2007) | | Sleep disturbances include any combination of problems initiating, maintaining, or profiting from sleep (Cole et al., 2007) | I felt tired. |
| | | | Last night, I had problems falling asleep. |
| | | | Last night, I had problems sleeping through the night. |
| | | | Last night, I woke up too early. |
| Self-compassion (Neff, 2003; Neff, 2011) | | Self-compassion describes a non-judging understanding for one's own suffering, shortcomings, or failure. It can be divided in the three facets of self-kindness, sense of common humanity, and mindfulness (Neff, 2003; Neff, 2011) | I tried to be friendly to myself. |
| | | | I told myself everyone has tough times once in a while. |

*Note.* Items and constructs represent the questionnaire version used in the feasibility study.

**Primary Outcome Measures.** *Single-Case Experimental Design:* The treatment target as derived from the person-specific network and assessed by the EMA questionnaire is the main outcome regarding effectiveness of the POINT Pain procedure.

*Conventional pain measures:* Additional to the individual target process, the Pain Disability Index (PDI) (Mewes et al., 2009; Tait et al., 1990), and an adapted version of the Quebec Back Pain Disability Scale (QBPDS) (Speksnijder et al., 2016) will be assessed three times: before the EMA (pre-test), immediately after the last session of phase C (post-test), and three months after the last session of phase C (follow-up). Both measures assess pain-related disability.

*Evaluation:* To assess feasibility and acceptance of the study procedure, patients as well as therapists will answer adapted versions of the System Usability Scale (SUS; e.g. “I think I would like to use this app frequently.”) (Brooke, 1996; Gao et al., 2020; Lyon et al., 2020) and the User Experience Questionnaire (UEQ-S) (Schrepp et al., 2017) in the M-path app. The SUS consists of ten items using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). The SUS will be assessed twice: once for the M-path app and once for its dashboard. The UEQ-S assesses the subjective impression of the user experience with eight items on a 7-point Likert scale (-3 to +3) on six subscales: attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty.

Additionally, a semi-structured interview will be conducted. Patients will be asked about their initial expectations (e.g. “What did you expect at the beginning? Have these expectations been met?”), the onboarding process (e.g. “How can we improve on the onboarding process?”), the practical use of the M-path app (“How did you get on with the M-path app?”), feasibility of the study procedure, including the EMA phases and surveys (e.g. “Would you change anything about the survey, including the frequency of assessments?”), and negative side effects (e.g. “Did you experience any negative side effects? How could negative side effects be reduced?”). Therapists will answer the same questions, completed by the domains clarity of the dashboard (e.g. “Did you use the dashboard? What would you like to change about the dashboard?”) and utility for clinical practice (e.g. “Was the app part of the treatment/supervision? What could be changed to maximize its utility?”). Adapted questionnaires and the semi-structured interview are based on the procedure described by Scholten, Schemer, and colleagues (2024).

For the POINT Pain project, the semi-structured interview will be complemented by questions regarding the presentation of the person-specific networks (e.g. “Was the presentation of the networks easily understandable? What would improve the understandability of the networks?”), acceptance of the algorithm-suggested intervention (e.g. “Did you agree with the algorithm-suggested intervention?”), and the clinical utility of the person-specific networks (e.g. “Did you use the network in therapy? How did you use it?”).

Finally, compliance rates of all study phases on the patients’ end will be drawn upon for implications on feasibility and acceptance. A compliance rate of at least 80 % will be considered good.

The selection of outcome measures beyond the EMA questionnaire was based on recommendations by Dworkin and colleagues (2005).

**Secondary Outcome Measures.** Secondary outcome measures will be assessed at pre-test, post-test, and follow-up. They are: pain intensity (11-point scale), affective and sensory pain description (German short-form McGill Pain Questionnaire; Melzack, 1987), pain coping mechanisms (German Pain Solutions Questionnaire; Sielski et al., 2017), and pain self-efficacy (German Pain Self-Efficacy Questionnaire; Nicholas, 2007). Subjective changes in symptoms will be assessed at post-test and follow-up only, using one item of the Patient Global Impression of Change scale (Dworkin et al., 2005).

**Data Analysis.** All analyses will be carried out using the most current version of software R in RStudio (R Core Team, 2025). Data preprocessing utilised the tidyverse package (Wickham et al., 2019). Network graphs were generated employing the qgraph package (Epskamp et al., 2012).

***Network Analysis.*** For the network analysis, participant data is preprocessed, including calculation of descriptive statistics (mean, median, standard deviation) for each variable. Positive items, such as those measuring positive affect and acceptance, undergo recoding to ensure consistent valence directionality across all items.

The following statistical criteria are used to guide variable selection to ensure robust network estimation (Scholten, Schemer, et al., 2024): (1) Visual inspection of data for

problematic distributions (skewness, kurtosis, outliers), leading to exclusion of highly skewed variables (skewness > 3). (2) exclusion of variables with low variance (SD < .2 for min-max scaled variables), (3) exclusion of variables with high correlation (r > .9) with others, prioritizing the most clinically representative variable if necessary, and (4) exclusion of time points with missing data.

With a maximum of 126 data assessments during EMA per person, robust network estimation can be assumed with three to eight variables (Levinson et al., 2021; Mansueto et al., 2023). The number of items is further reduced based on mean values and personal relevance. Up to six items with the highest mean are included first. Up to two additional items are added if patients indicate further items as relevant.

Hence, a temporal (lag-1) and residual contemporaneous network will be modeled using the package “graphicalVAR” in R (Epskamp et al., 2018; Epskamp & Asena, 2024). Data is not detrended because assessment spanned only three weeks (Epskamp et al., 2018).

***Adapted Algorithm.*** DATA-IN is used to determine the treatment target (Rubel et al., 2018). In the temporal network, the outstrength of each item is estimated by averaging the outgoing associations to other items in the network. In the contemporaneous network, the strength scores are estimated by averaging the associations of the respective items with all connected items in the network. To facilitate interpretation by expressing scores as percentages relative to the maximum network strength, both scores are normalised within each individual. Therefore, each individual score is divided by the maximum strength within the respective networks. The normalised individual strength scores of each node are averaged and serve as an indicator of overall item strength. The item with the highest overall strength is the treatment target that determines the treatment module according to the matching matrix.

***SCED Evaluation.*** In line with current practices, monitoring of the treatment effect will be observed in weekly visual analyses of trend and mean (Hague et al., 2015; Manolov et al., 2014) and supplemented by statistical analyses to make statements about effect size and

significance (Brossart et al., 2014, 2018; Ninci et al., 2015). Since there is no clear gold standard for the evaluation of SCED data in research to date, this work is based on the recommendation to consider various statistical parameters in order to obtain more information for the evaluation of SCED data (Brossart et al., 2014). To evaluate the existence of a treatment effect, the non-parametric baseline-corrected Tau (BC-Tau) will be used (Tarlow, 2017). Non-overlap statistics perform pairwise comparisons of baseline and intervention data and then reflect the percentage of data that does not overlap. BC-Tau is therefore bounded between -1 and +1. BC-Tau is computed using the R package SingleCaseES (function Tau_BC) (Pustejovsky et al., 2026). The calculation of BC-Tau involves 3 steps: First, the slope of the baseline trend is tested for significance based on Kendall's rank correlation. If the slope is not significantly different from zero, then no baseline correction is made. If the slope is significantly different from zero, the baseline trend is corrected in a second step using Theil-Sen regression. In a third step, the residuals of the Theil-Sen regression are used to calculate tau. Kendall's rank correlation including the adjustment for ties is calculated according to the recommendations of Tarlow (2017). By conducting a statistical analysis of the significance of a baseline trend, we follow the recommendation in the literature to correct only for theoretically and empirically justified baseline trends (Brossart et al., 2018).

As a supplement to Tau-U, Hedges' g is used to quantify the magnitude of the effect (Carlin & Costello, 2021; Lakens, 2013). Hedges' g is a direct estimator of Cohen's d, corrects for unequal sample size (or observations per phase) and for overestimation bias associated with small sample sizes (Carlin & Costello, 2021), which makes it very suitable for SCED. Due to the closeness to Cohen's d, comparisons across different outcome measures and to the group design are possible (Shadish, 2014).

**Patient and public involvement.** Although this proof-of-concept study was not co-designed with patients, they are greatly involved from beginning to end of the study procedure. Involvement starts with the onboarding where participants are asked to give their feedback on the EMA questionnaire.

Participants may indicate variables of particular interest to them that will be taken into consideration as nodes of the personalised network. In addition, participants can formulate up to two idiographic items that will be monitored throughout psychotherapy.

Evaluating the feasibility and acceptability of the study procedure for participants aims to include their interests. Opportunities to improve the treatment of CPP should be explored while limiting the burden on participants (see below). Participants' experiences will be assessed, both qualitatively and quantitatively, at the end of the study. Feedback throughout the study will be welcomed and recorded. Following research projects will evolve from the patients' feedback.

**Ethics and dissemination.** The study has been accepted by the local ethics committee of the psychology department of University Kaiserslautern-Landau (#LEK-457). Participants receive detailed, written study information at the beginning of the pre-test appointment and provide informed consent before proceeding in the study.

The study will be conducted, as far as relevant and applicable, in accordance with the ethical principles and recommendations originating from the Declaration of Helsinki (The World Medical Association, 2008) and corresponding to the international guidelines on "Good Clinical Practice" (https://ichgcp.net/de) (Good Clinical Practice Network, n.d.). The current version of the Declaration will be observed when conducting the intervention, evaluation, and documentation.

As there is no clear recommendation regarding the optimal EMA questionnaire length regarding the induced burden (May et al., 2018), several measures are taken to reduce the burden that could potentially be caused by the assessments on the participants: (1) The item set of the EMA questionnaire consists of maximally 33 items and items on sleep are assessed only once per day, reducing the item set during EMA to 30 items in five out of six measurement timepoints. (2) As soon as possible (Phase B and subsequent phases), participants switch to three assessments per week for the SCED, further reducing the potential assessment-induced burden.

(3) Throughout the SCED phase, the questionnaire can be answered within a three-hour timeframe so that interference with everyday life is minimised. (4) If necessary, the randomised schedule can be fixed upon request. (5) To enhance compliance throughout the assessments, participants generate idiographic items over the course of the diagnostic phase. The items are hence included in the daily assessments. (6) Participants use their own smartphones for data collection, ensuring low-threshold accessibility. (7) The app used for this purpose, M-path, is designed to be intuitive and engaging. (8) By integrating positive items (e.g., related to values or positive affect), the aim is to prevent participants from repeatedly focusing solely on negative aspects of their lives. (9) To strike the optimal balance between enabling time-saving responses while avoiding the questionnaire to feel overly repetitive or monotonous, as well as preventing mindless responding, items belonging to the same construct were held together, while the order of constructs presented in the questionnaire and the order of the items within each construct was randomized (Eisele et al., 2021). Single-item measures were always presented first in a randomised order. (10) The EMA procedure was piloted to ensure the assessment-induced burden was reasonable, as recommended by Forkmann and colleagues (2018). Participants receive 50 € for their general participation and additional 50 € for each EMA phase in which they complete at least 80 % of the questionnaires, resulting in a maximum financial incentive of 150 €.

The follow-up assessment was purposefully set three months after the last session of phase C so that a subsequent treatment could be started in a timely manner. A booster session with the study therapist is scheduled once a month until the follow-up assessment. If necessary, participants will be referred to subsequent psychotherapy.

Results of this project shall be published in suitable journals. Furthermore, the project is presented at diverse professional congresses, reaching practitioners as well as scientists. Materials and data will be made openly available via the Open Science Framework.

## Discussion

The present study protocol aims at evaluating POINT Pain, an approach to personalise CBT for CPP using person-specific network analysis. It combines EMA and

SCED methodologies with data-driven clinical decision-making to translate the call for a paradigm shift in the treatment of CPP into clinical practice (Bartels et al., 2022; Lutz, Schwartz, et al., 2022; McCracken, 2020, 2021, 2023). The main focus of this study is assessing feasibility and acceptance of such a procedure on patients' as well as therapists' ends, while simultaneously delivering first insights on the effectiveness on the individual level. The POINT Pain project thus paves the way for further research when it comes to compare effects of personalised and process-oriented versus treatment as usual.

To develop a research project combining these many approaches and methods, many decisions have to be made. Often evidence-based gold-standards for such decisions are yet missing, beginning with the question which processes to assess. When applying network analysis, there are several possibilities to reduce the data to model person-specific networks, and different parameters upon which clinical decisions could be based. Summed up: When translating new methods into clinical practice, balancing innovation, methodological rigour, and pragmatism is an ongoing challenge in the decision-making process, that we tried to tackle:

For example, we decided to partly rely on centrality parameters for the clinical decision-making process, as they are often considered to give information on the importance of nodes within the network (Hofmann et al., 2016; Levinson et al., 2021, 2023). Yet, centrality parameters were initially developed in other than psychological contexts, therefore it is not yet established if they are generalisable to psychometric data (Wright & Woods, 2020). In fact, centrality parameters should be interpreted with caution, as they might not always be clinically relevant, inferences based on centrality parameters can be imprecise (Bringmann, 2021; Hofmann & Curtiss, 2018), and might be confounded by highly correlating items that are represented as single nodes in the network (Fried & Cramer, 2017). Less central nodes can still represent important treatment targets, e.g. suicidality (Scholten et al., 2022), or because of their importance for functioning levels (Burger et al., 2020). We decided to use the mean scores of phase A to reduce the data for the person-specific networks and

based the target selection on the averaged centrality of contemporaneous and temporal networks to reflect clinical relevance adequately.

When analysing SCED data to estimate treatment effects, there are numerous, sometimes conflicting, recommendations. Visual analysis is commonly used in SCED research (Carlin & Costello, 2021; Morley, 2018) and is often recommended to evaluate the treatment process over time (Manolov et al., 2014; Vlaeyen et al., 2022). However, it has been criticised for its subjectivity (Tanious & Onghena, 2021). More recent approaches favour systematic statistical analysis of SCED data or at least combining visual analysis with statistical parameters (Morley et al., 2015; Tanious & Onghena, 2021).

Despite this shift, there is ongoing debate about which statistical parameters to use. For example, overlap-based measures like TAU-U (Parker et al., 2011) are sometimes criticised for not accurately reflecting effect sizes, while others argue that they do reflect effect-size but not necessarily whether the effect is caused by the treatment (Carter, 2013). In our study, we chose BC-Tau due to its several advantages (Tarlow, 2017): It is robust to autocorrelation, avoids floor or ceiling effects, stays within the conventional bounds of correlation or percentage-based effect size statistics, and provides better baseline trend control with a less conservative method. Additionally, BC-TAU is easy to graphed and implement, requires few distributional assumptions, and, like TAU-U, is suitable for designs with limited data points (Parker & Vannest, 2012; Tarlow, 2017; Vannest & Ninci, 2015). It also has adequate statistical power (Brossart et al., 2018; Giannakakos & Lanovaz, 2019; Parker et al., 2011; Parker & Vannest, 2012; Tarlow, 2017).

However, it is important to note that SCED parameters may not fully capture clinical significance. Criteria for clinically significant changes in individual patients are still unclear, as nomothetic gold standards for assessing clinical significance are not easily applied at the individual level.

The Duration-Adjusted Reliable Change Index (DARCI) is a promising method that could be implemented in SCED analysis (Helmich, 2024). It adapts the Reliable Change Index (RCI) to quantify symptom changes of varying durations in individual time-series data.

However, DARCI requires normative data, which is not yet available for the EMA questionnaire used in this study. Also, the Bayes Factor (BF) is another evaluation method that quantifies evidence for or against the null hypothesis in Bayesian inference (de Vries & Morey, 2013). However, the choice of priors is crucial, as vague priors can lead to non-convergence or unstable estimates. In this case, due to the lack of established assumptions in the existing literature, reliable priors could not be determined. Future research would benefit from a comprehensive overview of available procedures and parameters, with a unified taxonomy, as well as the development of gold standards for idiographic research in clinical practice.

With this proof-of-concept study, data will be generated that might serve to establish priors in the future. Until then, the BF will be analysed exploratorily. Another option to evaluate symptom improvement might be the standard deviation. However, there is currently no gold standard on how many standard deviations reflect “clinically significant improvement” in SCEDs. Furthermore, the EMA questionnaire used in this study has not yet been fully evaluated, therefore the responsiveness of its items is unknown. Upon completion of this study and evaluation of the questionnaire, data on item responsiveness will be available. In this proof-of-concept study, we compensated for these limitations by combining the EMA results with conventional measures (PDI, QBPDS) (Speksnijder et al., 2016; Tait et al., 1990). Future research should focus on demonstrating which SCED parameters are relevant for and applicable to clinical practice.

Another challenge is teaching study therapists, who have primarily been taught nomothetic research methods so far, to interpret and use network parameters and SCED. Hayes moaned this already in 1981 (Hayes, 1981), and Kazdin (2019) and Vlaeyen and colleagues (2020) still observed this nomothetic focus in the training of psychologists and psychotherapists decades later. Visual analysis, at least throughout the therapy process, might be more intuitive than interpreting unknown statistical parameters. We decided to address this challenge in three ways: (1) starting off with an intensive training comprising an introduction to network analysis, (2) using the first supervision to interpret and discuss the

network and resulting treatment target together with a researcher, offering further supervision for clarification if necessary, and (3) conducting weekly visual analyses of trend and mean value of the target process and combining TAU-U and Hedges' g to evaluate the existence of a treatment effect as well as its size.

This study is one of the first to combine EMA, person-specific network analysis, and SCED in chronic pain research. Processes instead of symptoms are focused by assessing a wide variety of constructs derived from evaluated CPP explanation models (table 10, also available as table 4 on OSF: https://osf.io/8xujc/?view_only=c05ad626aa064f6b83d771bfbea0e43e). Personalisation as well as data-driven clinical-decision making is approached using an algorithm based on person-specific networks. Instead of applying a whole set of interventions within a standardised protocol, each patient receives one module specifically fitting their personal treatment target. Due to the EMA phases as well as the broad inclusion criteria (i.e. all pain areas except head and neck/migraine, comorbidities allowed), the ecological validity of this study is arguably high. In addition, the patient and therapist perspectives are considered continuously throughout the study implementation. The POINT Pain project thus bridges not only the scientist-practitioner, but rather the scientist-practitioner-patient gap.

Despite these strengths, the study has also limitations that need to be considered: (1) While group-level data cannot necessarily be generalised to the individual, personalised data cannot necessarily be generalised to the group-level (Gloster et al., 2024). Attempts to aggregate the data from this study across all twelve participants can therefore only be exploratory. Results should primarily be interpreted at the individual level. A future scientific goal could be the bottom-up generation of subtypes within CPP (Gloster et al., 2024) by conducting further replications to enable meta-analyses across individuals (Moeyaert et al., 2020; Tanious et al., 2024). (2) Due to the fact that participants miss signals in the M-path app, it is possible especially in the SCED phases that the database is reduced. For example, in some cases the second baseline could not even include three measurement timepoints, which is considered the minimum (Hayes, 1981). In such a case, the second baseline might

have to be extended regardless of the initial randomisation. (3) While efforts were made to incorporate methodological recommendations, certain adaptations were essential for the translation of methods into clinical practice. The decisions outlined, including the selection of processes, data reduction strategies for network analysis, and the utilisation of algorithms to inform clinical decision-making, should be regarded as one among various viable approaches. (4) The primary outcome measure (target process of EMA questionnaire) is not yet psychometrically evaluated and norms and cut-offs are missing. This limits the explanatory power of this outcome measure. For this proof-of-concept study, the treatment effect will be based on a combination of decreasing scores in the target process and conventional measures of pain-related disability to compensate for the lack of cut-offs and norms.

Summed up, this proof-of-concept study is an ambitious and promising project that aims at combining various methodological approaches to take the next steps towards personalised, process-oriented, data-driven psychotherapy. Particularly in the case of CPP, the approaches described suggest that treatment effects could be optimised by adequately addressing the heterogeneity of the population.

For our exemplary patient Mrs. Algae that could mean an enhanced involvement in the clinical decision-making process as her data and her own hypotheses on relevant pain processes are considered. Her therapist can rely on an algorithm developed based on experts' ratings, thus minimising cognitive biases involved in the clinical decision-making process. Furthermore, both Mrs. Algae as well as her therapist receive frequent feedback on changes in Mrs. Algae's condition through regular assessments and weekly visual as well as statistical analyses. In the future, such a procedure could facilitate the ongoing clinical decisions like how long to stick to a certain intervention, when to switch to another, and looking at the data regarding which intervention should be the next.

In light of numerous methodological hurdles and the practical implementation complexities in clinical settings, POINT Pain delineates a prospective strategy for harnessing programs that have been proposed but not yet implemented in practice. Further research is

needed to take this and other approaches to the test and develop gold standards regarding the implementation of EMA, person-specific network analysis, and SCED altogether in clinical practice.

## Chapter 5: Feasibility and acceptability of the POINT Pain procedure

Scholten, S., Hofmann, V. E., Kininger, F., & Glombiewski, J. (preprint). Personalized Psychotherapy as Data-Informed Clinical Reasoning: A Mixed-Methods Proof-of-Concept Study. PsyArXiv. https://osf.io/preprints/psyarxiv/edscr_v1

Please note that all appendices are provided digitally for the printed hardcover versions of this dissertation. Consistent with the preprint, this manuscript is reproduced in American English.

### Abstract

*Objective:* Complex clinical presentations such as chronic pain with comorbid mental health difficulties require individualized clinical decision-making, yet existing treatment frameworks provide limited guidance at the individual level. This proof-of-concept study evaluated the feasibility and acceptance of a data-informed personalized psychotherapy framework integrating Ecological Momentary Assessment (EMA), person-specific network analysis, and single-case experimental designs (SCEDs).

*Method:* Twelve patients with chronic pain ($M_{Age}$ = 60.25, 58% identified as female) and comorbidities and nine therapists participated in the study. An ABA'C multiple-baseline design across participants was employed to explore the implementation and potential effects of the personalized psychotherapy framework. EMA-based self-monitoring, person-specific treatment target selection, and structured intervention planning were implemented throughout therapy. Quantitative outcomes included compliance and disability measures, and qualitative interviews were conducted with patients and therapists following treatment.

*Results:* Compliance exceeded 80% in at least seven participants across all phases, supporting the feasibility of intensive longitudinal assessment procedures. Qualitative analyses highlighted the importance of participant-centered assessment design and identified self-monitoring and structured data-informed reflection as central mechanisms for increasing awareness of everyday processes and supporting therapeutic reflection. Exploratory individual-level analyses showed mixed treatment effects, whereas exploratory

multilevel analyses indicated an average decrease in disability scores from baseline to intervention phase ($\beta_1 = 0.45$, $p = .03$).

*Conclusions:* Findings support the feasibility and acceptance of a recursive observing–deciding–intervening framework for personalized psychotherapy. The clinical value of data-informed personalization may lie less in algorithmic precision alone than in its capacity to support patient-centered, reflective clinical reasoning in complex cases.

**Introduction**

Mental health problems are among the leading contributors to the global burden of disease (Ferrari et al., 2024)**.** Although psychotherapy is effective on average, producing small to medium improvements (Cuijpers et al., 2024; Gaskell et al., 2023), effect sizes have not increased over time (Cuijpers et al., 2020; Hofmann et al., 2012; Miskovic-Wheatley et al., 2023; Newby et al., 2015; Vlaeyen & Crombez, 2020). Moreover, treatment response varies substantially between individuals, even under controlled conditions (Herzog & Kaiser, 2022; Kaiser, Volkmann, et al., 2022; Kaiser & Herzog, 2023; Scholten, Herzog, et al., 2025). It is estimated that around 30% of patients do not respond to treatment in clinical trials, with even higher rates observed in routine clinical care (Gloster et al., 2020; Lambert, 2017). Furthermore, deterioration rates remain between 4% and 10% (Cuijpers et al., 2018), highlighting the need to tailor treatments more effectively to individual patients.

In response, there is increasing demand for evidence-based personalized psychotherapy (Barber & Solomonov, 2019; Deisenhofer et al., 2024; Levinson et al., 2024; Wright & Woods, 2020). In practice, therapists have always adapted their treatment to suit individual patients, selecting the target of the treatment, the intervention, dosage and sequence, as well as adapting the style of delivery or interaction (Cohen et al., 2021). Such decisions are often guided by clinical intuition and theoretical models, which are prone to systematic biases (Lutz, Schwartz, et al., 2022; Meehl, 1954; Tversky & Kahneman, 1974). For instance, optimism bias can affect how therapists evaluate their own performance and their patients' progress (Kaiser, Herzog, et al., 2022; Walfish et al., 2012). Consequently, personalized approaches should increasingly rely on individual patient data to inform the

selection, dose, sequencing, and adaptation of interventions (Lutz, Schwartz, et al., 2022; Wright & Woods, 2020).

However, most evidence-based treatments are developed and evaluated as standardized packages at the group level. Even personalization strategies often rely on subgroup-based approaches (Deisenhofer et al., 2024; Scholten & Glombiewski, 2025). For example, treatment selection may be stratified based on clinical and demographic factors (Delgadillo et al., 2022; Hill et al., 2011), or care may be matched by severity (Fletcher et al., 2021; Linton et al., 2018). However, these approaches do not adequately capture substantial heterogeneity and temporal dynamics within individuals. This mismatch is further compounded by several challenges when applying group-based evidence to individual patients. First, individuals diagnosed with the same mental disorder often differ substantially in their symptom profiles and underlying processes, particularly in complex and heterogeneous conditions such as depression or chronic pain (Forbes et al., 2024; Fried & Nesse, 2015; Vlaeyen & Crombez, 2020). Second, psychological processes show considerable temporal variability within individuals, which is not captured by typical RCT designs relying on relatively few assessment points, but is highly relevant for clinical decision-making over the course of treatment (Piccirillo et al., 2019). Third, these issues are formalized in the concept of ergodicity, which is rarely met in psychological data, thereby limiting the extent to which group-level findings can be generalized to within-person processes (Borsboom & Haslbeck, 2024; Molenaar, 2004). Finally, standard outcome measures focus primarily on symptom change and provide limited insight into individual mechanisms of change or guidance for ongoing clinical decision-making (Barber & Solomonov, 2019). As a result, this group-level evidence base offers little guidance for the ongoing, moment-to-moment decisions clinicians must make in practice. Efforts to address this challenge include approaches that tailor treatment based on individual characteristics, such as selecting modules based on pre-treatment assessments or adapting interventions using Routine Outcome Monitoring (ROM) (Gasslander et al., 2022; Lutz, Deisenhofer, et al., 2022; Martorella et al., 2017; Norcross & Wampold, 2011). However, these approaches often

rely on infrequent assessments and group-based norms that only partially align with the dynamic, process-oriented, individual nature of clinical practice.

Recent methodological advances offer promising avenues to address these limitations. Ambulatory Assessment[1], or *Ecological Momentary Assessment (EMA)*, enables the repeated measurement of psychological processes in daily life, capturing within-person dynamics with high temporal resolution (Trull & Ebner-Priemer, 2014, 2020). Compared to traditional ROM, EMA allows for a more fine-grained assessment of subjective experiences and behavior in real-world contexts and may enhance feedback-informed treatment. This approach builds on the tradition of ROM, which assesses patient-reported outcomes at regular intervals to track progress and inform clinical decision-making (Barkham et al., 2023). EMA data can be used for self-monitoring, diagnostic purposes, tracking change processes, and monitoring the effects of interventions, including homework assignments (Myin-Germeys et al., 2024; Piccirillo et al., 2026). It allows the integration of passive data, thereby providing a more detailed picture of within-person variability. While feedback based on ROM has shown small additive effects (de Jong et al., 2021; Lambert et al., 2018), EMA holds the potential to further enhance these effects by linking psychotherapy more closely to patients' everyday lives and by enabling the investigation of within- and between-person processes (Schemer et al., 2023; Wright & Zimmermann, 2019).

Building on intensive longitudinal data, the *Network Analysis (NA)* approach provides a framework to model the structure of psychological processes within individuals (Roefs et al., 2022). NA conceptualizes mental disorders as systems of interacting components, in which variables (e.g., symptoms, behaviors, cognitions) are represented as nodes and their associations as edges (Bringmann et al., 2022). This perspective has its roots in psychometric and theoretical developments emphasizing that mental disorders emerge from mutually interacting and reinforcing processes rather than a single underlying cause

[1] "Ambulatory assessment" is an umbrella term that encompasses passive sensing, ecological momentary assessment (EMA) and experience sampling methodology (ESM). The latter two terms originate from different research traditions, both describing the sampling of subjective experiences and individual behaviors. In the present study, we use EMA to describe repeated assessments of experiences and behaviors.

(Borsboom, 2017). Conceptually, this aligns closely with clinical case conceptualization approaches used in psychotherapy (Padesky, 2020; Scholten et al., 2022). Individual networks can be used to inform and refine case conceptualizations by identifying central or influential components within a person's symptom system (Burger, Epskamp, et al., 2022; Scholten, Klintwall, et al., 2025). These components may serve as potential treatment targets and thereby support the selection and prioritization of interventions. This approach is closely aligned with process-based therapy proposed by Hofmann and Hayes (2019), which emphasizes targeting core psychological processes rather than applying standardized treatment protocols based on diagnostic categories. First empirical studies suggest that using network-informed targets may lead to more efficient and potentially more effective treatments, providing preliminary support for this approach (Fisher et al., 2019; Levinson et al., 2023; Mansueto et al., 2025).

To evaluate such individualized interventions, *Single Case Experimental Designs (SCEDs)* provide a rigorous methodological framework (Vlaeyen et al., 2022). SCEDs involve repeated measurements within a single individual across different conditions (e.g., baseline and intervention phases), allowing the individual to serve as their own control (Kwasnicka et al., 2019; Schemer et al., 2023). These designs have a long tradition in psychological research, particularly in behavior therapy (Barlow et al., 2009; Hayes, 1981), but were partly overshadowed by the rise of randomized controlled trials. More recently, interest in SCEDs has increased due to their suitability for evaluating treatment effects at the individual level (Vlaeyen et al., 2020). In clinical practice, SCEDs enable the systematic monitoring of change and the evaluation of intervention effects within patients over time (e. g. Bentley et al., 2019; Simons et al., 2020). Beyond individual cases, they also allow for the aggregation of findings across individuals, offering a potential bridge between clinical practice and research (Tanious et al., 2024). As such, SCEDs can contribute to reducing research waste, support iterative treatment adaptation, and strengthen the scientist–practitioner model (Schemer et al., 2023).

Importantly, these approaches are highly complementary: EMA provides the data basis to model individual dynamics, NA translates these data into data-informed case conceptualizations that can indicate actionable treatment targets, and SCEDs enable the evaluation of resulting interventions within individuals. Despite this potential, their combined application to guide and evaluate personalized psychotherapy in a coherent framework remains largely unexplored (Berg et al., 2024; Schemer et al., 2023). The present proof-of-concept study aims to integrate these approaches into a unified framework for data-informed personalized psychotherapy. The study is conducted in patients with chronic pain; a highly heterogeneous population for whom individualized treatment approaches are particularly warranted (McCracken, 2023).

This study examines the feasibility and acceptance of this approach in clinical practice and explores its potential to produce meaningful changes in individualized treatment targets and disability measures (Hofmann et al., 2024). By combining intensive assessment, data-informed treatment selection, and within-person evaluation, this study seeks to provide an initial test of a Process-Oriented, Individualized, Network-based Therapy for Chronic Pain (POINT-Pain). Ultimately, the study may serve as a roadmap for the further development and implementation of evidence-based personalized treatments for complex mental disorders.

## Methods

The study design was preregistered prospectively on ClinicalTrials, before data were collected (https://clinicaltrials.gov/study/NCT06179784) and published in a study protocol (Hofmann et al., 2024). It was accepted by the local ethics committee of the psychology department of RPTU University Kaiserslautern-Landau (#LEK-457).

### *Procedure*

An ABA’C multiple baseline design across participants was employed to evaluate the effectiveness of POINT-Pain in an outpatient setting. Following established approaches in single-case research, baseline lengths were randomized across participants to allow replication of treatment effects while avoiding withdrawal of the intervention once introduced. Before proceeding with the study, informed consent was obtained based on a detailed,

written study information. The study began with an intensive baseline phase (A), during which participants completed EMA six times per day over 21 days using semi-randomized prompts distributed across waking hours. Based on these data, person-specific networks were estimated to identify a treatment target. Subsequently, a diagnostic phase (B) consisting of five weekly sessions was conducted, including clinical interview, biographical anamnesis, and functional analysis. Participants also identified personally relevant EMA items, which were used to inform the target selection. Up to two idiographic items were formulated and included in the assessment. From this point onwards, assessments were reduced to three times per week, randomly scheduled on two weekdays and one weekend day, and continued throughout the study. A second baseline phase (A') of randomized length (one to three weeks) followed, during which treatment planning was conducted by an interdisciplinary team of therapist, supervisor, using an algorithm-guided decision process. The intervention phase (C) began with two sessions of psychoeducation, followed by up to eight sessions of a process-targeted intervention selected based on the individual network. Treatment continued until clinically meaningful improvement in the individualized target was achieved and maintained for at least two weeks, or until the maximum number of sessions was reached. After the intervention, participants received two monthly booster sessions accompanied by continued assessments, followed by a final EMA phase (21 days, six assessments per day) and a three-month follow-up. According to the Risk of Bias in N-of-1 Trials Scale (RoBiNT; Tate et al., 2013, 2015), the study design reached a conservative risk-of-bias rating of 18 (out of 30 possible) points (see study protocol for further details, Hofmann et al., 2024). The Single-Case Reporting In BEhavioural Interventions (SCRIBE) was followed to report the present study (Tate et al., 2016).

***Study participants***

The study aimed to recruit 12 adult patients with chronic primary pain (CPP). For qualitative outcomes, such as feasibility and acceptance, thematic saturation is expected to be achieved with a sample size of approximately 12 participants (Guest et al., 2006; Turner-Bowker et al., 2018). To evaluate within-person effects, a sample size of n = 1 is sufficient

because each individual is analyzed separately. Inclusion criteria were: age ≥ 18 years, access to a compatible smartphone (Android ≥ 5.1 or iOS ≥ 11.0), a primary diagnosis of CPP (ICD-10: F45.4x), and subjective pain-related disability. Exclusion criteria comprised acute comorbid conditions requiring immediate treatment (e.g., substance abuse, psychosis, severe underweight, or suicidality), migraine, headache, or neck pain as the primary complaint, insufficient German language proficiency, illiteracy, and physical inability to attend regular outpatient sessions. Diagnoses and comorbidities were assessed using the German brief version of the Diagnostic Interview for Mental Disorders (Mini-DIPS; Margraf & Cwik, 2020). German language proficiency was assessed via self-report (5-point Likert scale), with scores ≥ 4 indicating insufficient proficiency. Concurrent participation in other psychotherapy studies or ongoing psychotherapy was not permitted.

### *Measures*

All assessments were conducted using m-Path (Mestdagh et al., 2023). M-Path is a research platform that is flexible and easy to use. It is used for ambulatory assessment and intensive longitudinal data collection.

**EMA items.** Psychological processes were assessed using the German version of the ProCEss item set, developed for the longitudinal assessment of key psychological processes in chronic pain using EMA (Hofmann, Glombiewski, Heider, et al., 2026; Hofmann, Glombiewski, Prasch, et al., 2026; Hofmann & Scholten, 2026). The item set is grounded in established psychopathological models of chronic pain and recommendations for core pain-related domains (Dworkin et al., 2005). It comprises 25 items assessing 14 clinically relevant processes, including pain-related worry (e.g., “It will never get better”), avoidance (e.g., stopping or avoiding activities due to pain), depressive symptoms (e.g., feeling sad or exhausted), acceptance, values-based behavior, expectations, thought suppression, task persistence, self-efficacy, self-compassion, positive and negative affect, as well as pain intensity and pain-related disability.

The processes are assessed using a coverage EMA model. Accordingly, items are phrased in the past tense and refer to the period since the last assessment (e.g., “How much

did the following statements apply to your experiences since the last beep?"). All items are rated on an 11-point Likert scale ranging from 0 ("not at all") to 10 ("completely"), approximating interval-level measurement.

Content validity and clinical utility were supported by positive evaluations from patients with chronic pain and clinical practitioners (Hofmann, Glombiewski, Prasch, et al., 2026). Psychometric evaluation of the German version indicated adequate within-person variability and generally satisfactory reliability at the process level. Lower reliability was observed for self-efficacy and self-compassion, and particularly for thought suppression, indicating the need for further refinement (Hofmann, Glombiewski, Heider, et al., 2026).

**Feasibility and acceptance.** Feasibility and acceptance were assessed using qualitative interviews, quantitative questionnaires, and compliance rates. Semi-structured interviews were conducted with patients and therapists as the final assessment of the study to explore expectations, usability, and perceived utility of the intervention components. Core domains included expectations, study onboarding, app usability, assessment burden (e.g., EMA frequency), feasibility of the study procedure, perceived utility of the intervention components, and potential negative effects. Interviews also addressed the comprehensibility and usefulness of person-specific networks and the acceptance of algorithm-guided intervention selection. Therapists were additionally asked about the clarity and clinical utility of the presentation of the results.

In addition, patients and therapists completed adapted versions of the System Usability Scale (SUS; Brooke, 1996; Gao et al., 2020) and the User Experience Questionnaire – Short Version (UEQ-S) (Schrepp et al., 2017) to evaluate the usability of the m-Path app and the associated presentation of the study results. Items were adapted to refer specifically to the m-Path app and results. The SUS consists of 10 items (e.g., "I think I would like to use this app frequently") rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The SUS has demonstrated good reliability (Cronbach's α typically > .80) and validity across a wide range of digital health applications. The UEQ-S comprises 8 items assessing user experience on 7-point semantic differential scales (−3 to +3; e.g.,

“complicated – easy”). The instrument captures two dimensions of user experience: *pragmatic quality* (goal-directed aspects such as perspicuity, efficiency, and dependability) and *hedonic quality* (non-task-related aspects such as stimulation and novelty). The UEQ-S has demonstrated satisfactory internal consistency (typically $\alpha \approx .70–.85$) and construct validity.

Feasibility was evaluated via compliance rates with the assessment protocol across study phases. A compliance rate of ≥ 80% was considered indicative of good feasibility.

**Secondary outcome measures.** Secondary outcomes were assessed at pre-treatment, post-treatment (end of intervention phase), and three-month follow-up. Measures were selected based on established recommendations for chronic pain trials (Dworkin et al., 2005).

Pain-related disability was assessed using the Pain Disability Index (PDI) and an adapted version of the Quebec Back Pain Disability Scale (QBPDS). The PDI consists of 7 items assessing the degree to which pain interferes with different life domains (e.g., work, social activities), rated on 11-point scales (0 = no disability to 10 = total disability), yielding a total score from 0 to 70 (Dillmann et al., 2011; Pollard, 1984; Tait et al., 1990). The QBPDS assesses functional limitations in daily activities of persons with back pain, with items rated on Likert-type scales and summed to a total score, with higher values indicating greater disability (Kopec et al., 1995). Formulations were adapted to replace back pain by pain in general. Both instruments have demonstrated good reliability and validity in chronic pain populations (typically $\alpha > .85$).

Pain intensity was measured using an 11-point numerical rating scale (0 = no pain to 10 = worst imaginable pain). Affective and sensory pain qualities were assessed using the German short-form McGill Pain Questionnaire, which provides subscale scores for sensory and affective pain descriptors (Melzack, 1975; Stein & Mendl, 1988). Pain coping was assessed using the German Pain Solutions Questionnaire (Sielski et al., 2017), and pain self-efficacy using the German Pain Self-Efficacy Questionnaire (Mangels et al., 2009), both

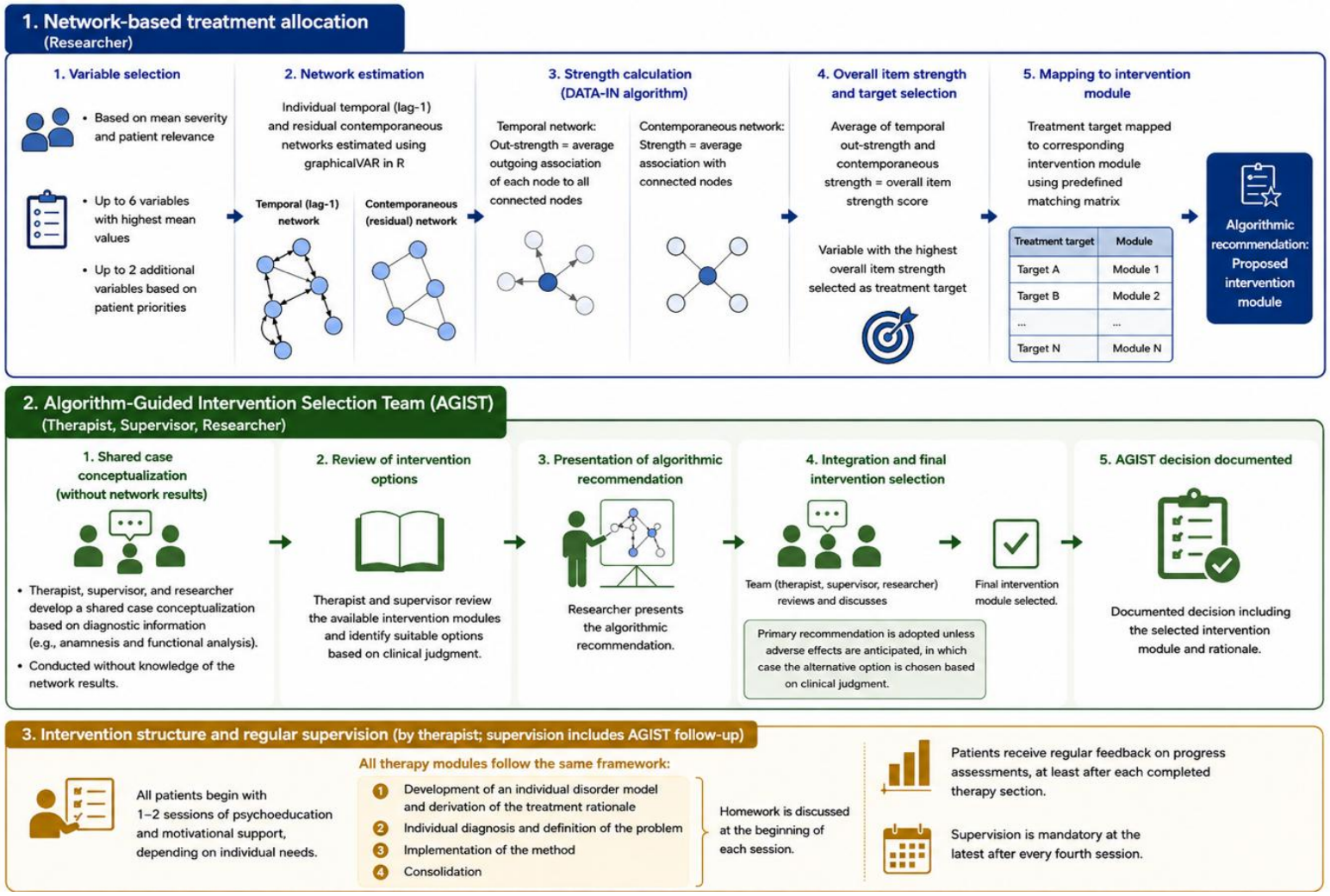
of which have shown good psychometric properties in German-speaking samples (α typically > .80).

### *Intervention*

**Treatment planning using an algorithm-guided decision process.** Participants were allocated to one of ten intervention modules using a structured, data-informed decision-making procedure (Algorithm-Guided Intervention Selection Team; AGIST). Prior to this process, person-specific networks were estimated from EMA data, and a primary treatment target was derived based on network characteristics (Rubel et al., 2018). An algorithm then identified two candidate intervention modules using a predefined matching matrix linking psychological processes to treatment components (see Analysis section). During the AGIST (Figure 9), the study therapist and supervisor first developed a shared case conceptualization based on diagnostic information (e.g., anamnesis and functional analysis), without knowledge of the network results. Subsequently, they reviewed the available intervention modules and identified suitable options based on clinical judgment. The network-derived treatment target and algorithm recommendations were then presented by a researcher. The final intervention was selected by integrating algorithmic recommendations with clinical expertise, with the primary recommendation being adopted unless adverse effects were anticipated, in which case the alternative option was chosen. The selected module was implemented throughout the intervention phase unless adverse effects or sustained non-response required reassignment, which was determined in supervision.

**Figure 9**

*Procedure of the Algorithm-Guided Intervention Selection Team (AGIST) and the process-targeted interventions*



**Process-targeted interventions.** The intervention comprised a set of modular, process-targeted treatment components derived from cognitive-behavioral and third-wave approaches to chronic pain (Figure 9). Modules included exposure in vivo, aiming to reduce avoidance and fear of movement by gradually engaging in feared activities; relaxation techniques, targeting physiological arousal and stress; and activity pacing, focusing on balancing activity and rest to enhance perceived control and flexibility in daily functioning. Cognitive coping interventions aimed to reduce maladaptive thought patterns and promote more adaptive cognitive responses, while attention control strategies sought to improve coping by flexibly directing attention away from pain. Resource activation targeted positive experiences and strengths, whereas acceptance-based interventions aimed to reduce experiential avoidance and foster a more adaptive relationship with pain. Values-based action interventions supported engagement in meaningful activities to improve quality of life. Sleep interventions aimed to improve recovery and sleep quality and self-compassion interventions to enhance self-worth and emotional resilience. All interventions were adapted from established treatment manuals for chronic pain and related conditions.

At the start of therapy, all patients received one or two sessions of psychoeducation and motivational support, depending on their individual level of knowledge. Hence, all therapy modules were structured in the same sequence, although the duration of the individual sections may vary from person to person. The sequence of each module was as follows:

1. Development of an individual disorder model, derivation of the treatment rationale
2. Individual diagnosis and definition of the problem
3. Implementation of the method
4. Consolidation

Of course, homework should be discussed at the beginning of each session. Patients should also receive regular feedback on progress assessments, at least after each completed therapy section (i.e., after the above-mentioned sections 1–4). Supervision was mandatory at the latest after every fourth session.

**Feedback.** Each week during therapy, therapists received a visual feedback report displaying the patient's target item over time. The report included a line plot depicting repeated measurements of the target variable across the different study phases, with phase transitions visually marked to facilitate interpretation of change over time. In addition, quantitative feedback regarding treatment effects was provided using the *TAU-BC statistic* and the *Bayes Factor* to support evaluation of changes associated with the intervention (de Vries et al., 2015; Tarlow, 2017). Therapists were instructed to review and discuss the feedback with patients at the beginning of each therapy session and to integrate the results into the ongoing therapeutic process.

**Procedural and treatment fidelity.** Before administering the intervention and interpreting the networks, all study therapists participated in a workshop on SCED and person-specific network analysis. Regular supervision enabled the timely discussion of specific difficulties in the treatment process (at least every fourth therapy session).

Treatment fidelity was assessed using a module-specific adherence checklist developed for the POINT Pain intervention based on established fidelity assessment approaches (e.g., Leeuw et al., 2009). The checklist was designed to capture adherence to the ten modularized CBT interventions for chronic primary pain and was derived from the treatment handbook and expert review. For each module, checklist items represented unique, permitted, and prohibited treatment elements across the four therapy phases (disorder model, diagnostics, implementation, and consolidation). Additional global items captured whether the assigned module had been implemented according to protocol, whether EMA feedback and the treatment rationale had been discussed, and raters' confidence in their overall judgment.

Treatment fidelity was evaluated by two independent raters who were not involved in treatment delivery. Four video-recorded therapy sessions per patient were selected to represent the course of treatment across therapy phases. After reviewing the selected sessions, raters provided a global dichotomous judgment (adherent vs. non-adherent)

regarding whether the assigned module had been delivered as intended. Interrater reliability was calculated using Cohen's Kappa (Cohen, 1960).

Additionally, treatment fidelity was assessed after every session. Therapists were asked to indicate all interventions that they used in the respective session. All therapists gave their consent to participate in the study and adhere to the procedure. This represents a self-rating of treatment fidelity.

### *Analyses*

All analyses were conducted in R (R Development Core Team, 2025, version 4.6.0) within RStudio (Posit, 2025, version 2026.04. 0+526). Several packages for data management, visualization, and statistical analysis, including BayesSingleSub (Morey, 2015/2024), coin (Hothorn et al., 2008), esc (Lüdecke, 2019), ggplot2 (Wickham, Chang, et al., 2025), Kendall (McLeod, 2025), lme4 (Bates et al., 2015), lmerTest (Kuznetsova et al., 2026), lubridate (Grolemund & Wickham, 2011), readr (Wickham et al., 2026), readxl (Wickham & Bryan, 2026), reshape2 (Wickham, 2007), rstatix (Kassambara, 2025), SingleCaseES (Pustejovsky et al., 2026), tidyr (Wickham, Vaughan, et al., 2025), tidyverse (Wickham et al., 2019), and xtable (Dahl et al., 2026). Missing observations and exclusions were handled separately for each analysis as described below.

**Network-based treatment allocation.** *Preprocessing:* Descriptive statistics (mean, median, standard deviation) were calculated for each EMA variable. Positively valenced items (e.g., positive affect, acceptance) were recoded where necessary to ensure consistent directionality across variables.

*Variable selection* followed predefined criteria to improve robustness of individual network estimation: (1) visual inspection for problematic distributions (skewness, kurtosis, outliers), with exclusion of highly skewed variables (skewness > 3); (2) exclusion of variables with low variance (SD < .20 after min–max scaling); (3) exclusion of highly correlated variables (r > .90), retaining the most clinically representative variable; and (4) exclusion of assessments with missing data. Given the maximum of 126 EMA assessments per participant, network estimation was restricted to three to eight variables**.** Variables were

selected based on mean severity and patient relevance: up to six variables with the highest mean values were included, with up to two additional variables with the highest mean added based on patient priorities.

*Network estimation:* Individual temporal (lag-1) and residual contemporaneous networks were estimated (Epskamp et al., 2018). Consistent with recommendations for short assessment periods, data were not detrended.

*Treatment allocation* was based on the DATA-IN algorithm (Rubel et al., 2018). In the temporal network, node out-strength was calculated as the average outgoing association of each variable to all connected variables. In the contemporaneous network, node strength was calculated as the average association with connected nodes. To facilitate interpretation and comparability, centrality values were transformed into proportional scores within individuals by dividing each node's centrality by the total sum of centrality values across all nodes in the respective network. These temporal and contemporaneous strengths were averaged to derive an overall item strength score. The variable with the highest overall strength was selected as the treatment target and mapped to the corresponding intervention module using a predefined matching matrix (V. Hofmann et al., 2023a).

**Qualitative evaluation of feasibility and acceptance.** ***Qualitative analysis.*** Qualitative data were analysed using an evaluative content analysis approach (Kuckartz & Rädiker, 2022). First, the interviewer (VEH) familiarised herself with the interview material by preparing case summaries and subsequently generating short paraphrases that condensed the essential meaning of participants' statements. Based on the study aims, both researchers (VEH, SSCH) jointly developed guiding questions to structure the analysis ("*How did participants experience the use of POINT Pain?", "What facilitated engagement with POINT Pain?", "What barriers or challenges emerged when using POINT Pain?", "What effects of POINT Pain were perceived by participants?", "What factors were perceived to contribute to change?*"). All paraphrases were then randomised and independently assigned by both researchers to one of the predefined research questions. Paraphrases that were judged not to contribute to any research question were excluded from further analyses. Interrater

agreement for this assignment step was quantified using Cohen's κ and interpreted according to established benchmarks (Landis & Koch, 1977). Second, one researcher (SSCH) conducted the initial coding by assigning concise descriptive codes to all retained paraphrases. These codes aimed to capture central features of the data and identify recurring patterns across participants. The interviewer (VEH), who had contextual knowledge from conducting the interviews, reviewed the coding and acted as an auditor to ensure that contextual meaning was adequately reflected. Third, codes were iteratively examined to identify broader patterns of meaning and generate candidate categories. To establish an initial category system, therapist data were analyzed separately for each research question, resulting in a preliminary coding framework capturing key topics. Fourth, categories were reviewed and refined by analyzing patient data against the preliminary category structure. Similarities and differences between therapist and patient perspectives were explored and integrated into category definitions. Where patient perspectives extended beyond the existing framework, additional categories were generated and retained as patient-specific categories. Finally, both researchers collaboratively refined, defined, and named the categories. The auditor (VEH) reviewed the category structure and coded data, and disagreements were resolved through discussion until consensus was reached. Categories were then interpreted in relation to the guiding questions to draw conclusions regarding the feasibility and acceptance of the POINT Pain proof-of-principle study. The detailed qualitative analysis was preregistered to extend the study protocol (V. Hofmann, Glombiewski, & Scholten, 2026; V. E. Hofmann et al., 2024).

***Researcher reflexivity.*** The analysis was conducted by two researchers with backgrounds in cognitive behavioural therapy (CBT): a female postdoctoral researcher (SSCH), who led the POINT Pain project, and a female PhD student (VEH), who conducted the interviews and was involved in project implementation. Both researchers identify as White and approached the data from a clinical and CBT-oriented perspective. Throughout the analysis, discussions were used to reflect on how their professional roles, involvement in

the project, and theoretical orientation may have shaped data interpretation and theme development.

**Quantitative evaluation of feasibility and acceptance.** Feasibility outcomes were summarized descriptively. Questionnaire-based usability outcomes were scored according to instrument-specific procedures:

Following standard scoring procedures for the SUS, responses to positively worded items were transformed by subtracting 1, and responses to negatively worded items by subtracting the item score from 5. The transformed item scores were summed and multiplied by 2.5 to yield a total score ranging from 0 to 100, with higher scores indicating better perceived usability (Gao et al., 2020).

Mean scores are calculated for both UEQ dimensions (pragmatic and hedonic quality), with higher values indicating more positive evaluations (Schrepp et al., 2017). According to UEQ interpretation guidelines, mean values between −0.8 and +0.8 indicate a neutral evaluation, values above +0.8 indicate a positive evaluation, and values below −0.8 indicate a negative evaluation. Although the theoretical score range extends from −3 (most negative evaluation) to +3 (most positive evaluation), values above +2 or below −2 are uncommon in applied settings because scores represent averages across users.

**Exploratory analysis at the individual level.** ***Visual analysis.*** Weekly visual feedback plots displayed trajectories of the target variable across study phases. Analyses focused on changes in level and trend between phases (Lane & Gast, 2014).

***Single-case effect estimation.*** Treatment effects were quantified using baseline-corrected Tau (BC-Tau)**.** BC-Tau is a non-parametric effect size that estimates the proportion of non-overlapping data between baseline and intervention phases while accounting for baseline trends and ranges from −1 to +1 (Tarlow, 2017). To complement BC-Tau, Bayesian tests for each participant were estimated to quantify evidence for treatment-related changes between the second baseline phase and the therapy phase (de Vries & Morey, 2013). Separate analyses were conducted for changes in intercept and trend of the individualized target variable while accounting for autocorrelation in repeated observations. Bayes Factors

(BF) were computed using Markov Chain Monte Carlo estimation (10,000 iterations) and expressed as the relative evidence for improvement under the intervention compared to the null hypothesis of no treatment effect. They were interpreted as likelihood ratios comparing the observed data under competing hypotheses**.** A BF of 1 indicates that the data are equally compatible with both hypotheses. Values increasingly greater than 1 indicate stronger evidence favoring H0 (no intervention effect) over H1 (intervention effect), whereas values increasingly smaller than 1 indicate stronger evidence favoring H1 over H0. For ease of interpretation, BFs < 1 were inverted (1/BF) to express evidence in favor of the alternative hypothesis. The strength of evidence depends on both the number of observations and variability within phases.

***Within-person regressions.*** To estimate phase-related change for the target variable and disability respectively within participants, separate regression models were fitted:

$$Score_i = \beta_0 + \beta_1 Phase_i + e_i$$

where $\beta_0$ represented the estimated baseline level and $\beta_1$ the estimated change associated with the intervention phase.

Standardized change scores were calculated as:

$$Effect\ Size = \frac{Treatment\ Mean - Baseline\ Mean}{Baseline\ SD}$$

Negative values indicated lower outcome levels during treatment relative to baseline.

***Comparison of Pre- and Post-Treatment Networks.*** As an exploratory analysis, pre-treatment and post-treatment networks were visually compared to examine potential changes in network structure and centrality patterns over the course of treatment. Idiographic network changes between the pre- and post-treatment EMA periods were examined using the Individual Network Invariance Test (Hoekstra et al., 2024). It compares a constrained model assuming homogeneous network structures across measurement periods with an unconstrained model allowing network parameters to vary between periods. Temporal GVAR networks were estimated for each participant separately, and model comparison was based on ΔBIC values, with positive values indicating support for network homogeneity and

negative values indicating support for heterogeneity between pre- and post-treatment networks. Missing data were handled using full information maximum likelihood estimation (FIML). Given the limited number of EMA observations and the complexity of temporal network models, some idiographic models showed convergence problems or numerical instabilities; these results were interpreted exploratorily.

**Exploratory analysis at the group-level.** ***Multi-level model.*** Linear mixed-effects models were estimated to estimate average treatment effects across participants while accounting for repeated measurements nested within individuals:

A random-intercept model was estimated first:

$$Score_{ij} = \beta_0 + \beta_1 Phase_{ij} + u_{0j} + e_{ij}$$

To assess heterogeneity in treatment response, a random-slope model was additionally estimated. Models were fitted using restricted maximum likelihood (REML) and compared using likelihood-ratio tests, AIC, and BIC. Because random slopes did not improve model fit, the random-intercept model was retained.

***Analysis of secondary outcomes.*** Secondary outcomes were assessed at pre-treatment, post-treatment, and follow-up**.** Descriptive statistics (mean, SD, median, minimum, maximum) were computed for each outcome and time point. Descriptive visualizations were generated to illustrate individual and group-level trajectories across time. Given the small sample and expected deviations from normality, longitudinal changes were evaluated using Friedman tests for repeated measures.

### *Transparency and openness*

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study, and we follow JARS (Appelbaum et al., 2018). All data, analysis code, and research materials are available in the Open Science Framework [Project link: https://osf.io/9tuqr/overview?view_only=2a908f5aa87143809199f37339534ef1; Data, code, and material related to this publication: https://osf.io/tsdc8/overview?view_only=4e564f92f03e40b2ad5e37c678fe70b0]. The authors used ChatGPT (OpenAI, 2026) and DeepL (DeepL SE, 2026) to support the translation of

text included in the manuscript, as well as for language editing and stylistic refinements. ChatGPT was additionally used to assist with the development and refinement of coding for statistical analyses and to create and refine Figure 9. All outputs generated with these tools were reviewed, verified, and edited by the authors, who take full responsibility for the content of the manuscript.

## Results

### *Sample Characteristics*

A total of *N* = 29 participants were recruited between November 2023 and June 2024 through the outpatient clinic's waiting list, referrals from healthcare providers, and public advertisements. Of these, *N* = 15 participants were enrolled in the study. During the study, *N* = 3 participants discontinued participation, resulting in a final sample of *N* = 12 participants included in the analyses. Data collection was completed in August 2025. A detailed overview of participant flow is provided in the OSF project ("S1_Participant flow"; https://osf.io/tsdc8/overview?view_only=4e564f92f03e40b2ad5e37c678fe70b0).

The final sample consisted of *N* = 12 participants with chronic primary pain (Table 11). Participants had a mean age of *M* = 60.25 years (*SD* = 7.2, range = 54-80). All participants met criteria for chronic primary pain (ICD-10: F45.41). Comorbid mental disorders were present in *n* = 5 participants, with the most frequent diagnoses being depressive disorders (*n* = 5).

Therapists had a mean age of 32.3 years (range: 26–39) and were predominantly female (n = 7), with two male therapists. Two therapists were fully licensed, while seven were in clinical training. Most had between 0 and 5 years of professional experience (n = 7), with three reporting 6–10 years and one reporting 11–15 years of experience. Three therapists treated two patients each.

**Table 11**

*Sociodemographic characteristics of the patients*

| ID | Gender identity | Age | Country of Birth | Highest school degree | Highest vocational degree | Current working position |
|---|---|---|---|---|---|---|
| 1 | male | 50-59 | Eastern European Country | High school diploma | PhD | Full-time employee |
| 2 | male | 60-69 | Germany | High school diploma | PhD | Retiree |
| 3 | male | 80-89 | Germany | Technical College Entrance Qualification | Bachelor | Retiree |
| 4 | female | 50-59 | Germany | Secondary School Diploma | Completed apprenticeship | Chronically ill |
| 5 | female | 60-69 | Germany | Junior High School Diploma | No vocational degree | Housewife or househusband |
| 6 | female | 50-59 | Eastern European Country | High school diploma | Completed apprenticeship | Part-time employee |
| 7 | female | 60-69 | Germany | Junior High School Diploma | Completed apprenticeship | Part-time employee |
| 8 | female | 60-69 | Germany | Secondary School Diploma | Completed apprenticeship | Part-time employee |
| 9 | female | 50-59 | Germany | High school diploma | 2. Midterm Exam | Part-time employee |
| 10 | male | 50-59 | Germany | Junior High School Diploma | Completed apprenticeship | Part-time employee |
| 11 | female | 50-59 | Other | Secondary School Diploma | Completed apprenticeship | Part-time employee |
| 12 | male | 60-69 | Germany | High school diploma | Master | Retiree, Self-employed |

***Adherence***

Treatment fidelity was assessed using module-specific adherence checklists applied to video-recorded therapy sessions. On average, raters required approximately 9.4 minutes to complete the checklist beyond the duration of the selected therapy sessions. Across the

evaluated interventions, the checklists showed substantial interrater agreement between the two independent raters (Cohen's κ = .63), indicating good reliability of the global adherence ratings. In ten therapies, therapists adhered to the protocol. Adherence for one therapy was only approved by one rater. One therapist did not adhere to the protocol according to both raters. Raters reported high confidence in their judgments.

Only three therapists reported any deviations from the protocol. All the other therapists said that they had only used the recommended module throughout the entire therapy course. A comparison of external fidelity ratings with therapists' self-reported adherence showed only slight agreement (Fleiss' κ = 0.16), indicating discrepancies between external observation and therapists' self-assessment of module delivery.

### *Feasibility and acceptance*

**Qualitative results.** As the first step of the qualitative analysis, all paraphrases were assigned to the guiding research questions. A good rater agreement was reached for patients' (Cohen's κ = .76) and therapists' paraphrases (Cohen's κ = .83). Results of the following steps of the analysis are presented in a narrative summary to each research question separately (for the complete Codebook + Data see OSF ("Qual. Data + Code", https://osf.io/tsdc8/overview?view_only=4e564f92f03e40b2ad5e37c678fe70b0):

*How did participants experience the use of POINT-Pain?*

Participants described POINT-Pain as a structured yet flexible framework that was integrated into ongoing psychotherapy processes. Therapists reported introducing the visualizations and app functions early in treatment, realizing the intervention according to the protocol, and using supervision to reflect on the data, whereas patients described independently engaging with their data through the m-Path app (*General use in psychotherapy process*). Participants emphasized the challenge to adhere to the intervention structure with adaptations to individual patient needs and therapist preferences (*Balancing structure and flexibility*). For example, one therapist described "refram[ing] it and manag[ing] to get the curve after all," while a patient explained that therapy focused on improving interpersonal functioning.

Both therapists and patients described the data visualizations as useful for maintaining therapeutic focus and supporting treatment decisions (*Data as orientation*). Therapists used the network to explain treatment rationale and justify shifts in therapeutic approach, while patients appreciated that therapy planning was guided by data rather than intuition alone. Network and feedback plots were regularly discussed in sessions and often served as a starting point for reflecting on symptom relations and treatment targets (*Use of visualizations in therapy discussions*). Patients additionally described engaging with their self-monitoring data between sessions through the app (*Patient engagement with self-monitoring data*).

Some participants also reported deviations from the study protocol, including irregular use of network feedback or omitted intervention components (*Deviations from the study protocol*). These deviations were typically attributed to practical barriers, forgetfulness, or difficulties understanding the visualizations.

*What effects of POINT Pain were perceived by participants?*

Therapists and patients described a wide range of perceived treatment effects, including reductions in symptoms and comorbid distress, improvements in functioning, and learning concrete strategies for coping with pain and emotional distress (*Perceived treatment effects*). Patients particularly emphasized gaining a better understanding of the psychology of pain, increased self-awareness, and benefits from specific intervention modules such as strengthening personal values or fostering self-compassion. Some participants also described negative effects, including burden associated with frequent assessments that repeatedly reminded them of their pain. In some cases, therapists and patients reported little or no perceived change (e.g., Therapist: “I don’t really have much hope that much has changed.”; Patient: “The pain is still there.”; *Negative side effects and non-response*).

Therapists additionally reported learning to adopt a more structured and goal-oriented therapeutic approach by defining central treatment targets, maintaining intervention focus, and systematically evaluating progress and goal attainment (*Goal-oriented and focused treatment planning and delivery*). They also emphasized the development of therapeutic,

technical, and methodological competencies through participation in the study (*Professional learning and skill acquisition*). For example, one therapist stated, “For me, self-compassion hadn’t even crossed my mind before,” while another reflected, „I learned a lot about pain.”

*What factors were perceived to contribute to change?*

Patients and therapists attributed therapeutic change to common therapeutic factors and the structured delivery of treatment, including regular sessions, therapist guidance, and explicit therapeutic focus (*General therapeutic processes)*. Patients described feeling accepted, valued, listened to, and accompanied by a professional throughout the therapeutic process. Therapists emphasized the role of the therapeutic relationship and creating space to discuss and reflect on problems. Particularly, patients and therapists highlighted that repeated self-observation, personalized feedback, and impressions from everyday life in therapy may have led to increased awareness of patterns in everyday life and opportunities for reflection (*Self-monitoring and reflective awareness)*. Adopting new ways of understanding, responding to and coping with pain and everyday challenges was put forward as another potential working mechanism (*Development of new perspectives and coping strategies).*

Therapists also attributed the effect of therapy to the structured therapeutic process, including explicit goal setting, maintaining focus on selected interventions, accountability, and adherence to the treatment plan (*Goal-orientation and structured treatment planning and delivery)*. One therapist mentioned that using the information of the network guided understanding and treatment decisions based on the matching algorithm.

However, some therapists were also unable to identify or attribute therapeutic changes to a specific process or intervention component (*Uncertainty about mechanisms of change).* Patients additionally attributed some changes to contextual factors, such as concurrent physiotherapy or having “time to process things” after sessions, which were perceived to support therapeutic effects beyond specific intervention techniques (*Contextual mechanisms of change).*

*What facilitated engagement with POINT Pain? What barriers or challenges emerged when using POINT Pain?*

The implementation was shaped by technical, procedural, interpersonal, and ethical factors. Therapists described facilitators and barriers in roughly equal measure, whereas patients reported substantially more barriers than facilitators. Experiences varied considerably between participants and often reflected opposite poles of the same issue, such as "Formulating idiographic items was easy." and “I realized that I didn't have many ideas either, so only very lackluster ideas emerged, which were harder to put into words [idiographic items].”

Overall, successful implementation appears to depend on a participant-centered study design that includes understandable terminology and labelling of items, addressing initial concerns, providing motivation, ensuring accessible technical infrastructure and support, and striking a balance between treatment structure and flexibility. Therapists additionally emphasized the importance of specific training for m-Path and modules and ongoing supervision for integrating the procedure into their routine therapeutic practice. Barriers and facilitators are presented in Table 12 along with recommendations to address the barriers in future studies or practice settings.

**Table 12**

*Barriers, facilitators, and recommendations for future implementation*

| Barriers | Facilitators | Recommendations |
|---|---|---|
| **Personal burden** | | |
| • Cognitive and attentional strain due to high expectations or careless misinterpretations<br>• Patient emotional and practical burden filling out EMA and SCED assessments<br>• Overwhelming complex information<br>• Lack of personal motivation | • Gaining new experience [T]<br>• Study was less complicated than expected [T]<br>• Enjoying training and supervision [T] | • Think about longer assessment period, 4-5 assessments per day and longer response windows [P]<br>• Think about fixed time points [P]<br>• Use gamification to incentivize assessment [P] |
| **Integration into routine clinical practice** | | |
| • Limitations in adjusting length, duration, and format in study setting [P]<br>• Integration into routine clinical practice is a challenge [T]<br>• Limited time resources [T] | • Preference for 1:1 setting<br>• Being at home facilitated EMA | • Allow flexibility through a limited number of „Joker sessions" in the study protocol [T]<br>• *Enable remote participation* |
| **Technical and practical usability** | | |
| • Software and technical difficulties (e.g., missing m-Path beep)<br>• Difficulties to formulate (more than one) idiographic items | • Easy start into the study [P]<br>• User-friendly and easy to access software and material (PDF-results, instruction videos)<br>• Convenient questionnaire length, assessments frequency, and integration into everyday life | • *Provide ongoing technical support for patients and therapists*<br>• *Be available on all channels (phone, mail, personal contact…)* |

| | | |
|---|---|---|
| | • Easy formulation of idiographic items<br>• Support from study team and supervision [T] | |
| **Interpretability and communication of feedback** | | |
| • Difficulties to display results in the m-Path app on the phone<br>• Labels were cryptic<br>• Mix of negative and inversely coded positive items made interpretation difficult<br>• Lack of data literacy impeded easy understanding | | • Provide text-based interpretations of the network<br>• *Think of separating positive and negative items into different networks*<br>• *Formulate comprehensive item labels* |
| **Protocol adherence** | | |
| • Restriction due to algorithm recommendation<br>• Items, network, or intervention didn't match or distract from therapy process.<br>• Wish to deviate from the protocol [T]<br>• Unclear indication for network approach [T] | • Motivation<br>• Structured framework facilitated treatment<br>• Study procedure increased motivation<br>• Combination of individual-level data and clinical judgement supported therapeutic work and provided useful starting point for treatment<br>• Appreciating freedom to realize the module [T]<br>• Treatment within restricted timeframe [T]<br>• Matching person-specific information and intervention selection [T] | • Use more personalized items [P]<br>• Provide module-specific training including role-plays in addition to existing training [T]<br>• Include training how to use m-Path [T]<br>• Provide FAQs for trouble shooting [T] |

| | |
|---|---|
| • Individualized, goal-oriented procedure [P]<br>• Using feedback [P] | |
| **Concerns** | |
| • Items were not well-differentiated. [P]<br>• Uncertainty about meaning of items [P]<br>• Vague, overlapping therapy modules [T]<br>• Statistical operationalization of treatment success [T]<br>• Far-reaching consequences of the algorithm that is based on arbitrary assessment time point, data quality, and statistical decision | • *Continue item validation and evaluation*<br>• *Clearly describe recommended, tolerated and forbidden interventions of every module in the therapy handbook*<br>• *Take concerns seriously, discuss them with participant, address them if possible or share them with the research community to find solutions together.* |

*Note.* [P] indicates that the topic was raised by patients; [T] indicates that the topic was raised by therapists. Recommendations in *italic* are proposed by the study team. Participants formulated all other suggestions.

**Quantitative results.** Compliance ranged from 50 – 100% with high variations across phases. While compliance varied between 73-98% during the EMA phases, the lowest compliance was present in the randomized baseline phase and post-therapy (50%), whereas 100% compliance was achieved during the SCED phases. Overall, at least seven patients reached the pre-defined criterium of 80% compliance in every phase, with a maximum of 11 patients reaching 80% in the diagnostic phase and in the post-treatment EMA phase.

Patients and therapists rated the System Usability Scale (SUS) separately for m-Path and for the presentation of the results. Patients (*M(SD)* = 85.19) and therapists (*M(SD)* = 69.44) rated the use of m-Path higher than the presentation of the results (Patients: *M(SD)* = 79.23; therapists: *M(SD)* = 53.06). Thus, while m-Path seems useful, the results are only moderately useful in their current form.

The results of the UEQ indicated a positive hedonic quality for patients (*M(SD)* = 1.54(1.29)) and therapists (*M(SD)* = 1(0.84)). The pragmatic quality was lower in both groups of participants (patients: *M(SD)* = 0.87(0.59), and it did not meet the criteria for a positive evaluation in the therapist sample (*M(SD)* = 0.64(0.64)).

***Individual-level exploratory analyses***

**Visual analysis** revealed consistent improvement patterns in level and trend for the target variable and disability in five patients (P1, P3, P6, P9 and P11) during the intervention phase compared to the baseline phase. Two patients showed lower levels but slightly increasing trends (P5 and P7). Three patients showed mixed results: they exhibited a higher level and trend of the target variable compared to baseline, but a lower level of disability (P2, P4, and P12). One patient exhibited only a change in the trend of the target variable, alongside higher levels of disability with a downward trend (P10). One patient exhibited a trend and level in the opposite direction (P8), indicating an exacerbation of symptoms (see OSF “S2 PP1 Visual Analyses of Target and Disability”, https://osf.io/tsdc8/overview?view_only=4e564f92f03e40b2ad5e37c678fe70b0).

**Single-Case Effect Estimation.** Visual results were further examined using Baseline-Corrected TAU, Bayes Factor analyses, and within-person regression analyses (Table 13). Baseline-Corrected TAU did not indicate significant change for any participant. Bayes Factor analyses indicated greater evidence for the alternative hypothesis (intervention effect at the mean level) relative to the null hypothesis (no intervention effect) in four patients (P1, P3, P5, P6). Regarding trend effects, Bayes Factors indicated evidence for an intervention effect in two patients (P6 and P12).

Within-person regression analyses of the target item revealed lower scores during the intervention phase than during the second baseline phase for eight patients, and higher scores for four patients (Table 13). One patient improved significantly (P1: SMD = -0.88, 95% CI [-1.34, -0.24]) and two patients deteriorated significantly (P2: SMD = 1.37, 95% CI [0.28, 2.41]; P4: SMD = 1.18, 95% CI [1.15, 4.36]). Within-person regression analyses of the disability item showed lower scores for disability during the intervention phase compared with

the second baseline phase in most patients, although effects varied across individuals. Two participants showed increases instead. Four patients showed significant improvements with small to medium effect sizes (P1: SMD = -0.88, 95% CI [-1.34, -0.24]; P4: SMD = -1.46, 95% CI [-2.31, -0.56]; P9: SMD = -0.63, 95% CI [-1.74, -0.07]).

The Individual Network Invariance Test (INIT) showed convergence problems or numerical instabilities in seven network comparisons (P1, P5, P6, P7, P8, P9, P11), limiting interpretability of these results. Two test results showed no preference for either the homogeneous or heterogeneous model (P2 and P10; ΔBIC = 0.00). Among the remaining interpretable comparisons, ΔBIC values indicated relatively greater support for network homogeneity across pre- and post-treatment periods in three participants (P3, P4, and P12). Exact ΔBIC values are reported in Table 13.

***Group-level exploratory analyses***

**A linear mixed-effects model with random intercepts** was the best fit for the data. There was a significant overall reduction in disability scores from Baseline Phase to Intervention Phase. On average, scores decreased by $\beta_1$ = 0.45 (*SE* = 0.21, df = 611.35, t = 8.16, *p* = 0.03) from Baseline Phase to Intervention Phase. Participants differed substantially in their baseline levels but not in how strongly they responded to the intervention. Adding random slopes for phase did not significantly improve model fit, suggesting no substantial evidence for variability in intervention effects across participants ($\chi^2(2) = 1.75$, *p* = .42).

**Descriptive statistics** indicated small reductions in disability (PDI and QBPDS) and small increases in self-efficacy across assessment time points. Figure 10 depicts individual- and group-level trajectories across time. However, Friedman tests for repeated measures did not indicate statistically significant longitudinal changes (PDI: $\chi^2(2) = 3.17$, *p* = .20; QBPDS: $\chi^2(2) = 4.22$, *p* = .12; Self-Efficacy: $\chi^2(2) = 5.52$, *p* = .06).

**Table 13**

*Overview of Target Items, Modules, and individual-level exploratory analyses*

| | | | | Baseline | | Intervention | | Regression | | TAU-BC | | Bayes Factor | | INIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Target | Item | Module | *M* | *(SD)* | *M* | *(SD)* | $\beta_1$ | *p* | TAU | [2.5%; 97.5] CI | Mean | Trend | ΔBIC |
| | | | | | | | | - | < .05 | > 0 | No 0 | < 1 | < 1 | |
| **1** | **Pain intensity** | **How strong was your pain on average?** | **Attention control** | 1.60 | (0.89) | 0.81 | (0.52) | **- 0.79** | **.01** | 0.34 | [-0.07; 0.74] | **0.25** | 15.31 | -3311.84[X] |
| 2 | **Positive Affect*** | **I felt cheerful despite my pain.** | **Resource activation** | 3.17 | (0.98) | 4.51 | (1.29) | **1.35** | **.01** | - 0.20 | [-0.45; 0.04] | 7.03 | 3.22 | 0.00 |
| 3 | Avoidance (#5) | I stopped activities because of my pain. | Activity and Rest | 8.00 | (1.00) | 6.56 | (1.73) | - 1.44 | .17 | 0.21 | [-0.20; 0.62] | **0.85** | 3.98 | **23.30** |
| 4 | **Thought Suppression (#11)** | **I tried to ignore my pain.** | **Activity and Rest** | 4.33 | (2.34) | 7.09 | (1.70) | **2.75** | **.00** | - 0.39 | [-0.79; 0.01] | 9.93 | 5.67 | **26.35** |

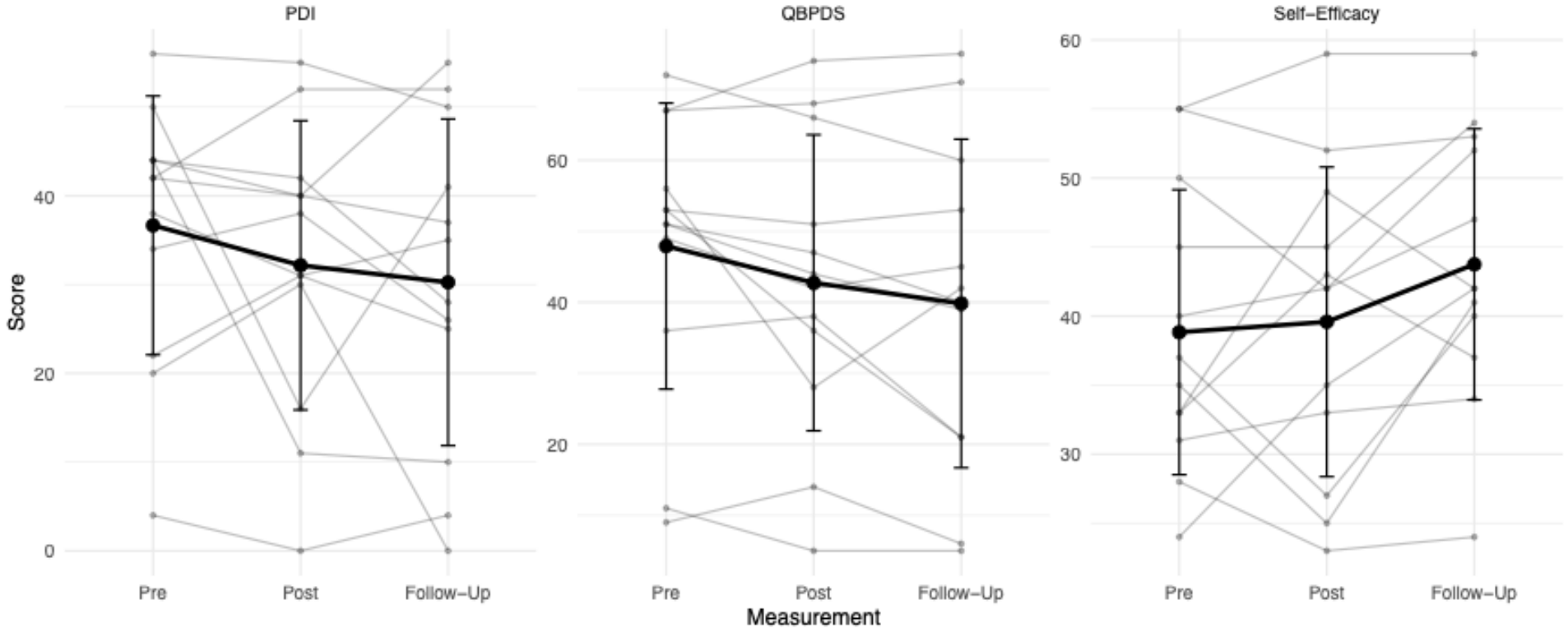
| | | | | Baseline | | Intervention | | Regression | | | TAU-BC | Bayes Factor | | INIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Target | Item | Module | *M* | *(SD)* | *M* | *(SD)* | $\beta_1$ | *p* | TAU | [2.5%; 97.5] CI | Mean | Trend | ΔBIC |
| | | | | | | | | - | < .05 | > 0 | No 0 | < 1 | < 1 | |
| 5 | Self-efficacy (#8)* | I was confident I could get something done, even though I was in pain. | Attention control | 6.50 | (1.05) | 5.61 | (1.07) | - 0.89 | .06 | 0.24 | [-0.16; 0.63] | **0.52** | 8.32 | 11932350 1396252.00 X |
| 6 | Disability | How much did you feel disabled because of your pain? | Resource activation | 2.33 | (2.08) | 1.22 | (1.47) | - 1.12 | .22 | 0.15 | [-0.24; 0.54] | **0.72** | **0.35** | -431.25 X |
| 7 | Disability | How much did you feel disabled because of your pain? | Resource activation | 6.75 | (1.42) | 6.56 | (1.52) | - 0.19 | .70 | 0.03 | [-0.34; 0.41] | 2.76 | 12.50 | 24714360 013473.90 X |

| | | | | Baseline | | Intervention | | Regression | | TAU-BC | | | Bayes Factor | | INIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Target | Item | Module | *M* | *(SD)* | *M* | *(SD)* | $\beta_1$ | *p* | TAU | [2.5%; 97.5] CI | | Mean | Trend | ΔBIC |
| | | | | | | | | - | < .05 | > 0 | No 0 | | < 1 | < 1 | |
| 8 | Disability | How much did you feel disabled because of your pain? | Resource activation | 3.17 | (2.99) | 4.17 | (1.99) | 1.01 | .28 | - 0.10 | [-0.48; | 0.28] | 4.95 | 5.98 | 274.50 [X] |
| 9 | Self-efficacy (#9)* | I was sure I could lead a fulfilling life, even though I was in pain. | Value-based action | 8.00 | (0.63) | 7.29 | (1.21) | - 0.71 | .17 | 0.24 | [-0.11; | 0.60] | 1.07 | 3.18 | -28.00 [X] |
| 10 | Pain-related worry (#1) | I thought: “It will never get better!” | Cognitive coping | 6.88 | (2.85) | 6.85 | (2.98) | - 0.02 | .99 | - 0.00 | [-0.47; | 0.47] | 2.98 | 5.79 | 0.00 |
| 11 | Self-compassion (#4)* | I tried to be friendly to myself.“ | Self-compassion | 5.33 | (0.58) | 4.12 | (1.95) | - 1.21 | .30 | 0.22 | [-0.19; | 0.62] | 1.10 | 2.28 | 37824766 8122020. 00 [X] |
| 12 | Thought suppression (#1) | I thought, “Hang in there!” | Activity and Rest | 3.67 | (2.89) | 4.97 | (1.75) | 1.30 | .25 | - 0.18 | [-0.65; | 0.30] | 3.32 | **0.55** | **6.43** |

*Note.* *reversely coded; [X]INIT estimation caused warning indicating that the test cannot be interpreted.

**Figure 10**

*Pre-, post-, and follow-up assessments of secondary outcomes*



## Discussion

This proof-of-concept study aimed to determine the feasibility and acceptance of integrating ecological momentary assessment (EMA), network analysis, and single-case experimental designs (SCEDs) into a unified framework for data-informed, personalized psychotherapy. The study was conducted with a sample of twelve patients with chronic pain and comorbidities, such as depression, because this population is highly heterogeneous and therefore particularly likely to benefit from individualized treatment approaches. Overall, patients and therapists emphasized the usefulness of self-monitoring and the structured, data-based approach for orientation, goal setting, reflexive awareness, and maintaining therapeutic focus. While feasibility and acceptance were established, qualitative and quantitative analyses also indicated room for improvement regarding participant burden, data interpretation, and procedural flexibility. An exploratory analysis examining the potential to produce meaningful changes in individualized treatment targets and disability measures yielded mixed results, warranting further refinement at the individual level and investigation in larger samples before generalizable conclusions can be drawn.

Currently, best-practice data-informed clinical decision-making primarily relies on diagnostic classification and the selection of corresponding treatment protocols (S. G. Hofmann & Hayes, 2019). In addition, Routine Outcome Monitoring (ROM) procedures have been developed to provide feedback throughout therapy and to detect non-response or deterioration (Barkham et al., 2023; Lambert et al., 2018). However, when treating individual patients with complex presentations or comorbidities, these frameworks provide limited guidance for the ongoing moment-to-moment clinical decisions therapists are required to make (Stade et al., 2025). Designing the personalized psychotherapy approach used in the present study highlighted several unresolved questions along the individual-level clinical decision-making pathway that may contribute to the research–practice gap (Scholten & Glombiewski, 2025). These questions concern how patient difficulties should be conceptualized and assessed beyond diagnostic categories; how patient-defined goals and individual-level data can be integrated to inform case conceptualization, the identification of

potential working mechanisms, and treatment target selection; how intervention procedures, sequencing, and dosage should be matched to identified targets; and how treatment progress, meaningful change, and the need for adaptation should be evaluated over time at the individual level.

To address these challenges, the present study implemented a structured framework for personalizing psychotherapy based on individual patient data that integrates three interconnected steps: observing, deciding, and intervening. These steps combine EMA, network analysis, and single-case experimental designs SCEDs – methods that, despite their conceptual complementarity, have rarely been integrated within a single clinical framework. Accordingly, the following discussion is organized along these three process steps and reflects on the methodological and clinical decisions required at each stage of personalized treatment planning and evaluation.

***Observing: Ecological Momentary Assessment and Self-Monitoring***

EMA was used to implement observation in two different baseline phases. Patients reported high burden when EMA was conducted six times per day for 21 days. However, they also reported missing the intensive assessment when the schedule was reduced to three weekly assessments. These findings suggest a nonlinear trade-off between participant burden and perceived informational value: very frequent assessments may increase burden, whereas very sparse assessments may reduce perceived relevance and engagement.

This pattern supports a more general design principle for personalized assessment systems: the optimal observation strategy is contingent on the clinical question and the timescale of the processes of interest, rather than on a universal “ideal” sampling rate. In other words, EMA schedules should be conceptualized as epistemic tools that must be matched to the temporal structure of the target phenomena, ranging from rapidly fluctuating affective or behavioral processes to slower-moving patterns of symptom change and treatment response. From this perspective, different levels of assessment intensity may serve distinct purposes within the same case formulation process. High-frequency bursts may be particularly suited for capturing short-term dynamics and identifying potential

mechanisms (Andresen et al., 2025), whereas lower-frequency assessments may be sufficient for tracking broader treatment trajectories.

Accordingly, rather than prescribing fixed EMA protocols, the present findings support flexible and hybrid monitoring architectures. These may include combinations of measurement bursts for mechanism detection, sustained moderate-frequency monitoring for ongoing case formulation, and brief routine outcome monitoring (ROM) intervals for tracking global treatment progress (Janssens et al., 2018; Wrzus & Neubauer, 2023). Importantly, such flexibility also implies that assessment design should be treated as an iterative clinical decision rather than a static methodological choice.

Finally, the qualitative findings suggest that the value of intensive self-monitoring extends beyond data collection. Participants and therapists described EMA as an active component of the therapeutic process, facilitating self-observation, enhancing awareness of contextual variability in symptoms, and supporting reflective integration of daily-life experiences into psychotherapy. This indicates that EMA may function not only as an assessment infrastructure but also as a process-supporting intervention element. Consistent with prior qualitative work on feedback-informed and EMA-supported psychotherapy (Bos et al., 2022; Bringmann et al., 2020; Riese et al., 2021; Scholten, Schemer, et al., 2024), these findings highlight the potential of self-monitoring to contribute to engagement and meaning-making processes within treatment.

### *Deciding: Data-Informed Clinical Reasoning and Treatment Selection*

Second, *deciding* was implemented through person-specific network estimation (Epskamp et al., 2018), structured selection of treatment targets (Rubel et al., 2018), and matching of interventions using a pre-defined decision matrix (Hofmann, Glombiewski, & Scholten, 2026). Prior to implementing data-driven recommendations, this decision process was rehearsed in a structured supervision format (Algorithm-Guided Intervention Selection Team; AGIST), which functioned as a deliberative space for translating individualized data into clinical decisions.

Qualitative findings indicated that AGIST was experienced by therapists as a particularly valuable component of the process. It provided a structured context for reflecting on clinical decision-making, clarifying patient aims, identifying candidate treatment targets, and selecting interventions in a transparent and goal-oriented manner. Therapists further reported that this structured reflection represented a key learning experience throughout study participation (Levinson et al., 2024).

At the same time, both patients and therapists raised ethical concerns regarding the potential implications of data-driven decision-making. These concerns mirror ongoing methodological debates on the clinical translation of network-based approaches (Bringmann, 2024), particularly regarding the reliability of time-varying data (Bringmann et al., 2018; Haslbeck et al., 2021; Scholten, Rubel, et al., 2024), issues of construct validity (Bringmann, 2024; Razum et al., 2026), challenges in identifying treatment targets (Bringmann et al., 2019; Cusack et al., 2025), and instability or incompleteness of person-specific network estimates (Zhang et al., 2025). Together, these issues highlight that statistical network estimation may not always provide stable or sufficient guidance for clinical decision-making.

Importantly, however, the present findings suggest that the clinical value of the network approach is not contingent on the statistical accuracy of network models alone. Rather, its primary contribution may lie in providing a structured language for representing interactions between symptoms, experiences, and behaviors in a way that supports collaborative case conceptualization. In this sense, even simplified or qualitatively derived “perceived causal networks” may be sufficient—or in some cases preferable—for communicating dynamic relationships in psychotherapy (Klintwall et al., 2023; Seewald et al., 2025; Vogel et al., 2025). Hybrid approaches that combine patient knowledge, clinical expertise, and empirical data may further strengthen this translational step (Burger, Epskamp, et al., 2022; Scholten, Klintwall, et al., 2025).

A central implication emerging from the present study concerns the role of patient goals within the decision-making process. Patient goals should not only guide the therapeutic endpoint but also structure ongoing data collection and interpretation. Monitoring key goals

(e.g., primary complaints or personally defined targets; (Cooper & Xu, 2023; Weisz et al., 2011) provides a stable reference point for evaluating progress. In contrast, dynamically assessed variables may be understood as potential mechanisms, i.e., processes that influence the likelihood of goal attainment over time. Importantly, mechanisms are not limited to obstacles but include any maintaining or change-driving processes that systematically affect goal-relevant outcomes.

From this perspective, goals, mechanisms, and interventions represent complementary levels of clinical reasoning rather than a linear sequence. Goals define the desired state (the “destination”), mechanisms describe the dynamic system that influences movement toward or away from this state (the “terrain and conditions”), and interventions represent actionable leverage points that modify these dynamics (the “means of transportation and route adjustments”). This structure allows for flexible clinical reasoning while maintaining a coherent link between data, formulation, and action.

### *Intervening: Structured Treatment Delivery and Process Evaluation*

Intervening was implemented through the delivery of a single selected intervention over ten sessions, following a structured format that included diagnostic assessment, formulation of a treatment rationale, active intervention, and consolidation. Both patients and therapists emphasized that this focused format facilitated learning, patients‘ integration of new coping strategies into everyday life and therapists‘ increase in their own procedural competence. However, patients also reported that the intervention was perceived as too long, that therapists experienced limited flexibility, and that there were concerns regarding conceptual overlap between different interventions. These observations point to a more fundamental challenge in personalized psychotherapy, namely the need for clearer delineation and modularization of intervention components to support transparent selection and sequencing decisions. Future research should therefore examine the unique, shared, and common effects of psychotherapeutic interventions, their optimal dosage, and potential sequencing mechanisms, in order to improve both the precision and interpretability of intervention selection processes.

SCED results showing the patient's progress were provided weekly. Therapists expressed the need for clearer interpretive guidelines to translate analytical outputs into concrete clinical decisions, similar to the established ROMs (Gasslander et al., 2022; Lutz, Deisenhofer, et al., 2022; Martorella et al., 2017; Norcross & Wampold, 2011). This reflects a broader gap between methods of analyzing SCED data and clear guidelines for clinicians. Future research must determine which analyses are suitable for ongoing individual-level evaluation and feedback (Kininger et al., 2025). Furthermore, patients reported a range of meaningful changes, such as new perspectives and the application of new coping strategies, that standard outcome measures did not fully capture (De Smet et al., 2020). This discrepancy raises questions about what constitutes clinically meaningful change in personalized psychotherapy. It also suggests that conventional outcome measures may underestimate important experiential, process-related, and behavioral dimensions of improvement.

Finally, participants highlighted the relevance of contextual factors in shaping therapeutic processes. While the present framework focuses primarily on intra-individual dynamics, psychological change unfolds within broader biological, social, and environmental contexts that both constrain and enable treatment effects. These contextual conditions may therefore represent important boundaries of personalized intervention models and warrant more explicit consideration in future developments of individualized psychotherapy approaches.

In conclusion, the study highlights the value of self-monitoring and a data-informed framework for fine-grained clinical decision-making in personalized psychotherapy. Together, these components can be understood as an integrated system of observing, deciding, and intervening, in which continuous observation of patient processes informs clinical decision-making, decisions guide the selection and implementation of interventions, and interventions in turn generate new observational data that refine subsequent understanding and treatment choices.

This cyclical structure supports increased clinical awareness and reflective practice by making implicit therapeutic reasoning more explicit and data-informed. In particular, it facilitates the articulation and iterative updating of clinicians' and patients' beliefs about symptom dynamics and treatment processes (Herzog et al., 2023), thereby providing a structured context for revising intuitive assumptions and enhancing shared understanding of the therapy process.

### *Strengths and limitations*

A key strength of the study is its high ecological validity, achieved through intensive longitudinal assessment, the incorporation of patient-defined goals, and active involvement of both patients and therapists in the therapeutic process. This design allowed for a close integration of real-world clinical practice and idiographic data analysis, thereby supporting a highly individualized and context-sensitive approach to treatment planning and evaluation.

At the same time, several limitations should be acknowledged. First, the study has a risk-of-bias reaching a conservative quality rating of 18 out of 30 possible points on the RoBiNT Scale (Tate et al., 2015). Ratings were reduced because participants did not begin assessment concurrently and because blinding procedures, while difficult to implement in psychotherapy research, could not be fully achieved. The present study did not include systematic replication of treatment effects across phases or cases, limiting causal inference regarding intervention effects. Furthermore, due to limited personnel resources, members of the research team also served as therapists in at least four cases, which may have compromised assessor blinding and treatment fidelity. Future studies should therefore aim to strengthen methodological rigor through increased separation of clinical and research roles, enhanced blinding procedures, and replication-focused designs. Second, it remains unclear which components of the integrated framework – EMA, network modeling, intervention selection, or SCED-based evaluation – are primarily responsible for observed effects, or whether therapeutic benefit emerges from their combination. Third, there is currently no clear consensus regarding optimal methodological procedures for person-specific network estimation and interpretation; for example, the use of centrality indices as treatment targets

remains under debate (Bringmann et al., 2019; Cusack et al., 2025). Finally, the use of personalized data limits the extent to which findings can be generalized to group-level inferences, as individual-level effects may not aggregate meaningfully across individuals. Future research should further address the diversity of clinical samples and the generalizability of findings across populations and treatment contexts.

### *Clinical implications*

Overall, the present findings suggest that personalized psychotherapy may benefit from being conceptualized not as the application of isolated individualized techniques, but as a recursive system of observation, decision-making, and intervention that continuously integrates patient-specific data into clinical reasoning. From this perspective, the primary clinical value of data-informed personalization may lie less in algorithmic precision alone and more in its capacity to raise awareness, structure reflection, enhance shared understanding, and support iterative belief updating about therapeutic processes (Herzog et al., 2023). Future developments should therefore focus not only on improving methodological sophistication, but also on strengthening the interpretability, flexibility, and clinical usability of personalized psychotherapy frameworks in routine care.

# Chapter 6: Discussion

This dissertation comprised three main components. First, the ProCEss item set was developed to assess key psychological processes of chronic pain using EMA, and its psychometric properties were evaluated. Second, a matching matrix linking each item to two corresponding CBT modules was created in close collaboration with expert clinicians and psychological pain researchers. Third, the feasibility and acceptability of the integrated POINT Pain approach, combining EMA, person-specific network analysis, guided clinical decisions, and SCED were evaluated from the perspectives of both practitioners and individuals seeking psychotherapeutic treatment for chronic pain.

The ProCEss item set constitutes a comprehensive instrument for assessing multiple psychological processes of chronic pain using EMA – a tool that did not previously exist. In the absence of established gold standards for evaluating EMA instruments (Eisele et al., 2021), the ProCEss item set was evaluated following current methodological recommendations (Dejonckheere et al., 2022; Eisinga et al., 2013) and empirical precedents (Forkmann et al., 2018). Similar to the mPCS, which was developed to assess pain catastrophising thoughts momentarily (Frumkin et al., 2023), the ProCEss item set generally exhibited higher reliability at the between-person level than at the within-person level, with ICCs exceeding what is typically expected for EMA items (Eisele et al., 2021). Nevertheless, most within-person reliability indices were still sufficient, and as Frumkin and colleagues (2023) noted, even with large ICCs, meaningful within-person fluctuations can persist. Summed up, the ProCEss item set presents a promising tool for future research based on the validation and evaluation results and its successful application in the POINT Pain proof-of-principle study as well as in the creation of a matching matrix containing target-level treatment recommendations.

Previous algorithmic decision-support tools have typically relied on the assessment of symptoms, often based on diagnostic criteria, which were summarised into factors for which interventions were recommended (Fernandez et al., 2017; Kaiser & Laireiter, 2017; Rubel et al., 2018). In contrast, the matching matrix presented in this dissertation adopts a more

process-oriented approach, providing treatment recommendations at the item level rather than a factor level. This approach was initially necessary because the validity of the ProCEss item set had not yet been fully established. Moreover, the decision to remain at the item level is empirically supported by evidence that aggregating items into scales can result in the loss of therapeutically relevant information (Pena Loray et al., 2025). Post hoc, our own findings further corroborate this choice, as clinicians frequently recommended different treatment modules for items that were intended to assess manifestations of the same psychological process.

Given the established content validity of the ProCEss questionnaire, these findings underscore the need for further evaluation of convergent and discriminant validity to better understand the associations between individual items. At the same time, they suggest that clinicians may prefer different treatment approaches to target distinct facets of the same psychological process. Recent evidence further indicates that specific interventions may not act in isolation on single targets, but rather target multiple processes simultaneously (Eronen, 2020; Henry et al., 2022). The extent of this so-called “fat-handedness” of interventions remains challenging to estimate reliably (Eronen, 2020). At the same time, theoretically proposed mechanisms of action that are considered specific to treatment forms like ACT, CBT, or others could not be detected, implying a shared set of mechanisms that all treatment forms have in common (Burns, 2025). Overall, the proposed matching matrix presents both a methodological approach on how further matching matrices can be developed systematically as well as a first step towards investigating the effects of isolated interventions on the individual level.

An individual-level application of network analysis for chronic pain, including subsequent target selection and personalised treatment recommendations, has not yet been conducted. In general, personalisation approaches have been investigated mainly with a focus on network analysis: For example, Levinson and colleagues (2021) conducted a proof-of-concept study in the context of eating disorders, using EMA-derived person-specific networks to guide treatment selection, followed by an open trial assessing the feasibility,

acceptability, and preliminary efficacy of the procedure (Levinson et al., 2023). They concluded that network-based target selection was feasible and acceptable in the clinical setting and observed promising effects on their outcome measures. However, the treatment selection relied on a literature review rather than a data-driven or collaborative process involving additional experts. Moreover, the person-specific networks were based on disorder-specific symptoms rather than a process-oriented framework.

In the context of chronic pain, network analysis has also been increasingly applied. Åkerblom, Cervin, and colleagues (2021) estimated group-based pre- and post-treatment networks using a large sample and identified potential treatment targets for future research. Several other studies have applied network analysis cross-sectionally to investigate associations between pain symptoms (Beeckman et al., 2019; Courbalay et al., 2021), or between pain symptoms and comorbid conditions (Axelsson-Landberg et al., 2026; Gómez Penedo et al., 2020; Hinze et al., 2021; McWilliams et al., 2017; Thompson et al., 2019). A few studies explicitly compared pre- and post-treatment networks (Gómez Penedo et al., 2020; Liew et al., 2021, 2022). However, person-specific networks have not yet been applied in chronic pain research.

This underscores the innovative contribution of POINT Pain in demonstrating the feasibility and acceptability of integrating all of the approaches that have been advocated to enhance outcomes of CBT for chronic pain: process-orientation (McCracken, 2020, 2021, 2023; Scholten & Glombiewski, 2025), facilitated by longitudinal assessment; personalisation (McCracken, 2023; Scholten, Herzog, et al., 2025; Scholten & Glombiewski, 2025), for example by conceptualising individual psychopathological models as person-specific networks; and turning towards a more idiographic research approach to evaluate treatment effects, for example by using SCED (Morley et al., 2015; Scholten, Schemer, et al., 2024).

**Methodological considerations**

Innovative approaches are often accompanied by a lack of established gold standards. Consequently, in both the preparatory studies for developing the ProCEss item set and matching matrix, as well as in the POINT Pain proof-of-principle study itself, several

methodological decisions had to be made in the absence of clear guidelines. These decisions should therefore be understood as proposed solutions, subject to replication and likely refinement.

***ProCEss item set***

The ProCEss item set was developed for cEMA to capture broader fluctuations and represent experiences across larger portions of the day. A key limitation of cEMA is that the specific timing of the reported experiences remains unknown unless explicitly assessed (Eisele et al., 2021), which is currently not the case in the ProCEss item set. This may complicate the interpretation of temporal networks derived from this data, as the temporal precedence of variables cannot be clearly established.

Moreover, cEMA and momentary EMA may engage different cognitive processes. Whereas momentary EMA prompts direct introspection, cEMA is more likely to activate episodic memory processes (May et al., 2018). Although this increases the potential for recall bias – one of the biases EMA is designed to reduce – cEMA may nonetheless provide more reliable estimates of pain-related processes than sporadic “spot check” assessments (May et al., 2018).

An alternative to cEMA would be purely momentary assessment, for example by asking: “At this very moment, how intense is your pain on a scale from 0 = no pain to 10 = maximum pain?” Momentary EMA is particularly well suited to capturing rapid dynamics (Stone et al., 2021). However, the evaluation results do not suggest that the processes assessed by the ProCEss item set fluctuate at very high frequencies. Moreover, a purely momentary assessment approach would risk reducing the coverage of daily experiences unless the sampling frequency were substantially increased, which would in turn increase participant burden (Stone et al., 2021).

Hybrid approaches combining coverage-based and momentary assessments are conceivable (Stone et al., 2023). Yet, participants might find it difficult to differentiate between items requiring a momentary versus a retrospective timeframe (Stone et al., 2023), potentially compromising response validity. Furthermore, methodological challenges arise

when these data are used for temporal network modelling, particularly given assumptions of equally spaced time lags and comparable time scales across variables (Bringmann, 2021). In conclusion, both momentary and cEMA have specific advantages and challenges and given the current structure of the ProCEss item set, cEMA appears to be the more suitable method.

The evaluation of the ProCEss item set could be extended in several respects. First, EMA is typically regarded as particularly suitable for assessing state-like features (Eisele et al., 2021). The relatively low within-person variability observed for most ProCEss items therefore raises the question of whether some of the assessed processes may be more trait-like than initially assumed. At the same time, the distinction between trait and state is not always clear-cut, as many psychopathological processes exhibit a degree of temporal stability (also reflected in diagnostic criteria) while still showing meaningful fluctuations (Eisele et al., 2021).

Against the background of the ongoing debate regarding the most appropriate timescales for EMA – and for specific EMA instruments in particular - (Fritz et al., 2024; Jover Martínez et al., 2024; Wright & Woods, 2020) the present findings warrant further theoretical and empirical consideration. Notably, an artificial reduction of sampling frequency did not substantially alter variability estimates for the ProCEss items, suggesting that the measurement frequency alone may not account for the observed patterns. Similarly, Frumkin and colleagues (2023) discuss that reliability indices might likely improve rather by adding more items instead of increasing measurement points. This, however, contradicts the idea of a modular item set where individual items can be left out regardless of their process or scale association.

Fried and colleagues (2017) discuss several potential causes of low variability in EMA data, which may in turn attenuate connectivity in networks estimated from such data. One explanation concerns insufficient data density. Although the ProCEss evaluation included a sample size comparable to prior EMA studies (Ben-Zeev et al., 2009; Chepenik et al., 2006; Dejonckheere et al., 2022), it was not adequate for all planned analyses – most notably multilevel factor analyses – given the relatively large number of items. Future evaluation

efforts would benefit from larger samples, both in terms of participants and measurement occasions, as well as from more stringent inclusion criteria regarding compliance.

A further potential source of reduced variability lies in erroneous responses (Fried et al., 2017). While such responses cannot entirely be ruled out, several design features were implemented to minimise this risk, including randomisation of item order and sliding position, as well as allowing participants to navigate back within the questionnaire. These measures likely reduced the systematic response artefacts to a minimum and should therefore be continued.

Finally, Fried and colleagues (2017) highlight an exclusive focus on maladaptive processes as a possible contributor to restricted variability. Although the adaptiveness of a given process depends on contextual factors and aims (Ciarrochi et al., 2022) and is therefore not always clearly delineated, the ProCEss item set deliberately includes both resource-oriented and problem-focused items. From the perspective of response variability – as well as considering the interventional character of EMA (Bentley et al., 2019; Frumkin et al., 2019; Schiepek et al., 2019; Schorrlepp et al., 2025) – this balanced composition represents a conceptual strength of the instrument.

With regard to the validity of the ProCess item set, patterns of missing data and their potential systematicity warrants closer examination (May et al., 2018). In addition, the choice of response scale may influence the content validity and measurement properties of an instrument (Eisele et al., 2021; Johnston et al., 2014). For regular instruments, five- to seven-point scales are commonly applied and recommended (Menold & Bogner, 2015). Seven-point scales are commonly used in EMA research as well (Eisele et al., 2021; May et al., 2018) and are recommended for bipolar scales (Boateng et al., 2018). The ProCess item set includes bipolar scales, which have been advocated for instruments intended for network analysis (Nemani et al., 2025). At the same time, the use of an 11-point scale approximates interval-level (Wu & Leung, 2017) and is common in EMA research in chronic pain as well (May et al., 2018) which may facilitate interpretation for participants. Reducing the number of

response options therefore does not appear advantageous at present, although empirical comparisons of different scale formats could further inform this decision.

To mitigate challenges related to ambiguous content validity or potential reactance to specific items – issues that may be particularly relevant for assessing acceptance with the ProCEss item set – the direct involvement of individuals with lived experience from the earliest stages of item development could be beneficial (Eisele et al., 2021). An alternative or complementary strategy is the inclusion of idiographic items, up to fully idiographic test batteries in which some or all items are formulated collaboratively with the individual participant (Cooper & Xu, 2023; Sales et al., 2023; Wright & Woods, 2020). Idiographic items are considered to provide optimal predictive value at the individual level and may be particularly sensitive to change (Wright & Woods, 2020). However, their use limits comparability across individuals and constrains the aggregation of data. Moreover, statistical parameters derived from idiographic items can be difficult to interpret in the absence of a clear reference norm or comparative framework (Wright & Woods, 2020).

Given that the ProCEss item set includes the option to personalise the item assessing values-based behaviour, the selective inclusion of additional idiographic items – as implemented in the proof-of-principle study (Hofmann et al., 2024) – preserves comparability and enables subgroup- or group-level analyses while still allowing for meaningful individual tailoring.

Lastly, the ProCEss item set could be extended in the future to include additional processes and context variables. To date, the ProCEss has been evaluated and applied as a standardised instrument, and was therefore kept as short as possible to minimise participant burden. In future personalised applications, where not all items are administered to each participant, additional processes could be incorporated without substantially increasing burden. Context variables should be prioritised in such extensions, as they are particularly relevant for the interpretation of EMA data and process-based treatment (Hayes et al., 2020; Stone et al., 2021).

***Network-based target selection***

Following the determination of which processes to assess via EMA, the next methodological decision concerns how many and which nodes to include in person-specific networks. Naturally, networks can only incorporate processes that have been assessed, and gaps in assessment may introduce biases or limit interpretability (Fried & Cramer, 2017). Moreover, the number of nodes included in a network directly affects the resulting network structure, and consequently the selection of treatment targets based on network parameters such as centrality (Bringmann, 2021; Levinson et al., 2021).

In the POINT Pain study, the number of nodes was a priori limited to six to eight in order to enhance the visual interpretability of the network. Consistent with the design of the matching matrix, which was based on individual items rather than aggregated scales, nodes in the network represented single items rather than aggregated nodes. Future adaptations could consider empirically whether items should be aggregated by estimating topological overlap: if multiple items exhibit highly similar edges with the remaining nodes in the network, they could be combined into a single node (Fried & Cramer, 2017).

Depending on the number of nodes included and the criteria defined for target selection, the resulting treatment targets may vary substantially (Levinson et al., 2021). A systematic comparison, similar to the proof-of-concept study by Levinson and colleagues (2021) in the area of eating disorders, could help to elucidate factors influencing target selection. To date, strength and outstrength centrality have often been employed for this purpose (Bringmann, 2021; Fisher et al., 2017; Nemani et al., 2025; Rubel et al., 2018; Scholten et al., 2022; Zhao et al., 2023), and also in POINT Pain. However, centrality measures in general were originally developed outside of the field of psychopathology, and it remains unclear to what extent they are generalisable to clinical contexts (Wright & Woods, 2020).

For example, high centrality does not necessarily imply maximal clinical relevance or optimal therapeutic impact. Processes may exhibit both functional and dysfunctional associations with other processes (Henry et al., 2022), and rare but clinically critical variables

– such as suicidality – may be overlooked if centrality is the sole criterion (Burger et al., 2020). While the need to empirically evaluate the effects of specific interventions remains (Henry et al., 2022), alternative approaches for selecting treatment targets from person-specific, data-driven networks warrant further investigation.

In POINT Pain, Vector Autoregressive (VAR) models were applied to estimate person-specific networks. VAR models are well suited for modelling intraindividual time series data and can be extended to multilevel frameworks to disentangle within-person dynamics from between-person differences (Fried & Cramer, 2017). They currently represent the most commonly applied modelling approach for timeseries data.

However, VAR models rely on several restrictive assumptions, most notably stationarity – that is, that associations between variables remain stable over time (Bringmann, 2021; Wright & Woods, 2020). Given the dynamic nature of psychopathological processes, this assumption is likely to be violated in the psychotherapeutic context (Wright & Woods, 2020).

Time-varying VAR models offer a promising alternative, as they allow network structures to change over time and provide techniques to account for varying timescales (Bringmann, 2021; Scholten, Rubel, et al., 2024). Yet, they require more measurement points than standard VAR models (Bringmann, 2021), thereby increasing participant burden. Moreover, their estimation and interpretation are considerably more complex. For widespread dissemination and practical feasibility in routine clinical practice, therapists would have to be trained in network theory and advanced time-series modelling.

An alternative or complementary approach to purely data-driven networks is the specification of so-called Perceived Causal Networks (PECANs), in which therapists and individuals with lived experience formalise causal associations between relevant processes based on their own hypotheses and experiences (Klintwall et al., 2023). This procedure is more efficient than longitudinal EMA assessments and can provide insight into associations and behaviours that are difficult to capture via self-report, such as avoidance behaviours. Stangier and colleagues (2024) published a study protocol for process-based therapy for

mood and anxiety disorders that includes both subjective causal networks and data-driven networks. However, the validity of PECANs remains uncertain (Klintwall et al., 2023), and in recent comparisons of subjective causal hypotheses with data-driven networks, correspondence was generally low (Frumkin et al., 2019; Nemani et al., 2025).

Building on network theory and extending it, control theory offers a framework for conceptualising the influence of interventions on dynamic systems (Henry et al., 2022). It can be modelled how an external input like a therapeutic intervention may shift the state of a system over time. It therefore provides an alternative theoretical perspective for interpreting centrality and what nodes most efficiently influence the whole system.

***Evidence-based personalised treatment recommendations***

Similar to the ProCEss item set, which may be extended in future iterations, the pool of interventions predefined in the matching matrix could likewise be broadened. Further improvements may be achieved by consulting a larger and equally diverse sample of expert clinicians and researchers, facilitating structured exchanges between practitioners and scientists, and incorporating personas (Bartels et al., 2023) to contextualise recommendations and better reflect the complexity of chronic pain phenotypes. Such an approach would move beyond simple item-to-module matches towards the identification of differentiated efficacy profiles.

Previous algorithmic decision-support tools based on the Unified Protocol for emotional disorders (Barlow et al., 2017) provide recommendations for a sequence of modules rather than a single module (Fernandez et al., 2017; Kaiser & Roth, 2022; Rubel et al., 2018). In the context of chronic pain, however, no comparable manual exists that would allow for a similarly structured sequencing approach. Moreover, the data-base for estimating treatment effects focused on a single time point or intervention is not given; modelling the effects of a sequence of interventions within a dynamic system is considerably more complex. Control theory may offer a promising conceptual framework for understanding and estimating such sequential intervention effects in an interacting system (Henry et al., 2022), yet the data-base to do so would have to be generated first. At the current stage,

implementing an assessment after each completed module – as proposed in POINT Pain – may contribute to providing the required robust, empirical data.

In order to reduce participant burden, regular EMA phases and network analyses could be augmented by Routine Outcome Monitoring (ROM), where participants are repeatedly assessed between therapy sessions and therapists are provided with feedback on the gathered data (Barkham et al., 2023; de Jong et al., 2025). The Trier Treatment Navigator presents a positive example where ROM is combined with machine learning algorithms in order to derive personalised treatment recommendations from ROM data (Lutz et al., 2019). It is important to note, however, that processes and outcomes should be distinguished (McCracken, 2021), which is why ROM is not suitable to replace the longitudinal assessment of psychotherapy-relevant processes entirely.

***Evaluating treatment effects using SCED***

In the POINT Pain proof-of-principle study, BC-Tau was used to determine the presence or absence of treatment effects based on the recommendation of Carlin and Costello (2021), while Hedges' g was calculated to quantify effect magnitude. There are several TAU parameters and they have not always been reported transparently in the literature, which hampers comparability and complicates meta-analytic synthesis (Kininger et al., 2025). BC-Tau, which corrects for baseline trends, has been recommended for clinical applications due to its relative comprehensibility and empirical support (Kininger et al., 2025; Tarlow, 2017). However, methodological concerns have been raised, including instances in which BC-Tau values exceeded the theoretically expected range, thereby compromising interpretability (Kininger et al., 2025).

Hedges' g has been recommended in SCED research because it adjusts for small and unequal sample sizes and allows comparisons across different SCED designs (Carlin & Costello, 2021; Kininger et al., 2025). Nevertheless, it originates from between-person research and has limited clinical interpretability in within-person designs. In particular, it does not provide a direct indication of whether a clinically meaningful effect is present, nor does it inherently distinguish between improvement and deterioration without additional information,

for example from visual analyses (Kininger et al., 2025). As noted by Kininger and colleauges (2025) in their comprehensive narrative review, the limitations of Hedges' g may outweigh its advantages in SCED research at the moment, suggesting that alternative indices should be considered when evaluating the presence and magnitude of statistically significant change.

One promising alternative is the Bayes factor (BF), which allows formal comparison of competing hypotheses regarding phase differences and may be particularly suitable for continuous monitoring of treatment progress (Kininger et al., 2025), that is currently often limited to visual analyses (Manolov et al., 2014). However, the calculation of the BF is more complex, and its interpretation requires familiarity with Bayesian inference, which may limit feasibility and acceptability in routine clinical settings (Kininger et al., 2025).

At present, neither a gold standard nor a clearly superior index for evaluating treatment effects in SCED has been established. Further methodological research is therefore needed to identify approaches that are both statistically and clinically interpretable.

Beyond statistical interpretability, clinical meaningfulness is a crucial criterion when evaluating treatment effects. Statistical significance does not necessarily imply clinical significance, understood as meaningful change for the individual and their social environment (Ogles et al., 2001). Several definitions of clinically significant change have been proposed, many of which are closely linked to statistical indices. One common approach is the assessment of statistically reliable change, typically calculated using the RCI (Jacobson & Truax, 1991). However, in chronic pain populations, a return to premorbid levels of functioning appears unrealistic (Turner & Turk, 2008). In addition, comorbid symptoms such as depression and anxiety may be too mild at baseline to allow for statistically reliable change, thereby limiting the applicability of such indices (Turner & Turk, 2008).

Another definition of clinically significant change focuses on recovery, meaning that a successfully treated individual should be distinguishable from an untreated affected individual (Ogles et al., 2001). Operationalising recovery usually requires normative data from both clinical and healthy populations. For many chronic pain outcomes, however, such normative

reference values are unavailable (Nicholas et al., 2008); for example, no universally accepted cut-off scores exist for instruments such as the PDI.

In the POINT Pain proof-of-principle study, clinically significant change was assessed pre- to post-treatment and at follow-up using the Patient Global Impression of Change item (Dworkin et al., 2005). To complement such global ratings and enable continuous monitoring of treatment progress, outcome-specific improvement criteria could be defined, including for the ProCEss item set. Similar approaches have been implemented in other conditions, for example by using reductions in the frequency of occurrence of headaches as an improvement benchmark (Blanchard & Schwarz, 1988). Establishing such predefined criteria would, however, require further evaluation of the ProCEss item set with regard to its sensitivity to change.

Lastly, the primary aim of the POINT Pain proof-of-principle study was to examine the feasibility and acceptability of its integrated framework for practitioners and individuals receiving treatment. Robust conclusions regarding efficacy cannot yet be drawn.

To reliably estimate the efficacy – and later effectiveness – of POINT Pain within a SCED framework, systematic replication is essential (Tanious et al., 2024). In SCED research, replication can occur within cases, between cases, or across independent studies. Given that psychotherapeutic effects cannot simply be switched on and off with the introduction or withdrawal of an intervention, replication across cases and studies appears to be the most appropriate strategy for evaluating the effects of POINT Pain.

Overall, all methodological decisions made within POINT Pain regarding target and module as well as index selection are to be understood as informed proposals rather than new gold standards. Wherever possible, decisions were grounded in existing recommendations and empirical research; however, substantial questions remain concerning the assessment of relevant processes, the optimal estimation of person-specific networks, the identification of the most promising treatment targets, and the evaluation of subsequent intervention effects. The following section outlines the implications of future research and clinical practice that arise from these remaining challenges.

**Implications for research and practice**

This dissertation raises the general question: Is the integrated approach of process-orientation and personalisation based on network analysis, as proposed in POINT Pain, ready for clinical research – or even for routine clinical practice? Against the background of missing gold standards and a rapidly evolving methodological landscape – where increasingly complex modelling approaches are continuously introduced – substantial challenges remain for both research and clinical implementation.

All efforts associated with the approaches outlined above ultimately aim to improve treatment outcomes for individuals living with chronic pain. To achieve this goal, resulting procedures must be feasible and acceptable for both practitioners and individuals in treatment; otherwise, implementation in routine care is unlikely.

All stakeholders need to be convinced of the added value of the additional workload associated with repeated assessments and data interpretation. Exactly this added value has still to be demonstrated (Bringmann, 2021; Wright & Woods, 2020). In addition, psychotherapists require a basic understanding of idiographic or individual-level research methods and network theory in order to meaningfully integrate such approaches into clinical decision-making. Although calls to strengthen these approaches in the training of clinical psychologists have been made for decades, idiographic research methods have yet to become a standard component of psychological curricula (Hayes, 1981; Kazdin, 2019; Vlaeyen et al., 2020).

It is therefore the responsibility of researchers – particularly as idiographic approaches gain increasing prominence – to translate methodological advances into comprehensible and practically applicable knowledge for clinicians, thereby contributing to bridging the science-practice gap. The POINT Pain proof-of-principle study provides a first step in establishing such feasible and acceptable procedures by involving practitioners and participants and feeding back their needs and suggestions into future research projects.

For successful implementation in routine clinical practice, methodological gold standards to guide clinical decision-making would be highly valuable. Further research is

needed to determine the optimal timing and frequency of assessments to estimate reliable and clinically meaningful networks (Fried et al., 2017; Wright & Woods, 2020). It also remains to be established whether targeting central processes represents the most efficient and effective strategy (Fried et al., 2017).

Investigating additional applications of network models – for example, comparing pre- and post-treatment networks to evaluate treatment outcomes (e.g. Åkerblom, Cervin, et al., 2021) – could increase their clinical utility, ensuring that networks are not treated as "one-time use products". In the POINT Pain proof-of-principle study, pre- and post-treatment networks were estimated and could therefore contribute to this field of research. To the same end, easily interpretable effect-size indices for SCED data are needed so that practitioners can meaningfully use the generated data to monitor treatment progress. Similar to the multitude of available centrality parameters in network analysis, there are various indices applied in SCED research (Kininger et al., 2025). Ultimately, practitioners as well as researchers must be able or enabled to correctly interpret indices that should inform clinical decisions like when to change to another module or even terminating treatment.

Finally, integrating clinical expertise into the network modelling process could enhance their acceptability (Burger et al., 2020). In this regard, further exploration of the correspondence between subjective, clinician- or patient-derived networks and data-driven ones appears particularly worthwhile.

Assuming clinicians can be convinced to take on the time and effort to inform themselves about idiographic research methods and models – for example by financial compensation or continuing education credits - repeated assessments place a considerable burden on individuals with chronic pain as well. Depending on factors such as functional disability, symptom severity, or even access to the required devices, EMA may not be feasible for everyone (Bentley et al., 2019). This can lead to systematically missing data, dropouts, or selection biases in feasibility studies such as POINT Pain.

Moreover, in EMA studies participants are often financially compensated. In routine clinical practice, such compensation is unlikely to be feasible (Bentley et al., 2019). Omitting

compensation could negatively affect compliance rates (Wrzus & Neubauer, 2023), reducing the quality and completeness of the data used for personalised models and the subsequent clinical decisions derived from them (Dejonckheere et al., 2022; Fritz et al., 2024).

As Stangier and colleagues (2024) note, the additional effort associated with personalised, process-oriented approaches may be especially worthwhile for non-responders or individuals considered difficult to treat. Further research is needed to determine whether there are specific subgroups of individuals for whom longitudinal assessments such as EMA or SCED are feasible, and whether these are the same individuals for whom such assessments provide meaningful clinical value.

The clinical value of EMA and SCED also depends on the specific variables that are assessed. To maximise utility, theoretically relevant items should be distinguished from empirically informative ones (Hofmann & Curtiss, 2018). Data collected in the POINT Pain proof-of-principle study provide insight into which ProCEss items participants subjectively rated as most relevant, which can guide future research – for example, by examining the correspondence between items rated as important and the network-based targets.

Furthermore, because the ProCEss item set was administered in its entirety across the full sample, the resulting data may be aggregated to estimate cross-sectional networks. These aggregated networks could then be compared with person-specific networks to explore similarities and differences between idiographic and nomothetic structures (Fried et al., 2017).

All of these challenges and directions for future research raise the question of whether methodological difficulties with network models, process assessment, and SCED parameters must be fully resolved before any clinical applications are attempted. At the same time, without establishing the feasibility and acceptability of these approaches for practitioners and individuals seeking treatment, efforts to address these methodological challenges risk having limited practical impact.

Against the backdrop of modest CBT effect sizes for chronic pain (Williams et al., 2020) and substantial individual differences in treatment response (McCracken & Turk, 2002;

Murillo et al., 2022), personalised treatment is considered a promising opportunity to enhance efficacy (Fernandez et al., 2017; Wright & Woods, 2020). Although comparisons with treatment as usual are still rare, personalisation approaches that have been investigated so far demonstrated promising results (Åsenlöf et al., 2005, 2009; Evers et al., 2002; Ferwerda et al., 2017; Gasslander et al., 2022; Kerns et al., 2014; van Koulil et al., 2010).

Process-orientation provides a theoretical framework to facilitate evidence-based interventions across therapy types (Hofmann & Hayes, 2019), consistent with findings that different treatment modalities likely share underlying mechanisms of action (Burns, 2025).

Finally, idiographic research methods complement these approaches by actively involving participants, bridging the science-practice gap (Levinson et al., 2024), and enabling a bottom-up procedure that mitigates invalid generalisations from group-level data to individuals (Gloster et al., 2024). When scaled sufficiently, idiographic research might support the empirical identification of relevant patient subgroups (Gloster et al., 2024) and meta-analytic approaches can support the generalisability of SCED data to the group-level (Schemer et al., 2023). Taken together, these opportunities appear to justify the methodological and practical challenges that must be addressed in future research.

**Conclusion**

CBT is a guideline-recommended treatment for chronic pain (Becker & Straßner, 2023; National Institute for Health and Care Excellence [NICE], 2021) with nomothetically established efficacy (Williams et al., 2020). However, in the context of increasing calls for tailored treatments (e.g. McCracken, 2023; Scholten et al., 2025) and growing criticism of generalising group-based averages like effect-sizes to individuals (Hayes et al., 2020; McCracken, 2023; Wright & Woods, 2020), both psychotherapy research and CBT for chronic pain are evolving with the aim of enhancing treatment effectiveness.

Several innovative approaches have been proposed to advance personalisation, most prominently a shift from symptom- to process-orientation (Hayes et al., 2020; Hofmann & Hayes, 2019; McCracken, 2023), the use of person-specific network analyses to formalise individual psychopathological models based on longitudinal data (Bringmann, 2021; Schemer

et al., 2023; Scholten, Rubel, et al., 2024), and the development of data-informed tools to support evidence-based clinical decision-making (Lutz, Schwartz, et al., 2022).

Although the body of research in these areas is steadily expanding, methodological gold standards are often lacking. As a result, researchers frequently have to rely on established conventions rather than on empirically validated best practices. Furthermore, although the above-mentioned methods have been applied and investigated on their own, an integrative framework to combine process-oriented, personalised, network-based CBT for chronic pain was so far missing.

This dissertation presents a concrete proposal for integrating process-oriented and personalised CBT, person-specific network analysis based on longitudinal assessments, and a support tool guiding clinical decisions in the form of a matching matrix. In four studies involving both practitioners and individuals with lived experience of chronic pain, the new ProCEss item set was validated to enable the assessment of multiple key psychological chronic pain processes in EMA research and facilitating person-specific network analyses. The content validity as well as clinical utility of this instrument could be established. The item set was thus piloted and evaluated in two EMA studies, generally supporting the reliability and displaying mixed results regarding the variability of the item set. Future research is needed in order to establish the reliability on the item-level to support a personalised applicability of the ProCEss item set, as well as identifying possible causes and consequences of the rather low observed within-person variability. To make the ProCEss item set a useful tool for the monitoring and evaluation of treatment effects, its sensitivity to change must be established.

Using an adapted group Delphi technique and a focus group with psychological pain researchers, a matching matrix linking two CBT modules to all of the ProCEss items was developed in close collaboration with expert clinicians. It presents an interim step towards data-oriented clinical support tools, is expected to be well accepted by practitioners due to the collaborative approach (Levinson et al., 2024), and to facilitate evidence-based and reasonably reliable clinical indications. Its transparent, systematic approach facilitates future

replications, and the diversity of the sample contributed to the reliability of the results (Baker et al., 2006; Blind & Cuhls, 2001; Powell, 2003). Future research should focus on investigating the effects of specific interventions (Henry et al., 2022) on various processes, since interventions likely do not produce isolatable effects on single processes (Eronen, 2020), to provide the data-base for data-oriented support tools.

Finally, a proof-of-principle study was preregistered in the form of a detailed, openly accessible study protocol to ensure feasibility and acceptability of the proposed integrative framework of POINT Pain. Feasibility and acceptability of all relevant stakeholders, in this context most importantly psychotherapists and their patients, present prerequisites to move the field forward. The results of the proof-of-principle study demonstrated the procedure to be feasible and acceptable for both practitioners and participants seeking treatment for chronic pain. Resolving methodological issues will likely improve feasibility and acceptability, for example by educating psychotherapists in idiographic research methods, providing best practice guidelines for interpreting person-specific networks, and easily interpretable, reliable parameters to evaluate treatment effects as measured in SCED. The participants of the proof-of-principle study provided detailed feedback on specific facilitators as well as obstacles for feasibility that should be considered in future research projects. Future research is needed to develop guidelines and gold standards as well as to demonstrate the added value of personalisation and complex idiographic models to justify the burden associated with these approaches (Bringmann, 2021; Wright & Woods, 2020).

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# Appendices

## Appendix A: Supplement ProCEss validation

## Appendix A1.1

*ProCEss development stages in original language (German)*

| Konstrukt | Modell | Definition | Erste Version Item | Angelehnt an | Kommentar | Zweite Version (nach formlosem Feedback) | Kommentar | Version in erster Evaluation | Kommentar | Finale Version |
|---|---|---|---|---|---|---|---|---|---|---|
| Katastrophisieren | Fear-Avoidance (Vlayen & Linton, 2003) / Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Katastrophisieren beschreibt die Neigung, negative Aspekte einer Situation oder möglicher Konsequenzen in übertriebenem Maße wahrzunehmen und darüber zu grübeln bzw. diese zu antizipieren. (Dorsch Lexikon der Psychologie (o. D.)) | Ich habe gedacht, dass es nie mehr besser wird. | PASS-20-GV/PCS (GV) | Bevorzugt, da von Crombez et al. (2020) empfohlen | Ich habe gedacht, dass es nie mehr besser wird. | Angleichung an Gedanken-Unterdrückungs-Items | Ich habe gedacht: "Es wird nie mehr besser" | | Ich habe gedacht: "Es wird nie mehr besser" |
| | | | Ich habe gedacht, dass ich nicht mehr kann. | PCS (GV) | Bevorzugt, da von Crombez et al. (2020) empfohlen | Ich habe gedacht, dass ich nicht mehr kann. | | Ich habe gedacht: "Ich kann nicht mehr" | Von Patient:innen als weniger valide eingeschätzt, Vermischung mit Subskalität, neue Formulierung Patient:innenvorschlag, zudem klarer als dysfunktional einzuordnen | Ich habe gedacht: "Ich halte es nicht mehr aus" |
| | | | Was denken Sie, ist das Schlimmste, was passieren kann? | Eigene Formulierung | Item Reduktion zur Verringerung der Belastung, Einheitlichkeit der Skala | | | | | |
| Vermeidung | | Vermeidung stellt eine Verhaltensweise dar, bei der bestimmte Erlebnisse (im Schmerzkontext: Erleben von Schmerz) vermindert, reduziert oder beendet werden. (McCracken, 2005) | Ich habe eine Aktivität wegen meiner Schmerzen beendet. | PASS-20-GV | Um eindeutige Unterscheidung funktional vs. dysfunktional benötigt; Schmerzbezug eingefügt | Ich habe eine Aktivität wegen meiner Schmerzen beendet. | | Ich habe eine Aktivität wegen meiner Schmerzen beendet. | 11-stufige Skala nicht anwendbar, Item erscheint dichotom | Ich habe Aktivitäten wegen meiner Schmerzen abgebrochen. |
| | | | Ich habe eine anstrengende Tätigkeit abgelassen. | AEQ | | Ich habe eine anstrengende Tätigkeit wegen meiner Schmerzen an jemand anderen abgegeben. | | Ich habe eine anstrengende Tätigkeit wegen meiner Schmerzen an jemand anderen abgelassen. | | Ich habe anstrengende Tätigkeiten wegen meiner Schmerzen an jemand anderen abgelassen. |
| | | | Ich habe mindestens eine Aktivität, die Schmerzen hervorruft, vermieden. | PASS-20-GV | | Ich habe mindestens eine Aktivität, die Schmerzen hervorruft, vermieden. | | Ich habe mindestens eine Aktivität, die Schmerzen hervorruft, vermieden. | Gegen Patient:innenvorschlag "verzichten" entschieden, da "vermeiden" allgemeiner, "Verzicht" schränkt eher auf angenehme Tätigkeiten ein; Angleichung im Plural an essex Items | Ich habe Aktivitäten, die Schmerzen hervorrufen, vermieden. |
| | | | Welchen Aktivitäten würden Sie ohne Schmerzen nachgehen? | eigene Formulierung | Item Reduktion zur Verringerung der Belastung, Einheitlichkeit der Skala | | | | | |
| Depression | | Eine depressive Episode ist gekennzeichnet durch gedrückte Stimmung und eine Verminderung von Antrieb und Aktivität. Auch bei leichten Formen können Schuldgefühle oder Gedanken über die eigene Wertlosigkeit auftreten. (BMM, 2023) | Ich war gereizt. | Kirtley et al., ESM Item Repository | Von Experten befürwortet aufgrund Relevanz | Ich war gereizt. | | Ich war gereizt. | | Ich war gereizt. |
| | | | Ich habe mich schuldig gefühlt. | | Erfassung Kernsymptome | Ich habe mich schuldig gefühlt. | | Ich habe mich schuldig gefühlt. | | Ich habe mich schuldig gefühlt. |
| | | | Ich habe mich traurig gefühlt. | | | Ich habe mich traurig gefühlt. | | Ich habe mich traurig gefühlt. | | Ich habe mich traurig gefühlt. |
| | | | Ich habe mich lustlos gefühlt. | eigene Formulierung | | Ich habe mich lustlos gefühlt. | | Ich habe mich lustlos gefühlt. | Umformulierung Patient:innenvorschlag, spiegelt Kernsymptomatik besser wider | Ich habe mich antriebslos gefühlt. |
| | | | | | | | Aufgrund von Problemen mit dem "müde" Item exploratorische Aufnahme eines weiteren Items basierend auf Formulierung von Patient:innen. Energielosigkeit bei Depression | Ich war erschöpft. | | Ich war erschöpft. |
| Akzeptanz | Psychological Flexibility (McCracken & Morley, 2014) | Akzeptanz ist eine annehmende Haltung, die zu zielgerichtetem Handeln im Rahmen der persönlichen Kontrolle und einem Abstandnehmen von Versuchen, unerwünschte Gefühle oder unveränderbare Zustände zu kontrollieren, führt (McCracken & Morley, 2014) | Ich war offen für alle meine Gefühle, die guten und die schlechten. | Bartels et al. (2022), MPFI | Item wurde als invalidierend empfunden, daher umformuliert | Ich habe versucht, mit meinen Schmerzen zu leben. | werde zwar verstanden, aber hohe Reaktanz neue Formulierung angelehnt an PaSol sowie Patient:innenformulierung | Ich habe versucht, mich mit meinen Schmerzen anzufreunden. | | Ich habe versucht, mich mit meinen Schmerzen anzufreunden. |
| | | | Ich habe gedacht, dass es in Ordnung ist, Schmerzen zu erleben. | CPAQ-G 2.0 | | Ich konnte akzeptieren, dass es für meine Schmerzen keine Lösung gibt. | | Ich konnte akzeptieren, dass es für meine Schmerzen keine Lösung gibt. | Vermeidung vermeiden, leichtere Verständlichkeit, Lanoftsbäkeit betonen | Ich konnte annehmen, dass der Schmerz mein Leben begleiten wird. |
| | | | Die Kontrolle meiner Schmerzen hatte für mich erste Priorität. | CPAQ-G 2.0 | Inversierung sollte vermieden werden, um Bearbeitung für Teilnehmende zu erleichtern | | | | | |
| Wertorientiertes Handeln | | Werte sind subjektiv wünschens- oder erstrebenswerte Zustände, die das Handeln beeinflussen. Sie beinhalten Einstellungen dazu, was richtig und falsch und was im Leben wichtig ist. (Oxford University Press (w. o.); Spektrum Lexikon der Psychologie (w. o.)) | Ich habe versucht, den Dingen, die mir wirklich wichtig sind, Vorrang zu geben. | MPFI | Ermöglichung von Individualisierung durch eigene Beispiele | Ich habe versucht, den Dingen, die mir wirklich wichtig sind [Beispiele], Vorrang zu geben. | | Ich habe versucht, den Dingen, die mir wirklich wichtig sind [Beispiele], Vorrang zu geben. | Trotz längerer Bearbeitungsdauer Reflektion bei diesem Item gewünscht; nach erstmaliger Auseinandersetzung mutmaßlich einfacher zu verstehen; Hilfestellungen nutzen | Ich habe versucht, den Dingen, die mir wirklich wichtig sind, Vorrang zu geben. |
| Erwartungen | Predictive Coding (Wiech, 2016) | Erwartungen sind Annahmen darüber, was geschehen wird, auf Grundlage vorher Erfahrungen und Wahrscheinlichkeit. (Oxford University Press (w. o.); Wiech, 2016) | Ich habe erwartet, dass ich Schmerzen haben werde. | Eigene Formulierung | Anker für Zeitraum eingefügt | Ich habe erwartet, dass ich (in den nächsten zwei Stunden) Schmerzen haben werde. | | Ich habe erwartet, dass ich (in den nächsten zwei Stunden) Schmerzen haben werde. | Probleme bei retrospektiver Beantwortung, deshalb als Präsens gewählt, damit Prädiktor für künftigen Schmerz; Umformulierung Patient:innenvorschlag | Ich gehe davon aus, dass meine Schmerzen als zur nächsten Befragung zunehmen. |
| Schmerzintensität | Pain Experience (Dworkin et al., 2005) | Die Schmerz Intensität reflektiert das subjektiv empfundene Ausmaß des Schmerzes. (Dworkin et al., 2005) | Wie stark sind Ihre Schmerzen gerade? | Bartels et al. (2022) | Anker für Zeitraum, Instruktion für Durchschnitt | Wie stark waren Ihre Schmerzen seit dem letzten Fragebogen im Durchschnitt? | | Wie stark waren Ihre Schmerzen in den letzten zwei Stunden im Durchschnitt? | Referenzzeitraum soll künftig in Instruktion, wird dafür hier gestrichen | Wie stark waren Ihre Schmerzen im Durchschnitt? |
| Beeinträchtigung | | Die Beeinträchtigung durch Schmerzen beschreibt eine Begrenzung in Bewegungen, Sinnen oder Aktivitäten, die die meisten Menschen ausüben können, aufgrund von Schmerzen. (Crombez et al., 2020. Oxford University Press (w. o.)) | Meine Schmerzen haben mich bei meinen allgemeinen Aktivitäten gestört. | Bartels et al. (2022) | Item Reduktion zur Verringerung der Belastung | | | | | |
| | | | Meine Schmerzen haben mich beim Gehen/Laufen beeinträchtigt. | | | | | | | |
| | | | Meine Schmerzen haben mich bei alltäglichen Arbeiten (inkl. Haushalt) gestört. | | | | | | | |
| | | | Wie sehr haben Sie sich durch Ihre Schmerzen beeinträchtigt gefühlt? | Eigene Formulierung | | Wie sehr haben Sie sich in den letzten zwei Stunden durch Ihre Schmerzen beeinträchtigt gefühlt? | | Wie sehr haben Sie sich in den letzten zwei Stunden durch Ihre Schmerzen beeinträchtigt gefühlt? | Referenzzeitraum soll künftig in Instruktion, wird dafür hier gestrichen | Wie sehr haben Sie sich durch Ihre Schmerzen beeinträchtigt gefühlt? |
| Gedanken-unterdrückung | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Gedankenunterdrückung bezeichnet ein kognitives Reaktionsmuster, das die Schmerzwahrnehmung oder Unterbrechung täglicher Aktivitäten durch Schmerzen willentlich beendet. (Hasenbring & Verbunt, 2010; Oxford University Press (w. d.)) | Ich habe gedacht: "Halte durch!" | AEQ | | Ich habe gedacht: "Halte durch!" | | Ich habe gedacht: "Halte durch!" | Item wird vorwiegend positiv; mittlerweile wahrgenommen, zu hohe Überlappung mit Selbstmitgefühl | |
| | | | Ich habe gedacht: "Reiß dich zusammen!" | | | Ich habe gedacht: "Reiß dich zusammen!" | | Ich habe gedacht: "Reiß dich zusammen!" | Gedanken werden als identisch bzw. austauschbar wahrgenommen (soweit von Expert:innen als auch Patient:innen), deutlich negativer konnotiert als "Halte durch" | Ich habe gedacht: "Reiß' dich zusammen!" / "Stell' dich nicht so an!" |
| | | | Ich habe gedacht: "Stell' dich nicht so an!" | | | Ich habe gedacht: "Stell' dich nicht so an!" | | Ich habe gedacht: "Stell' dich nicht so an!" | | |
| Aufgabenausdauer | | Aufgabenausdauer beschreibt eine körperliche Überaktivität trotz Schmerzen, die zur Überlastung körperlicher Strukturen führen kann. (Hasenbring & Verbunt, 2010) | Ich habe versucht, meine Aufmerksamkeit von meinen unangenehmen Gefühlen abzulenken. | Bartels et al. (2022) | | Ich habe versucht, meine Schmerzen nicht zu beachten. | | Ich habe versucht, meine Schmerzen nicht zu beachten. | Trotz Verneinung beibehalten, da gut verständlich; im ACQ bei Aufgabenausdauer; assoziiert mit positivem Affekt | Ich habe versucht, meine Schmerzen nicht zu beachten. |
| | | | Ich habe trotz meiner Schmerzen weitergemacht. | AEQ | | Ich habe trotz meiner Schmerzen weitergemacht. | Starkere Betonung des überlastenden Verhaltens, Umformulierung Patient:innen-vorschlag | Ich habe trotz meiner Schmerzen durchgezogen. | | Ich habe trotz meiner Schmerzen durchgezogen. |
| Positiver Affekt | | Positiver Affekt stellt einen Gefühlszustand angenehmer Stimmung oder Gefühle dar, der annäherungs-orientiertes Verhalten begleitet oder ein Erleben von Entspannung, Zufriedenheit oder Gelassenheit vermuscht. (Finan & Garland, 2015) | Ich war gut gelaunt. | Kirtley et al., ESM Item Repository | Items wurden als redundant wahrgenommen. Reduktion | Ich war gut gelaunt. | Schmerzbezug eingefügt | Ich war trotz meiner Schmerzen gut gelaunt. | | Ich war trotz meiner Schmerzen gut gelaunt. |
| | | | Ich war fröhlich. | | | | | | | |
| | | | Ich war energiegeladen. | | Verwechslungsgefahr mit Reizbarkeit | | | | | |

| Konstrukt | Modell | Definition | Erste Version Item | Angelehnt an | Kommentar | Zweite Version (nach formlosem Feedback) | Kommentar | Version in erster Evaluation | Kommentar | Finale Version |
|---|---|---|---|---|---|---|---|---|---|---|
| Selbstwirksamkeit | Other (Nicholas, 2007) | Selbstwirksamkeit stellt die Überzeugung dar, auch schwierige Situationen aus eigener Kraft heraus erfolgreich bewältigen zu können und dazu die nötigen Fähigkeiten zu besitzen. (Bandura, 1977; Psychomeda Lexikon der Psychologie (o. D.)) | Ich war zuversichtlich, etwas im Haushalt erledigen zu können, obwohl ich Schmerzen habe. | Pain self-efficacy questionnaire; Bartels et al. (2022) | Umformulierung, da von Patientinnen als stereotyp bzw. sexistisch bemängelt | Ich war zuversichtlich, etwas erledigen zu können, obwohl ich Schmerzen habe. | Weitere Betonung des Selbstwirksamkeits-Aspekts | Ich habe mir zugetraut, etwas erledigen zu können, obwohl ich Schmerzen habe. | | Ich habe mir zugetraut, etwas erledigen zu können, obwohl ich Schmerzen habe. |
| | | | Ich war sicher, ein normales Leben führen zu können, obwohl ich Schmerzen habe. | | Umformulierung, um Selbstwirksamkeitserwartung mehr zu betonen | Ich war sicher, ein erfülltes Leben führen zu können, obwohl ich Schmerzen habe. | Interpretationsprobleme mit Begriff "erfüllend" | Ich war sicher, mein Leben zufriedenstellend führen zu können, obwohl ich Schmerzen habe. | | Ich war sicher, mein Leben zufriedenstellend führen zu können, obwohl ich Schmerzen habe. |
| Selbstmitgefühl | Other (Neff, 2003b; 2011) | Selbstmitgefühl beschreibt ein nicht-wertendes Verständnis für das eigene Leid, eigene Unzulänglichkeiten oder persönliches Versagen. Es kann in die drei Facetten Selbst-Freundlichkeit, Sinn gemeinsamer Menschlichkeit und Achtsamkeit unterteilt werden. | Ich habe versucht, liebevoll mit mir umzugehen. | SCS-D | Bemüht um leichtere Verständlichkeit | Ich habe versucht, freundlich mit mir umzugehen. | | Ich habe versucht, freundlich mit mir umzugehen. | ausreichend gute Verständlichkeit, Patient:innenformulierungen zu verhaltensbezogen, "freundlich" spiegelt Haltung und Verhalten am besten | Ich habe versucht, freundlich mit mir umzugehen. |
| | | | Ich habe mir gesagt, dass es bei jedem:r einmal schlecht läuft. | | Keine Erfassung der Achtsamkeits-Dimension aufgrund Überschneidung mit anderen Konstrukten | Ich habe mir gesagt, dass es bei jedem:r einmal schlecht läuft. | Assoziation mit "sich mit anderen vergleichen" bis hin zu "sich über andere stellen", Bemühung um mehr Betonung der gemeinsamen Menschlichkeit | Ich habe mir gesagt, dass ich mit meinen Problemen nicht allein bin. | | Ich habe mir gesagt, dass ich mit meinen Problemen nicht allein bin. |
| Negativer Affekt | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Negativer Affekt stellt einen allgemeinen und unangenehmen Gefühlszustand dar, unter dem viele verschiedene Stimmungen wie Ärger, Ekel, Nervosität und Scham zusammengefasst werden können. (Breyer & Bluemke, 2016; Watson & Clark, 1988) | | | | | | | Neu hinzugefügt aufgrund Patient:innenaussage und eigener Einschätzung als sehr relevant | Ich habe mich geschämt. |
| Zusatzfrage | | | | | Ermöglichen persönlicher Ergänzungen | oder uns zu Ihren Antworten auf diesen Fragebogen mitteilen? | | oder uns zu Ihren Antworten auf diesen Fragebogen mitteilen? | | oder uns zu Ihren Antworten auf diesen Fragebogen mitteilen? |
| Distraktoren | | | Dieses Fragebogensignal hat mich gestört. | | | Dieses Fragebogensignal hat mich gestört. | | | | |
| | | | Wie viele Fragebögen haben Sie heute schon ausgefüllt? | | Vereinheitlichung der Skala | Es fällt mir leicht, den Fragebogen auszufüllen. | | | | |
| | | | Hat etwas Ihre Antworten auf die Fragen beeinflusst? Wenn ja, was: | | | Ich bin gerade ungestört. | | | | |
| Schlafstörungen | Other (Cole et al., 2007) | Schlafstörungen bezeichnen jede Art von Problemen bei der Initiierung, Aufrechterhaltung oder dem Profitieren von Schlaf. (Cole et al., 2007) | Ich war müde. | Kirtley et al., ESM Item Repository | | Ich war müde. | | Ich war müde. | Größte Uneinigkeit bzgl. Validität in Expert:innenbefragung, Patient:innen-vorschlag: "Ich war erschöpft", als Depressionsitem eingefügt | |
| | | | Vergangene Nacht habe ich gut geschlafen. | | Item Reduktion zur Verringerung der Belastung | | | | | |
| | | | Vergangene Nacht hatte ich Probleme dabei einzuschlafen. | | | Vergangene Nacht hatte ich Probleme dabei einzuschlafen. | | Vergangene Nacht hatte ich Probleme dabei einzuschlafen. | Entfernung des gesamten Konstrukts aufgrund verschiedener Zeitskalen (Schlaf einmalige Erfassung am Tag) | |
| | | | Vergangene Nacht hatte ich Probleme durchzuschlafen. | Bartels et al. (2022) | | Vergangene Nacht hatte ich Probleme durchzuschlafen. | | Vergangene Nacht hatte ich Probleme durchzuschlafen. | | |
| | | | Ich bin zu früh aufgewacht. | | | Ich bin zu früh aufgewacht. | | Ich bin zu früh aufgewacht. | | |
| Schmerzbezogene Angst | Fear-Avoidance (Vlayen & Linton, 2000) | Wurde nicht entwickelt | Ich habe mich unruhig gefühlt. | Kirtley et al., ESM Item Repository | Konstrukt aufgrund Expertinnenrat entfernt (die meisten Patient:innen würden dem nicht zustimmen) | | | | | |
| | | | Die Angst hat körperliche Symptome verursacht. | Eigene Formulierung | | | | | | |
| | | | Was waren Ihre Angst Symptome? (Mehrfach-Auswahl Symptome) | DIPS/SKID Panik-attacken Symptome | | | | | | |
| Humor/Ablenkung | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Wurde nicht entwickelt | | | Konstrukt entfernt, eher allgemeines Coping | | | | | |
| Kontext | | | Mit wem sind Sie gerade im selben Raum? | Maes et al. (2015), ESM Item Repository | Kontext aufgrund schwieriger Abbildbarkeit nicht erfasst | | | | | |
| | | | Was machen Sie gerade? | Kirtley et al., ESM Item | | | | | | |
| | | | Wo sind Sie? | | | | | | | |


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*Note.* This table is also available at the ProCEss repository where it is easier to zoom in: https://rptu.de/s/vpcgks

## Appendix A1.2

*ProCEss development stages in preliminary English translation*

| Construct | Model | Definition | First item version | based on | Comments | second version (after informal feedback) | Comments | version of first evaluation | Comments | final version |
|---|---|---|---|---|---|---|---|---|---|---|
| Catastrophising | Fear-Avoidance (Vlayen & Linton, 2000)/ Avoidance-Endurance (Hasenbring & Verburt, 2010) | Catastrophising describes the tendency to perceive negative aspects of a situation or possible consequences in an excessive manner, and to ruminate about or anticipate them. | I thought that it will never get better. | PASS-20-GV | Recommended by Crombez et al. (2020) | I thought that it will never get better. | Assimilation to Thought Suppression items | I thought: "It will never get better!" | | I thought: "It will never get better!" |
| | | | I thought that I could not go on any longer. | PCS (GV) | Recommended by Crombez et al. (2020) | I thought that I could not go on any longer. | | I thought: "I can't stand it any longer!" | Evaluated as less valid by patients, confounded with suicidality; new formulation based on patients' suggestions, also more clearly dysfunctional | I thought: "I can't stand it any longer!" |
| | | | What do you think is the worst that can happen? | self-developed | Item reduction to reduce burden, same scale | | | | | |
| Avoidance | | Avoidance constitutes a behaviour aiming at prevention, reduction, or termination of the exposure to certain experiences (in pain context: experience of pain). | I stopped an activity because of my pain. | PASS-20-GV | clearer differentiation between functional vs. dysfunctional; added pain reference | I stopped an activity because of my pain. | | I stopped an activity because of my pain. | 11-point scale not feasible, item dichotomous | I stopped activities because of my pain. |
| | | | I asked others to do a strenuous activity for me. | AEQ | | Due to my pain I asked others to do a strenuous activity for me. | | Due to my pain I asked others to do a strenuous activity for me. | | Due to my pain I asekd others to do strenuous activities for me. |
| | | | I avoided at least one activity that causes pain. | PASS-20-GV | | I avoided at least one activity that causes pain. | | I avoided at least one activity that causes pain. | decided against patient's suggestion "relinquish", since "avoid" more general; "relinquish" limits to pleasurable activities; assimilate plural to other avoidance items | I avoided activities that cause pain. |
| | | | What activities would you pursue if you were pain-free? | self-developed | Item reduction to reduce burden, same scale | | | | | |
| Depression | | A depressive episode is marked by subdued mood and listlessness with a reduction of activity. Even in light forms feelings of guilt and thoughts about the own worthlessness can occur. | I felt irritable. | Kirtley et al., ESM Item Repository | recommended by expert due to relevancy | I felt irritable. | | I felt irritable. | | I felt irritable. |
| | | | I felt guilty. | | | I felt guilty. | | I felt guilty. | | I felt guilty. |
| | | | I felt sad. | | | I felt sad. | | I felt sad. | | I felt sad. |
| | | | I felt lifeless. | self-developed | Assessment of cardinal symptoms | I felt lifeless. | | I felt powerless. | New formulation suggested by patient, better reflects cardinal symptom | I felt listless. |
| | | | | | | | Due to problems with item "tired" exploratory inclusion of additional item based on patients' formulation: exhaustion in scope of depression | I was exhausted. | | I was exhausted. |
| Acceptance | Psychological Flexibility (McCracken & Morley, 2014) | Acceptance is an embracing attitude that leads to goal-oriented behaviour within the personal frame of control as well as distancing oneself from attempts to control unwanted feelings or unchangeable circumstances. | I was open for all of my feelings, the good and the bad. | Bartels et al. (2022), MPFI | Items perceived as invalidating | I tried to live with my pain. | conceivable, yet high reactance new formulation based on PaSol and patients' suggestions | I tried to befriend my pain. | | I tried to befriend my pain. |
| | | | I thought that it is okay to experience pain. | CPAQ-G 2.0 | | I could accept that there is no solution for my pain. | | I could accept that there is no solution for my pain. | avoid inversion, stress long-term character, facilitate comprehensibility | I was able to accept that the pain would accompany my life. |
| | | | Controlling my pain was my first priority. | CPAQ-G 2.0 | avoidne inversion to facilitate resounding | | | | | |
| Value-oriented behaviour | | Values are subjectively desirable states that influence behaviour. They include beliefs about what is right and wrong and what is important in life. | I tried to prioritise those things important to me. | MPFI | facilitate personalisation throuhg individual examples | I tried to prioritise those things important to me (individual examples). | | I tried to prioritise those things important to me (individual examples). | Despite longer response times reflection for this item desirable; after first response item understood more easily; using comprehension aids | I tried to prioritise those things important to me (individual examples). |
| Expectations | Predictive Coding (Wiech, 2016) | Expectations describe beliefs about what will happen based on previous experiences and likelihood. | I expected to experience pain. | self-developed | added anchor for timeframe | I expected to experience pain in the upcoming two hours. | | I expected to experience pain in the upcoming two hours. | Problems with retrospective response, revision now present tense, so that predictor for future pain; patients' suggestion | I assume that my pain will increase until the next survey. |
| Pain intensity | Pain Experience (Dworkin et al., 2008) | Pain intensity reflects the subjective extent of pain. | How strong is your pain right now? | Bartels et al. (2022) | Anchor for timefrime, average | How strong was your pain during the past two hours on average? | | How strong was your pain during the past two hours on average? | Timeframe will be included in instruction, therefore deleted here | How strong was your pain on average? |
| Pain-related disability | | Disability because of pain describes a limitation in movement, senses, and activities most people can do, caused by pain. | My pain disturbed me with my general activities. | Bartels et al. (2022) | Item reduction to reduce burden | | | | | |
| | | | My pain disturbed me with my walking. | | | | | | | |
| | | | My pain disturbed me with my everyday activities (incl. household). | | | | | | | |
| | | | How much did you feel disabled because of your pain? | self-developed | | How much did you feel disabled because of your pain during the past two hours? | | How much did you feel disabled because of your pain during the past two hours? | Timeframe will be included in instruction, therefore deleted here | How much did you feel disabled because of your pain? |
| Thought Suppression | Avoidance-Endurance (Hasenbring & Verburt, 2010) | Thought suppression denotes a cognitive reactive pattern that forcefully ends the perception of pain or the disruption of daily activities by pain. | I thought: "Hold on!" | AEQ | | I thought: "Hold on!" | | I thought: "Hold on!" | Item mostly perceived as positive, compassionate too much overlap with self-compassion | |
| | | | I thought: "Pull yourself together!" | | | I thought: "Pull yourself together!" | | I thought: "Pull yourself together!" | Thoughts perceived as identical/ interchangeable (both by patients and experts), clearly connotated more negatively | I thought: "Pull yourself together!"/"Don't make such a fuss!" |
| | | | I thought: "Don't make such a fuss!" | | | I thought: "Don't make such a fuss!" | | I thought: "Don't make such a fuss!" | | |
| Task Persistence | | Task persistence describes a physical over-activity despite pain that can lead to over-use of bodily structures. | I tried to divert my attention away from my unpleasant feelings. | Bartels et al. (2022) | | I tried not to think about my pain. | | I tried not to think about my pain. | good comprehensibility despite negation; in AEQ task persistence, associated with positive affect | I tried not to think about my pain. |
| | | | I went on despite my pain. | AEQ | | I went on despite my pain. | Stressing over-use more, patients' suggestion | I pulled through despite my pain. | | I pulled through despite my pain. |
| Positive Affect | | Positive affect marks an emotional state of pleasant mood or feelings that promotes approach-oriented behaviour or causes the experience of relaxation, contentment, or serenity. | I felt cheerful. | Kirtley et al., ESM Item Repository | perceived as redundant, item reduction | I felt cheerful. | added pain reference | I felt cheerful despite my pain. | | I felt cheerful despite my pain. |
| | | | I was happy. | | | | | | | |
| | | | I felt energised. | | could be mixed up with irritability | | | | | |
| Self-efficacy | Other (Nicholas, 2007) | Self-efficacy constitutes the belief to be able to handle even difficult situations successfully and to possess the required abilities. | I was confident to be able to get the household done even though I was in pain. | Pain self-efficacy questionnaire; Bartels et al. (2022) | stereotypical, sexist interpretation | I was confident I could get things done despite being in pain. | further stressing self-efficacy | I trusted myself to be able to do something even though I was in pain. | | I trusted myself to be able to do something even though I was in pain. |
| | | | I was sure to be able to lead a fulfilling life even though I was in pain. | | stressing self-efficacy expectations more | I was confident I could live a fulfilling life despite my pain. | problems with term "fulfilling" | I was sure that I could live my life satisfactorily, even though I was in pain. | | I was sure that I could live my life satisfatorily, even though I was in pain. |
| Self-compassion | Other (Neff, 2003b; 2011) | Self-compassion describes a non-judging understanding for one's own suffering, shortcomings, or failure. It can be divided in the three facets of self-kindness, sense of common humanity, and mindfulness. | I tried to treat myself lovingly. | SCS-D | facilitating comprehensibity | I tried to be friendly to myself. | | I tried to be friendly to myself. | comprehensibility sufficient, patients' suggestions too behaviour-oriented, friendly reflects attitude and behaviour best | I tried to be friendly to myself. |
| | | | I told myself that everyone has tough times every once in a while. | | No assessment of mindfulness due to overlap with other constructs | I told myself everyone has tough times once in a while. | associated with comparing oneself to others up to put oneself above others, stressing shared humanity more | I have told myself that I am not alone with my problems. | | I have told myself that I am not alone with my problems. |
| Negative Affect | Avoidance-Endurance (Hasenbring & Verburt, 2010) | Negative affect describes a general and unpleasant feeling that sums up several moods such as anger, disgust, nervousness, or shame. | | | | | | | Added after patients' formulation, considered relevant | I felt ashamed. |
| Open question | | | | | Enabling personal additions | Would you like to add something or tell us something regarding your answers? | | Would you like to add something or tell us something regarding your answers? | | Would you like to add something or tell us something regarding your answers? |
| Distractors | | | This questionnaire prompt disturbed me. | | Same scale | This questionnaire prompt disturbed me. | | | | |
| | | | How many questionnaires have you filled out today? | | | It is easy for me to answer this questionnaire. | | | | |
| | | | Did something impact your answers to this questionnaire? If yes, what was ist: | | | I am currently undisturbed. | | | | |

| Construct | Model | Definition | First item version | based on | Comments | second version (after informal feedback) | Comments | version of first evaluation | Comments | final version |
|---|---|---|---|---|---|---|---|---|---|---|
| Sleep disturbance | Other (Cole et al., 2007) | Sleep disturbances include any combination of problems initiating, maintaining, or profiting from sleep. | I was tired. | Kirtley et al., ESM Item Repository | | I was tired. | | I was tired. | Largest disagreement regarding validity in expert survey, patients' suggestion "I was exhausted" added for depression | |
| | | | Last night I slept well. | | Item reduction to reduce burden | | | | | |
| | | | Last night I had problems falling asleep. | Bartels et al. (2022) | | Last night I had problems falling asleep. | | Last night I had problems falling asleep. | Whole construct deleted due to different timescale (only once per day) | |
| | | | Last night I had problems sleeping through the night. | | | Last night I had problems sleeping through the night. | | Last night I had problems sleeping through the night. | | |
| | | | I woke up too early. | | | I woke up too early. | | I woke up too early. | | |
| pain-related anxiety | Fear-Avoidance (Vlayen & Linton, 2000) | not developed | I felt restless. | Kuppens, ESM Item Repository | deleted according to expert recommendation (patients would not agree with items) | | | | | |
| | | | The fear has caused physical symptoms. | self-developed | | | | | | |
| | | | What were your anxiety symptoms? (Multiple choice) | DIPS/SKID panic attacs symptoms | | | | | | |
| humour/ distraction | Avoidance-Endurance (Hasenbring & Verburt, 2010) | not developed | | | deleted, considered general coping | | | | | |
| Context | | | Who are you currently in the room with? | Maes et al. (2015), ESM Item Repository | Context deleted due to missing gold standards | | | | | |
| | | | What are you doing right now? | Kirtley et al., ESM Item Repository | | | | | | |
| | | | Where are you? | | | | | | | |

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*Note.* This table is also available at the ProCEss repository where it is easier to zoom in: https://rptu.de/s/vpcgks

**Appendix A2**

*Probes of the first cognitive interview study with individuals suffering from chronic pain*

| General Probes | Optional Probes | Last question after each item |
|---|---|---|
| Bitte wiederholen Sie die Aussage in Ihren eigenen Worten! *(Please repeat the statement in your own words!)* | Was war der Grund dafür, dass Sie ihre Antwort geändert haben? *(What was the reason for your change of answer?)* | Wie gut passt das Item für Sie zu folgender Beschreibung? *(To what extent do you think the item fits the following description?)* |
| Wie leicht oder schwer war es für Sie auf die Antwort zu kommen? *(Was it easy or difficult to respond?)* | War etwas unklar? *(Was anything unclear about the statement?)* | |
| | Wenn Sie nicht die Möglichkeit hätten bei mir nachzufragen, was wäre Ihrer Meinung nach die Bedeutung? *(Without asking me, what is your perception of its meaning?)* | |
| | Was verstehen Sie unter der Formulierung "…"? *(How do you understand the phrase "…"?)* | |
| | Wie sicher waren Sie sich mit Ihrer Antwort? *(How sure are you with your answer?)* | |
| | Wie sind Sie auf die Antwort gekommen? *(How did you come up with the answer?)* | |
| | Wie sicher sind Sie sich mit Ihrer Angabe von …? *(How sure are you with your answer of …?)* | |

| General Probes | Optional Probes | Last question after each item |
|---|---|---|
| | Etwas in eigenen Worten wiederholen? *(Could you repeat in your own words?)*<br>Wie gut können Sie sich an letzte Nacht erinnern? *(How well do you remember last night?)* | |

**Appendix A3**

*Probes of practitioners' cognitive interviews*

| German version | English version | Purpose |
|---|---|---|
| Welche Informationen würden eine Antwort auf diese Frage im therapeutischen Setting liefern? | What information would an answer to this question provide in a therapeutic setting? | Comprehensibility |
| Welches Konstrukt oder welche Konstrukte könnte dieses Item messen? | Which construct could this item measure? | Comprehensibility |
| Das Item wurde entwickelt, um folgendes Konstrukt X zu messen. Könnte es darüber hinaus weitere Konstrukte messen? | This item was developed to measure the following construct X. Could it also measure additional constructs? | Discriminant validity |
| Erachten Sie das Item im Hinblick auf die Aufrechterhaltung der chronischen Schmerzstörung als funktional oder dysfunktional? | Do you consider the item functional or dysfunctional in terms of maintaining the chronic pain disorder? | Comprehensibility |
| Können Sie das Item auf einer Skala von 0 bis 10 hinsichtlich als wie klinisch nützlich Sie das Item in der Praxis finden bewerten? | Can you rate this item on a scale from 0 to 10 how clinically useful you find this item in clinical practice? | Relevance |

## Appendix A4

*Construct fit assessment of cognitive interviews with affected individuals*

| Construct | Item | | Patient's Perspective | Explanation: Misfit and other Criteria |
|---|---|---|---|---|
| | | | Construct-Fit | |
| 1 Catastrophising | 1 | I thought that it will never get better. | Eleven out of twelve rated the item as representative according to the construct definition. | |
| | 2 | I thought that I could not go on any longer. | Nine out of twelve rated the item as representative according to the construct definition. | The item "I thought that I could not go on any longer" was perceived by patients as more closely related to depression than to catastrophising, interpreted as "I don't want to live any longer". |
| 2 Avoidance | 3 | I stopped an activity because of my pain. | All participants rated the item as representative according to the construct definition. | |
| | 4 | Due to my pain, I asked others to do a strenuous activity for me. | All participants rated the item as representative according to the construct definition. | |
| | 5 | I avoided at least one activity that causes pain. | Eleven out of eleven participants rated the item as representative according to the construct definition. | |
| 3 Depression | 6 | I felt irritable. | Nine out of twelve rated the item as representative according to the construct definition. | The item "I felt irritable" was noted by patients as reflecting a direct reaction to pain rather than a depressive symptom. One patient suggested that depression is generally characterized by passivity, whereas irritability in response to pain reflects a more active state. |
| | 7 | I felt guilty. | All participants rated the item as representative according to the construct definition. | |
| | 8 | I felt sad. | All participants rated the item as representative according to the construct definition. | |
| | 9 | I felt listless. | Ten out of eleven participants rated the item as representative according to the construct definition. | Criterion **comprehension**: The item "I felt listless" required extra time to understand the meaning of "listless", with patients finding it difficult to associate it with depression. |
| 4 Thought Suppression | 10a | I thought: "Hold on!" | Ten out of ten participants rated the item as representative according to the construct definition. | |
| | 10b | I thought: "Pull yourself together" | Ten out of ten participants rated the item as representative according to the construct definition. | |
| | 10c | I thought: "Don't make such a fuss!" | Nine out of ten participants rated the item as representative according to the construct definition. | Criterion **burden**: The item "I thought: 'Don't make such a fuss!'" required patients to reflect a little longer, particularly in comparison to the preceding items "I thought: 'Pull yourself together'" and "I thought: 'Hold on!'" (thought suppression). These items appeared very similar, and patients reported difficulties identifying any differences between the three statements. |
| | 11 | "I tried not to think about my pain." | Ten out of ten participants rated the item as representative according to the construct definition. | |
| 5 Task Persistence | 12 | I went on despite my pain. | Eleven out of eleven participants rated the item as representative according to the construct definition. | |
| 6 Positive Affect | 13 | I felt cheerful. | Ten out of eleven rated the item as representative according to the construct definition. | |
| 7 Acceptance | 14 | I tried to live with my pain. | Nine out of twelve participants rated the item as representative according to the construct definition. | The item "I tried to live with my pain" caused difficulties in relation to the definition of acceptance. Several patients argued against the definition of acceptance, explaining that they do not accept their pain, as illustrated by the quote: "I don't accept the pain; I fight against it. I do something about it". |
| | 15 | I could accept that there is no solution for my pain. | Eleven out of twelve participants rated the item as representative according to the construct definition. | |
| 8 Values | 16 | I tried to prioritise those things important to me [individual examples]. | Eleven out of twelve participants rated the item as representative according to the construct definition. | The item "I tried to prioritise those things important to me [individual examples]" caused some difficulties, as patients needed more time to think of individual examples and felt somewhat overwhelmed by the task. |
| 9 Expactations | 17 | I expected to experience pain in the upcoming two hours. | All participants rated the item as representative according to the construct definition. | |
| 10 Self-efficacy | 18 | I was confident I could get things done despite being in pain. | All participants rated the item as representative according to the construct definition. | |

| Construct | Item | | Patient's Perspective | Explanation: Misfit and other Criteria |
|---|---|---|---|---|
| | 19 | I was confident I could live a fulfilling life despite my pain. | Ten out of twelve participants rated the item as representative according to the construct definition. | The item "I was confident I could live a fulfilling life despite my pain" posed comprehension difficulties, as patients reported uncertainty regarding whether the item aimed to assess what people "expect for their lives" or whether they believe they can live a "normal life". |
| 11 Sleep | 20 | I felt tired. | Ten out of twelve participants rated the item as representative according to the construct definition. | The item "I felt tired", was tended to associate more with exhaustion, as one patient associated it with the statement "I am tired of life," which reflects a closeness to the construct of depression. |
| | 21 | Last night, I had problems falling asleep. | All participants rated the item as representative according to the construct definition. | |
| | 22 | Last night, I had problems sleeping through the night. | All participants rated the item as representative according to the construct definition. | |
| | 23 | Last night, I woke up too early. | All participants rated the item as representative according to the construct definition. | |
| 12 Self-compassion | 24 | I tried to be friendly to myself. | Ten out of twelve participants rated the item as repreaentative according to the construct definition. | The item "I tried to be friendly to myself" prompted patients to express uncertainty about the meaning of the phrase "friendly to myself." Patients explained that seeing the construct definition before answering this item would have made it easier to understand. However, they ultimately responded to the item in line with its intended meaning. |
| | 25 | I told myself everyone has tough times once in a while. | Nine out of twelve participants rated the item as representative according to the construct definition. | The item "I told myself everyone has tough times once in a while" revealed that patients felt it was unrelated to their pain, with some noting that comparing themselves to others made them uncomfortable. |
| 13 Pain Intensity | 26 | How strong was your pain during the past two hours (on average; 0 = no pain, 10 = maximally imaginable pain)? | All participants rated the item as representative according to the construct definition. | |
| 14 Disability | 27 | How strong was your pain during the past two hours (on average; 0 = no pain, 10 = maximally imaginable pain)? | All participants rated the item as representative according to the construct definition. | |

*Note.* All participants = 12. When, for example, "nine out of ten" is reported, this indicates that two participants are missing because they were either not asked or technical problems occurred.

## Appendix B: Supplement ProCEss evaluation

## Appendix B1.1

*ProCEss development stages in original language (German)*

| Konstrukt | Modell | Definition | Erste Version Item | Angelehnt an | Kommentar | Zweite Version (nach formlosem Feedback) | Kommentar | Version in erster Evaluation | Kommentar | Finale Version |
|---|---|---|---|---|---|---|---|---|---|---|
| Katastrophisieren | Fear-Avoidance (Vlayen & Linton, 2000)/ Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Katastrophisieren beschreibt die Neigung, negative Aspekte einer Situation oder mögliche Konsequenzen in übertriebenem Maße wahrzunehmen und darüber zu grübeln bzw. diese zu antizipieren. (Dorsch Lexikon der Psychologie (o. D.)) | Ich habe gedacht, dass es nie mehr besser wird. | PASS-20-GV/PCS (GV) | Bevorzugt, da von Crombez et al. (2020) empfohlen | Ich habe gedacht, dass es nie mehr besser wird. | Angleichung an Gedanken-Unterdrückungs-Items | Ich habe gedacht: "Es wird nie mehr besser!" | | Ich habe gedacht: "Es wird nie mehr besser!" |
| | | | Ich habe gedacht, dass ich nicht mehr kann. | PCS (GV) | Bevorzugt, da von Crombez et al. (2020) empfohlen | Ich habe gedacht, dass ich nicht mehr kann. | | Ich habe gedacht: "Ich kann nicht mehr!" | Von Patient:innen als weniger valide eingeschätzt. Vermischung mit Suizidalität; neue Formulierung Patient:innenvorschlag, zudem klarer als dysfunktional einzuordnen | Ich habe gedacht: "Ich halte es nicht mehr aus!" |
| | | | Was denken Sie, ist das Schlimmste, was passieren kann? | Eigene Formulierung | Item Reduktion zur Verringerung der Belastung, Einheitlichkeit der Skala | | | | | |
| Vermeidung | | Vermeidung stellt eine Verhaltensweise dar, bei der bestimmte Erlebnisse (im Schmerzkontext: Erleben von Schmerz) verhindert, reduziert oder beendet werden. (McCracken, 2005) | Ich habe eine Aktivität wegen meiner Schmerzen beendet. | PASS-20-GV | Um eindeutige Unterscheidung funktional vs. dysfunktional bemüht; Schmerzbezug eingefügt | Ich habe eine Aktivität wegen meiner Schmerzen beendet. | | Ich habe eine Aktivität wegen meiner Schmerzen beendet. | 11-stufige Skala nicht anwendbar, Item erscheint dichotom | Ich habe Aktivitäten wegen meiner Schmerzen abgebrochen. |
| | | | Ich habe eine anstrengende Tätigkeit abgegeben. | AEQ | | Ich habe eine anstrengende Tätigkeit wegen meiner Schmerzen an jemand anderen abgegeben. | | Ich habe eine anstrengende Tätigkeit wegen meiner Schmerzen an jemand anderen abgegeben. | | Ich habe anstrengende Tätigkeiten wegen meiner Schmerzen an jemand anderen abgegeben. |
| | | | Ich habe mindestens eine Aktivität, die Schmerzen hervorruft, vermieden. | PASS-20-GV | | Ich habe mindestens eine Aktivität, die Schmerzen hervorruft, vermieden. | | Ich habe mindestens eine Aktivität, die Schmerzen hervorruft, vermieden. | Gegen Patient:innenvorschlag "verzichten" entschieden, da "vermeiden" allgemeiner; "Verzicht" schränkt eher auf angenehme Tätigkeiten ein; Angleichung im Plural an obere Items | Ich habe Aktivitäten, die Schmerzen hervorrufen, vermieden. |
| | | | Welchen Aktivitäten würden Sie ohne Schmerzen nachgehen? | eigene Formulierung | Item Reduktion zur Verringerung der Belastung, Einheitlichkeit der Skala | | | | | |
| Depression | | Eine depressive Episode ist gekennzeichnet durch gedrückte Stimmung und eine Verminderung von Antrieb und Aktivität. Auch bei leichten Formen können Schuldgefühle oder Gedanken über die eigene Wertlosigkeit auftreten. (BfArM, 2023) | Ich war gereizt. | Kirtley et al., ESM Item Repository | Von Expertin befürwortet aufgrund Relevanz | Ich war gereizt. | | Ich war gereizt. | | Ich war gereizt. |
| | | | Ich habe mich schuldig gefühlt. | | | Ich habe mich schuldig gefühlt. | | Ich habe mich schuldig gefühlt. | | Ich habe mich schuldig gefühlt. |
| | | | Ich habe mich traurig gefühlt. | | Erfassung Kardinalsymptome | Ich habe mich traurig gefühlt. | | Ich habe mich traurig gefühlt. | | Ich habe mich traurig gefühlt. |
| | | | Ich habe mich lustlos gefühlt. | eigene Formulierung | | Ich habe mich lustlos gefühlt. | | Ich habe mich lustlos gefühlt. | Umformulierung Patient:innenvorschlag, spiegelt Kardinalsymptom besser wider | Ich habe mich antriebslos gefühlt. |
| | | | | | | | Aufgrund von Problemen mit dem "müde" Item exploratorische Aufnahme eines weiteren Items basierend auf Formulierung von Patient:innen; Energielosigkeit bei Depression | Ich war erschöpft. | | Ich war erschöpft. |
| Akzeptanz | Psychological Flexibility (McCracken & Morley, 2014) | Akzeptanz ist eine annehmende Haltung, die zu zielgerichtetem Handeln im Rahmen der persönlichen Kontrolle und einem Abstandnehmen von Versuchen, unerwünschte Gefühle oder unveränderbare Zustände zu kontrollieren, führt. (McCracken & Morley, 2014) | Ich war offen für alle meine Gefühle, die guten und die schlechten. | Bartels et al. (2022), MPFI | Item wurde als invalidierend empfunden, daher umformuliert | Ich habe versucht, mit meinen Schmerzen zu leben. | werde zwar verstanden, aber hohe Reaktanz neue Formulierung angelehnt an PaSol sowie Patient:innenformulierung | Ich habe versucht, mich mit meinen Schmerzen anzufreunden. | | Ich habe versucht, mich mit meinen Schmerzen anzufreunden. |
| | | | Ich habe gedacht, dass es in Ordnung ist, Schmerzen zu erleben. | CPAQ-G 2.0 | | Ich konnte akzeptieren, dass es für meine Schmerzen keine Lösung gibt. | | Ich konnte akzeptieren, dass es für meine Schmerzen keine Lösung gibt. | Vermeinung vermeiden, leichtere Verständlichkeit, Lanofristigkeit betonen | Ich konnte annehmen, dass der Schmerz mein Leben begleiten wird. |
| | | | Die Kontrolle meiner Schmerzen hatte für mich erste Priorität. | CPAQ-G 2.0 | Invertierung sollte vermieden werden, um Bearbeitung für Teilnehmende zu erleichtern | | | | | |
| Werteorientiertes Handeln | | Werte sind subjektiv wünschens- oder erstrebenswerte Zustände, die das Handeln beeinflussen. Sie beinhalten Einstellungen dazu, was richtig und falsch und was im Leben wichtig ist. (Oxford University Press (w. d.). Spektrum Lexikon der Psychologie (w. d.)) | Ich habe versucht, den Dingen, die mir wirklich wichtig sind, Vorrang zu geben. | MPFI | Ermöglichung von individualisierung durch eigene Beispiele | Ich habe versucht, den Dingen, die mir wirklich wichtig sind [Beispiele], Vorrang zu geben. | | Ich habe versucht, den Dingen, die mir wirklich wichtig sind [Beispiele], Vorrang zu geben. | Trotz längerer Bearbeitungsdauer Reflektion bei diesem Item gewünscht; nach erstmaliger Auseinandersetzung mutmaßlich einfacher zu verstehen. Hilfestellungen nutzen | Ich habe versucht, den Dingen, die mir wirklich wichtig sind, Vorrang zu geben. |
| Erwartungen | Predictive Coding (Wiech, 2016) | Erwartungen sind Annahmen darüber, was geschehen wird, auf Grundlage voriger Erfahrungen und Wahrscheinlichkeit. (Oxford University Press (w. d.); Wiech, 2016) | Ich habe erwartet, dass ich Schmerzen haben werde. | Eigene Formulierung | Anker für Zeitraum eingefügt | Ich habe erwartet, dass ich (in den nächsten zwei Stunden) Schmerzen haben werde. | | Ich habe erwartet, dass ich (in den nächsten zwei Stunden) Schmerzen haben werde. | Probleme bei retrospektiver Beantwortung, deshalb ins Präsens gesetzt, damit Prädiktor für künftigen Schmerz; Umformulierung Patient:innenvorschlag | Ich gehe davon aus, dass meine Schmerzen bis zur nächsten Befragung zunehmen. |
| Schmerzintensität | Pain Experience (Dworkin et al., 2005) | Die Schmerz Intensität reflektiert das subjektiv empfundene Ausmaß des Schmerzes. (Dworkin et al., 2005) | Wie stark sind Ihre Schmerzen gerade? | Bartels et al. (2022) | Anker für Zeitraum, Instruktion für Durchschnitt | Wie stark waren Ihre Schmerzen seit dem letzten Fragebogen im Durchschnitt? | | Wie stark waren Ihre Schmerzen in den letzten zwei Stunden im Durchschnitt? | Referenzzeitraum soll künftig in Instruktion, wird dafür hier gestrichen | Wie stark waren Ihre Schmerzen im Durchschnitt? |
| Beeinträchtigung | | Die Beeinträchtigung durch Schmerzen beschreibt eine Begrenzung in Bewegungen, Sinnen oder Aktivitäten, die die meisten Menschen ausüben können, aufgrund von Schmerzen. (Crombez et al., 2020; Oxford University Press (w. d.)) | Meine Schmerzen haben mich bei meinen allgemeinen Aktivitäten gestört. | Bartels et al. (2022) | Item Reduktion zur Verringerung der Belastung | | | | | |
| | | | Meine Schmerzen haben mich beim Gehen/Laufen beeinträchtigt. | | | | | | | |
| | | | Meine Schmerzen haben mich bei alltäglichen Arbeiten (inkl. Haushalt) gestört. | | | | | | | |
| | | | Wie sehr haben Sie sich durch Ihre Schmerzen beeinträchtigt gefühlt? | Eigene Formulierung | | Wie sehr haben Sie sich durch Ihre Schmerzen beeinträchtigt gefühlt? | | Wie sehr haben Sie sich in den letzten zwei Stunden durch Ihre Schmerzen beeinträchtigt gefühlt? | Referenzzeitraum soll künftig in Instruktion, wird dafür hier gestrichen | Wie sehr haben Sie sich durch Ihre Schmerzen beeinträchtigt gefühlt? |
| Gedanken-unterdrückung | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Gedankenunterdrückung bezeichnet ein kognitives Reaktionsmuster, das die Schmerzwahrnehmung oder Unterbrechung täglicher Aktivitäten durch Schmerzen willentlich beendet. (Hasenbring & Verbunt, 2010; Oxford University Press (w. d.)) | Ich habe gedacht: "Halte durch!" | AEQ | | Ich habe gedacht: "Halte durch!" | | Ich habe gedacht: "Halte durch!" | Item wird vorwiegend positiv; mittlerweile wahrgenommen, zu hohe Überlappung mit Selbstmitgefühl | |
| | | | Ich habe gedacht: "Reiß dich zusammen!" | | | Ich habe gedacht: "Reiß dich zusammen!" | | Ich habe gedacht: "Reiß dich zusammen!" | Gedanken werden als identisch bzw. austauschbar wahrgenommen (sowohl von Expert innen als auch Patient:innen), deutlich negativer konnotiert als "Halte durch!" | Ich habe gedacht: "Reiß dich zusammen!"/ "Stell' dich nicht so an!" |
| | | | Ich habe gedacht: "Stell' dich nicht so an!" | | | Ich habe gedacht: "Stell' dich nicht so an!" | | Ich habe gedacht: "Stell' dich nicht so an!" | | |
| | | | Ich habe versucht, meine Aufmerksamkeit von meinen unangenehmen Gefühlen abzulenken. | Bartels et al. (2022) | | Ich habe versucht, meine Schmerzen nicht zu beachten. | | Ich habe versucht, meine Schmerzen nicht zu beachten. | Trotz Verneinung beibehalten, da gut verständlich; im AEQ bei Aufgabenausdauer, assoziiert mit positivem Affekt | Ich habe versucht, meine Schmerzen nicht zu beachten. |
| Aufgabenausdauer | | Aufgabenausdauer beschreibt eine körperliche Überaktivität trotz Schmerzen, die zur Übernutzung körperlicher Strukturen führen kann. (Hasenbring & Verbunt, 2010) | Ich habe trotz meiner Schmerzen weitergemacht. | AEQ | | Ich habe trotz meiner Schmerzen weitergemacht. | Stärkere Betonung des übertretenden Verhaltens. Umformulierung Patient:innen-vorschlag | Ich habe trotz meiner Schmerzen durchgezogen. | | Ich habe trotz meiner Schmerzen durchgezogen. |
| Positiver Affekt | | Positiver Affekt stellt einen Gefühlszustand angenehmer Stimmung oder Gefühle dar, der annäherungs-orientiertes Verhalten begünstigt oder ein Erleben von Entspannung, Zufriedenheit oder Gelassenheit verursacht. (Finan & Garland, 2015) | Ich war gut gelaunt. | Kirtley et al., ESM Item Repository | Items wurden als redundant wahrgenommen, Reduktion | Ich war gut gelaunt. | Schmerzbezug eingefügt | Ich war trotz meiner Schmerzen gut gelaunt. | | Ich war trotz meiner Schmerzen gut gelaunt. |
| | | | Ich war fröhlich. | | | | | | | |
| | | | Ich war energiegeladen. | | Verwechslungsgefahr mit Reizbarkeit | | | | | |

| Konstrukt | Modell | Definition | Erste Version Item | Angelehnt an | Kommentar | Zweite Version (nach formlosem Feedback) | Kommentar | Version in erster Evaluation | Kommentar | Finale Version |
|---|---|---|---|---|---|---|---|---|---|---|
| Selbstwirksamkeit | Other (Nicholas, 2007) | Selbstwirksamkeit stellt die Überzeugung dar, auch schwierige Situationen aus eigener Kraft heraus erfolgreich bewältigen zu können und dazu die nötigen Fähigkeiten zu besitzen. (Bandura, 1977; Psychomeda Lexikon der Psychologie (o. D.)) | Ich war zuversichtlich, etwas im Haushalt erledigen zu können, obwohl ich Schmerzen habe. | Pain self-efficacy questionnaire; Bartels et al. (2022) | Umformulierung, da von Patientinnen als stereotyp bzw. sexistisch bemängelt | Ich war zuversichtlich, etwas erledigen zu können, obwohl ich Schmerzen habe. | Weitere Betonung des Selbstwirksamkeits-Aspekts | Ich habe mir zugetraut, etwas erledigen zu können, obwohl ich Schmerzen habe. | | Ich habe mir zugetraut, etwas erledigen zu können, obwohl ich Schmerzen habe. |
| | | | Ich war sicher, ein normales Leben führen zu können, obwohl ich Schmerzen habe. | | Umformulierung, um Selbstwirksamkeitserwartung mehr zu betonen | Ich war sicher, ein erfülltes Leben führen zu können, obwohl ich Schmerzen habe. | Interpretationsprobleme mit Begriff "erfüllend" | Ich war sicher, mein Leben zufriedenstellend führen zu können, obwohl ich Schmerzen habe. | | Ich war sicher, mein Leben zufriedenstellend führen zu können, obwohl ich Schmerzen habe. |
| Selbstmitgefühl | Other (Neff, 2003b; 2011) | Selbstmitgefühl beschreibt ein nicht-wertendes Verständnis für das eigene Leid, eigene Unzulänglichkeiten oder persönliches Versagen. Es kann in die drei Facetten Selbst-Freundlichkeit, Sinn gemeinsamer Menschlichkeit und Achtsamkeit unterteilt werden. | Ich habe versucht, liebevoll mit mir umzugehen. | SCS-D | Bemüht um leichtere Verständlichkeit | Ich habe versucht, freundlich mit mir umzugehen. | | Ich habe versucht, freundlich mit mir umzugehen. | ausreichend gute Verständlichkeit, Patient:innenformulierungen zu verhaltensbezogen, "freundlich" spiegelt Haltung und Verhalten am besten | Ich habe versucht, freundlich mit mir umzugehen. |
| | | | Ich habe mir gesagt, dass es bei jedem:r einmal schlecht läuft. | | Keine Erfassung der Achtsamkeits-Dimension aufgrund Überschneidung mit anderen Konstrukten | Ich habe mir gesagt, dass es bei jedem:r einmal schlecht läuft. | Assoziation mit "sich mit anderen vergleichen" bis hin zu "sich über andere stellen", Bemühung um mehr Betonung der gemeinsamen Menschlichkeit | Ich habe mir gesagt, dass ich mit meinen Problemen nicht allein bin. | | Ich habe mir gesagt, dass ich mit meinen Problemen nicht allein bin. |
| Negativer Affekt | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Negativer Affekt stellt einen allgemeinen und unangenehmen Gefühlszustand dar, unter dem viele verschiedene Stimmungen wie Ärger, Ekel, Nervosität und Scham zusammengefasst werden können. (Breyer & Bluemke, 2016; Watson & Clark, 1988) | | | | | | | Neu hinzugefügt aufgrund Patient:innenaussage und eigener Einschätzung als sehr relevant | Ich habe mich geschämt. |
| Zusatzfrage | | | | | Ermöglichen persönlicher Ergänzungen | oder uns zu Ihren Antworten auf diesen Fragebogen mitteilen? | | oder uns zu Ihren Antworten auf diesen Fragebogen mitteilen? | | oder uns zu Ihren Antworten auf diesen Fragebogen mitteilen? |
| Distraktoren | | | Dieses Fragebogensignal hat mich gestört. | | | Dieses Fragebogensignal hat mich gestört. | | | | |
| | | | Wie viele Fragebögen haben Sie heute schon ausgefüllt? | | Vereinheitlichung der Skala | Es fällt mir leicht, den Fragebogen auszufüllen. | | | | |
| | | | Hat etwas Ihre Antworten auf die Fragen beeinflusst? Wenn ja, was: | | | Ich bin gerade ungestört. | | | | |
| Schlafstörungen | Other (Cole et al., 2007) | Schlafstörungen bezeichnen jede Art von Problemen bei der Initiierung, Aufrechterhaltung oder dem Profitieren von Schlaf. (Cole et al., 2007) | Ich war müde. | Kirtley et al., ESM Item Repository | | Ich war müde. | | Ich war müde. | Größte Uneinigkeit bzgl. Validität in Expert:innenbefragung, Patient:innen-vorschlag: "Ich war erschöpft", als Depressionsitem eingefügt | |
| | | | Vergangene Nacht habe ich gut geschlafen. | | Item Reduktion zur Verringerung der Belastung | | | | | |
| | | | Vergangene Nacht hatte ich Probleme dabei einzuschlafen. | | | Vergangene Nacht hatte ich Probleme dabei einzuschlafen. | | Vergangene Nacht hatte ich Probleme dabei einzuschlafen. | Entfernung des gesamten Konstrukts aufgrund verschiedener Zeitskalen (Schlaf einmalige Erfassung am Tag) | |
| | | | Vergangene Nacht hatte ich Probleme durchzuschlafen. | Bartels et al. (2022) | | Vergangene Nacht hatte ich Probleme durchzuschlafen. | | Vergangene Nacht hatte ich Probleme durchzuschlafen. | | |
| | | | Ich bin zu früh aufgewacht. | | | Ich bin zu früh aufgewacht. | | Ich bin zu früh aufgewacht. | | |
| Schmerzbezogene Angst | Fear-Avoidance (Vlayen & Linton, 2000) | Wurde nicht entwickelt | Ich habe mich unruhig gefühlt. | Kirtley et al., ESM Item Repository | Konstrukt aufgrund Expertinnenrat entfernt (die meisten Patient:innen würden dem nicht zustimmen) | | | | | |
| | | | Die Angst hat körperliche Symptome verursacht. | Eigene Formulierung | | | | | | |
| | | | Was waren Ihre Angst Symptome? (Mehrfach-Auswahl Symptome) | DIPS/SKID Panik-attacken Symptome | | | | | | |
| Humor/Ablenkung | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Wurde nicht entwickelt | | | Konstrukt entfernt, eher allgemeines Coping | | | | | |
| Kontext | | | Mit wem sind Sie gerade im selben Raum? | Maes et al. (2015), ESM Item Repository | Kontext aufgrund schwieriger Abbildbarkeit nicht erfasst | | | | | |
| | | | Was machen Sie gerade? | Kirtley et al., ESM Item | | | | | | |
| | | | Wo sind Sie? | | | | | | | |


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*Note.* This table is also available at the ProCEss repository where it is easier to zoom in: https://rptu.de/s/vpcgks

## Appendix B1.2

*ProCEss development stages in preliminary English translation*

| Construct | Model | Definition | First item version | based on | Comments | second version (after informal feedback) | Comments | version of first evaluation | Comments | final version |
|---|---|---|---|---|---|---|---|---|---|---|
| Catastrophising | Fear-Avoidance (Vlayen & Linton, 2000)/ Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Catastrophising describes the tendency to perceive negative aspects of a situation or possible consequences in an excessive manner, and to ruminate about or anticipate them. | I thought that it will never get better. | PASS-20-GV | Recommended by Crombez et al. (2020) | I thought that it will never get better. | Assimilation to Thought Suppression items | I thought: "It will never get better!" | | I thought: "It will never get better!" |
| | | | I thought that I could not go on any longer. | PCS (GV) | Recommended by Crombez et al. (2020) | I thought that I could not go on any longer. | | I thought: "I can't stand it any longer!" | Evaluated as less valid by patients, confounded with suicidality; new formulation based on patients' suggestions, also more clearly dysfunctional | I thought: "I can't stand it any longer!" |
| | | | What do you think is the worst that can happen? | self-developed | Item reduction to reduce burden, same scale | | | | | |
| Avoidance | | Avoidance constitutes a behaviour aiming at prevention, reduction, or termination of the exposure to certain experiences (in pain context: experience of pain). | I stopped an activity because of my pain. | PASS-20-GV | clearer differentiation between functional vs. dysfunctional; added pain reference | I stopped an activity because of my pain. | | I stopped an activity because of my pain. | 11-point scale not feasible, item dichotomous | I stopped activities because of my pain. |
| | | | I asked others to do a strenuous activity for me. | AEQ | | Due to my pain I asked others to do a strenuous activity for me. | | Due to my pain I asked others to do a strenuous activity for me. | | Due to my pain I aseked others to do strenuous activities for me. |
| | | | I avoided at least one activity that causes pain. | PASS-20-GV | | I avoided at least one activity that causes pain. | | I avoided at least one activity that causes pain. | decided against patient's suggestion "relinquish", since "avoid" more general; "relinquish" limits to pleasurable activities; assimilate plural to other avoidance items | I avoided activities that cause pain. |
| | | | What activities would you pursue if you were pain-free? | self-developed | Item reduction to reduce burden, same scale | | | | | |
| Depression | | A depressive episode is marked by subdued mood and listlessness with a reduction of activity. Even in light forms feelings of guilt and thoughts about the own worthlessness can occur. | I felt irritable. | Kirtley et al., ESM Item Repository | recommended by expert due to relevancy | I felt irritable. | | I felt irritable. | | I felt irritable. |
| | | | I felt guilty. | | | I felt guilty. | | I felt guilty. | | I felt guilty. |
| | | | I felt sad. | | | I felt sad. | | I felt sad. | | I felt sad. |
| | | | I felt lifeless. | self-developed | Assessment of cardinal symptoms | I felt lifeless. | | I felt powerless. | New formulation suggested by patient, better reflects cardinal symptom | I felt listless. |
| | | | | | | | Due to problems with item "tired" exploratory inclusion of additional item based on patients' formulation; exhaustion in scope of depression | I was exhausted. | | I was exhausted. |
| Acceptance | Psychological Flexibility (McCracken & Morley, 2014) | Acceptance is an embracing attitude that leads to goal oriented behaviour within the personal frame of control as well as distancing oneself from attempts to control unwanted feelings or unchangeable circumstances. | I was open for all of my feelings, the good and the bad. | Bartels et al. (2022), MPFI | Items perceived as invalidating | I tried to live with my pain. | conceivable, yet high reactance new formulation based on PaSol and patients' suggestions | I tried to befriend my pain. | | I tried to befriend my pain. |
| | | | I thought that it is okay to experience pain. | CPAQ-G 2.0 | | I could accept that there is no solution for my pain. | | I could accept that there is no solution for my pain. | avoid inversion, stress long-term character, facilitate comprehensibility | I was able to accept that the pain would accompany my life. |
| | | | Controlling my pain was my first priority. | CPAQ-G 2.0 | avoiding inversion to facilitate responding | | | | | |
| Value-oriented behaviour | | Values are subjectively desirable states that influence behaviour. They include beliefs about what is right and wrong and what is important in life. | I tried to prioritise those things important to me. | MPFI | facilitate personalisation throuhg individual examples | I tried to prioritise those things important to me (individual examples). | | I tried to prioritise those things important to me (individual examples). | Despite longer response times reflection for this item desirable; after first response item understood more easily; using comprehension aids | I tried to prioritise those things important to me (individual examples). |
| Expectations | Predictive Coding (Wiech, 2016) | Expectations describe beliefs about what will happen based on previous experiences and likelihood. | I expected to experience pain. | self-developed | added anchor for timeframe | I expected to experience pain in the upcoming two hours. | | I expected to experience pain in the upcoming two hours. | Problems with retrospective response, revision now present tense, so that predictor for future pain; patients' suggestion | I assume that my pain will increase until the next survey. |
| Pain intensity | Pain Experience (Dworkin et al., 2005) | Pain intensity reflects the subjective extent of pain. | How strong is your pain right now? | Bartels et al. (2022) | Anchor for timefrime, average | How strong was your pain during the past two hours on average? | | How strong was your pain during the past two hours on average? | Timeframe will be included in instruction, therefore deleted here | How strong was your pain on average? |
| Pain-related disability | | Disability because of pain describes a limitation in movement, senses, and activities most people can do, caused by pain. | My pain disturbed me with my general activities. | Bartels et al. (2022) | Item reduction to reduce burden | | | | | |
| | | | My pain disturbed me with my walking. | | | | | | | |
| | | | My pain disturbed me with my everyday activities (incl. household). | | | | | | | |
| | | | How much did you feel disabled because of your pain? | self-developed | | How much did you feel disabled because of your pain during the past two hours? | | How much did you feel disabled because of your pain during the past two hours? | Timeframe will be included in instruction, therefore deleted here | How much did you feel disabled because of your pain? |
| Thought Suppression | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Thought suppression denotes a cognitive reactive pattern that forcefully ends the perception of pain or the disruption of daily activities by pain. | I thought: "Hold on!" | AEQ | | I thought: "Hold on!" | | I thought: "Hold on!" | Item mostly perceived as positive, compassionate too much overlap with self-compassion | |
| | | | I thought: "Pull yourself together!" | | | I thought: "Pull yourself together!" | | I thought: "Pull yourself together!" | Thoughts perceived as identical/ interchangeable (both by patients and experts), clearly connotated more negatively | I thought: "Pull yourself together!"/"Don't make such a fuss!" |
| | | | I thought: "Don't make such a fuss!" | | | I thought: "Don't make such a fuss!" | | I thought: "Don't make such a fuss!" | | |
| Task Persistence | | Task persistence describes a physical over-activity despite pain that can lead to over-use of bodily structures. | I tried to divert my attention away from my unpleasant feelings. | Bartels et al. (2022) | | I tried not to think about my pain. | | I tried not to think about my pain. | good comprehensibility despite negation; in AEQ task persistence, associated with positive affect | I tried not to think about my pain. |
| | | | I went on despite my pain. | AEQ | | I went on despite my pain. | Stressing over-use more, patients' suggestion | I pulled through despite my pain. | | I pulled through despite my pain. |
| Positive Affect | | Positive affect marks an emotional state of pleasant mood or feelings that promotes approach-oriented behaviour or causes the experience of relaxation, contentment, or serenity. | I felt cheerful. | Kirtley et al., ESM Item Repository | perceived as redundant, item reduction | I felt cheerful. | added pain reference | I felt cheerful despite my pain. | | I felt cheerful despite my pain. |
| | | | I was happy. | | | | | | | |
| | | | I felt energised. | | could be mixed up with irritability | | | | | |
| Self-efficacy | Other (Nicholas, 2007) | Self-efficacy constitutes the belief to be able to handle even difficult situations successfully and to possess the required abilities. | I was confident to be able to get some household done even though I was in pain. | Pain self-efficacy questionnaire; Bartels et al. (2022) | stereotypical, sexist interpretation | I was confident I could get things done despite being in pain. | further stressing self-efficacy | I trusted myself to be able to do something even though I was in pain. | | I trusted myself to be able to do something even though I was in pain. |
| | | | I was sure to be able to lead a fulfilling life even though I was in pain. | | stressing self-efficacy expectations more | I was confident I could live a fulfilling life despite my pain. | problems with term "fulfilling" | I was sure that I could live my life satisfactorily, even though I was in pain. | | I was sure that I could live my life satisfactorily, even thouch I was in pain. |
| Self-compassion | Other (Neff, 2003b; 2011) | Self-compassion describes a non-judging understanding for one's own suffering, shortcomings, or failure. It can be divided in the three facets of self-kindness, sense of common humanity, and mindfulness. | I tried to treat myself lovingly. | SCS-D | facilitating comprehensibility | I tried to be friendly to myself. | | I tried to be friendly to myself. | comprehensibility sufficient, patients' suggestions too behaviour-oriented; friendly reflects attitude and behaviour best | I tried to be friendly to myself. |
| | | | I told myself that everyone has tough times every once in a while. | | No assessment of mindfulness due to overlap with other constructs | I told myself everyone has tough times once in a while. | associated with comparing oneself to others up to put oneself above others, stressing shared humanity more | I have told myself that I am not alone with my problems. | | I have told myself that I am not alone with my problems. |
| Negative Affect | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Negative affect describes a general and unpleasant feeling that sums up several moods such as anger, disgust, nervousness, or shame. | | | | | | | Added after patients' formulation, considered relevant | I felt ashamed. |
| Open question | | | | | Enabling personal additions | Would you like to add something or tell us something regarding your answers? | | Would you like to add something or tell us something regarding your answers? | | Would you like to add something or tell us something regarding your answers? |
| Distractors | | | This questionnaire prompt disturbed me. | | Same scale | This questionnaire prompt disturbed me. | | | | |
| | | | How many questionnaires have you filled out today? | | | It is easy for me to answer this questionnaire. | | | | |
| | | | Did something impact your answers to this questionnaire? If yes, what was it: | | | I am currently undisturbed. | | | | |

| Construct | Model | Definition | First item version | based on | Comments | second version (after informal feedback) | Comments | version of first evaluation | Comments | final version |
|---|---|---|---|---|---|---|---|---|---|---|
| Sleep disturbance | Other (Cole et al., 2007) | Sleep disturbances include any combination of problems initiating, maintaining, or profiting from sleep. | I was tired. | Kirtley et al., ESM Item Repository | | I was tired. | | I was tired. | Largest disagreement regarding validity in expert survey, patients' suggestion "I was exhausted" added for depression | |
| | | | Last night I slept well. | | Item reduction to reduce burden | | | | | |
| | | | Last night I had problems falling asleep. | Bartels et al. (2022) | | Last night I had problems falling asleep. | | Last night I had problems falling asleep. | Whole construct deleted due to different timescale (only once per day) | |
| | | | Last night I had problems sleeping through the night. | | | Last night I had problems sleeping through the night. | | Last night I had problems sleeping through the night. | | |
| | | | I woke up too early. | | | I woke up too early. | | I woke up too early. | | |
| pain-related anxiety | Fear-Avoidance (Vlayen & Linton, 2000) | not developed | I felt restless. | Kuppens, ESM Item Repository | deleted according to expert recommendation (patients would not agree with items) | | | | | |
| | | | The fear has caused physical symptoms. | self-developed | | | | | | |
| | | | What were your anxiety symptoms? (Multiple choice) | DIPS/SKID panic attacs symptoms | | | | | | |
| humour/ distraction | Avoidance-Endurance (Hasenbring & Verburt, 2010) | not developed | | | deleted, considered general coping | | | | | |
| Context | | | Who are you currently in the room with? | Maes et al. (2015), ESM Item Repository | Context deleted due to missing gold standards | | | | | |
| | | | What are you doing right now? | Kirtley et al., ESM Item Repository | | | | | | |
| | | | Where are you? | | | | | | | |

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*Note.* This table is also available at the ProCEss repository where it is easier to zoom in: https://rptu.de/s/vpcgks

**Appendix B2.1**

*Fixed and Random intercepts per item of main evaluation*

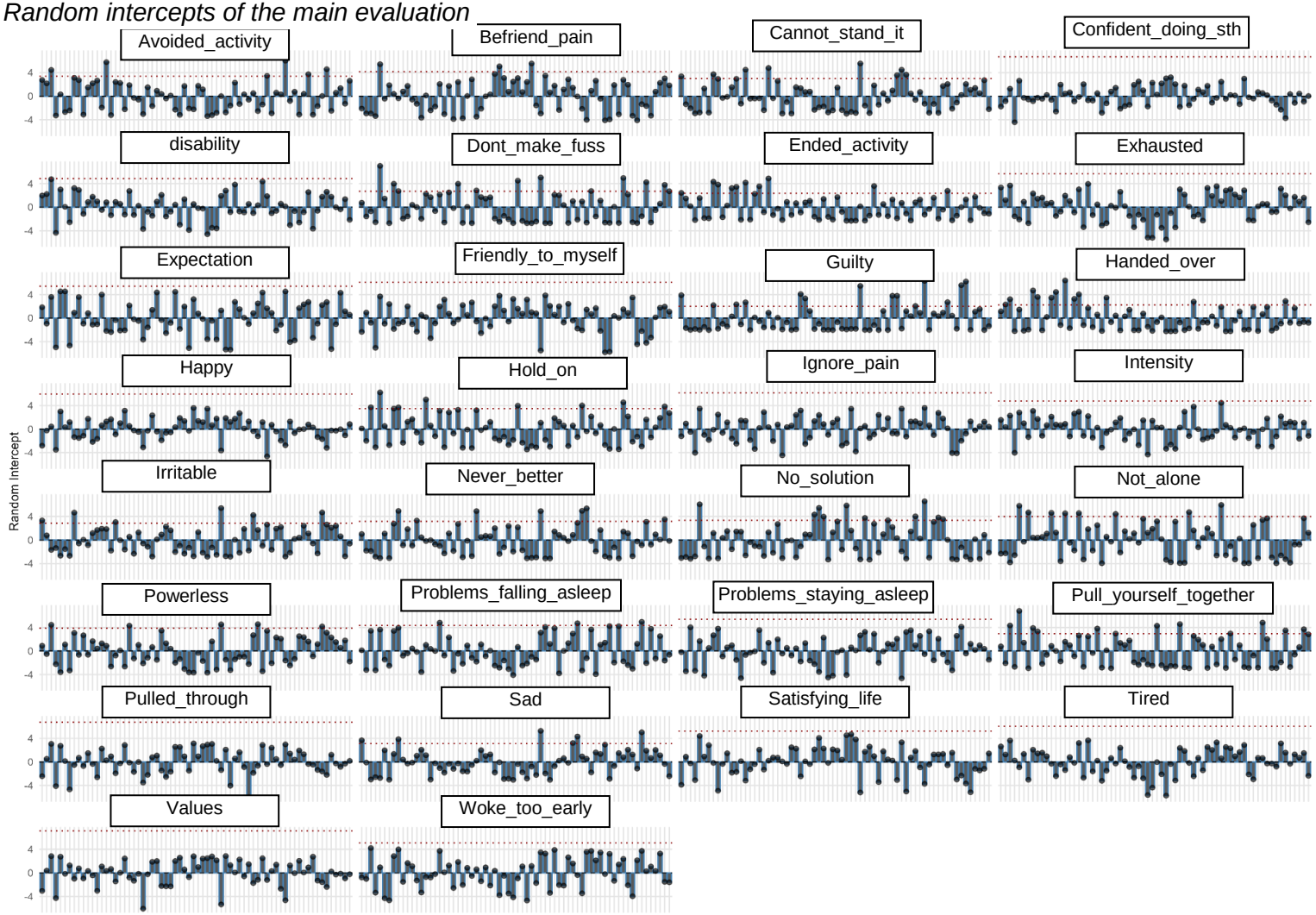
| Item | Fixed Intercept | Standard Deviation Random Intercept |
|---|---|---|
| How strong was your pain on average? | 4.79 | 1.96 |
| I expected to experience pain in the upcoming two hours.* | 5.43 | 2.86 |
| How much did you feel disabled because of your pain? | 4.85 | 2.19 |
| I felt cheerful despite my pain. | 5.94 | 1.79 |
| I pulled through despite my pain. | 6.75 | 2.09 |
| I tried to prioritise those things [examples] really important to me. | 7.09 | 2.09 |
| I tried to be friendly to myself. | 6.08 | 2.41 |
| I told myself that I am not alone with my problems. | 4.00 | 2.93 |
| I trusted myself to be able to do something even though I was in pain. | 6.67 | 1.66 |
| Last night I woke up too early. | 5.24 | 2.67 |
| Last night I had problems falling asleep. | 4.43 | 2.73 |
| Last night I had problems staying asleep. | 5.41 | 2.54 |
| I was tired. | 6.12 | 2.20 |
| I felt guilty. | 2.04 | 2.36 |
| I felt powerless.* | 3.89 | 2.40 |
| I was exhausted. | 5.75 | 2.39 |

| Item | Fixed Intercept | Standard Deviation Random Intercept |
|---|---|---|
| I was irritable. | 2.88 | 2.20 |
| I felt sad. | 3.10 | 2.12 |
| I thought: “It will never get better!” | 3.17 | 2.40 |
| I thought: “I can’t stand it any longer!” | 3.02 | 2.35 |
| I tried to befriend my pain. | 4.14 | 2.65 |
| I could accept that there is no solution for my pain.* | 3.37 | 2.82 |
| I stopped an activity because of my pain.* | 2.38 | 2.04 |
| I avoided at least one activity that causes pain.* | 3.44 | 2.47 |
| Due to my pain I asked others to do a strenuous activity for me.* | 2.30 | 2.20 |
| I thought: “Don’t make such a fuss!”* | 2.74 | 2.57 |
| I thought: “Pull yourself together!”* | 2.98 | 2.65 |
| I thought: “Hold on!” | 2.51 | 2.57 |
| I tried not to think about my pain. | 6.15 | 2.07 |

*Note.* *items were revised for final version; results are valid only for original German version

**Appendix B2.2**

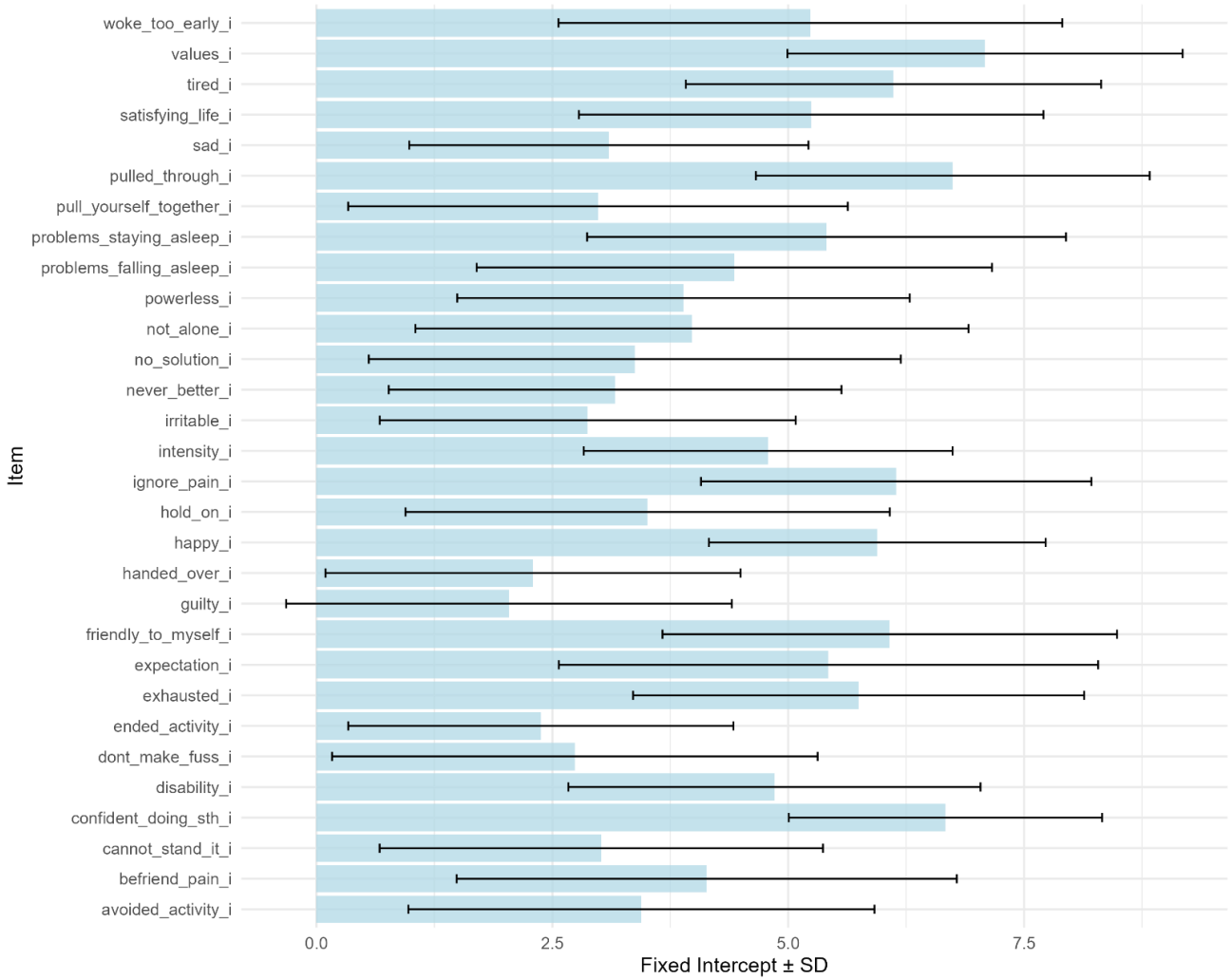
*Random intercepts of the main evaluation*




*Note.* Red dashed line = fixed intercept

## Appendix B2.3

*Fixed intercepts per item of the main evaluation*



## Appendix B3

*Response distributions per item of the main evaluation*

| Item | Response category | Percentage |
|---|---|---|
| intensity_i | 0 | 5.93 |
| intensity_i | 1 | 3.97 |
| intensity_i | 2 | 8.71 |
| intensity_i | 3 | 13.1 |
| intensity_i | 4 | 13.34 |
| intensity_i | 5 | 13.03 |
| intensity_i | 6 | 14.71 |
| intensity_i | 7 | 13.76 |
| intensity_i | 8 | 9.84 |
| intensity_i | 9 | 1.75 |
| intensity_i | 10 | 1.86 |
| expectation_i | 0 | 14.09 |
| expectation_i | 1 | 3.99 |
| expectation_i | 2 | 5.78 |
| expectation_i | 3 | 7.01 |
| expectation_i | 4 | 6.92 |
| expectation_i | 5 | 10.03 |
| expectation_i | 6 | 8.52 |
| expectation_i | 7 | 11.07 |
| expectation_i | 8 | 10.48 |
| expectation_i | 9 | 5.43 |
| expectation_i | 10 | 16.67 |
| disability_i | 0 | 9.96 |
| disability_i | 1 | 4.6 |
| disability_i | 2 | 9.37 |
| disability_i | 3 | 10.62 |
| disability_i | 4 | 9.21 |
| disability_i | 5 | 11.38 |
| disability_i | 6 | 11.85 |
| disability_i | 7 | 12.58 |
| disability_i | 8 | 11.14 |
| disability_i | 9 | 4.04 |
| disability_i | 10 | 5.24 |
| happy_i | 0 | 5.31 |
| happy_i | 1 | 2.24 |
| happy_i | 2 | 5.1 |
| happy_i | 3 | 6.73 |
| happy_i | 4 | 8.05 |
| happy_i | 5 | 12.94 |
| happy_i | 6 | 12.25 |
| happy_i | 7 | 15.86 |
| happy_i | 8 | 13.27 |
| happy_i | 9 | 6.66 |
| happy_i | 10 | 11.59 |
| satisfying_life_i | 0 | 11.78 |
| satisfying_life_i | 1 | 2.5 |
| satisfying_life_i | 2 | 7.46 |
| satisfying_life_i | 3 | 7.46 |
| satisfying_life_i | 4 | 7.18 |
| satisfying_life_i | 5 | 14.59 |
| satisfying_life_i | 6 | 10.36 |
| satisfying_life_i | 7 | 13.22 |
| satisfying_life_i | 8 | 10.29 |
| satisfying_life_i | 9 | 4.96 |
| satisfying_life_i | 10 | 10.2 |
| confident_doing_sth_i | 0 | 5.93 |
| confident_doing_sth_i | 1 | 1.35 |
| confident_doing_sth_i | 2 | 3.19 |
| confident_doing_sth_i | 3 | 4.18 |
| confident_doing_sth_i | 4 | 4.75 |
| confident_doing_sth_i | 5 | 9.42 |
| confident_doing_sth_i | 6 | 11.38 |
| confident_doing_sth_i | 7 | 15.16 |
| confident_doing_sth_i | 8 | 14.47 |
| confident_doing_sth_i | 9 | 9.63 |
| confident_doing_sth_i | 10 | 20.56 |
| pulled_through_i | 0 | 7.15 |
| pulled_through_i | 1 | 1.63 |
| pulled_through_i | 2 | 4.27 |
| pulled_through_i | 3 | 4.58 |
| pulled_through_i | 4 | 4.6 |
| pulled_through_i | 5 | 7.74 |
| pulled_through_i | 6 | 8.24 |
| pulled_through_i | 7 | 11.97 |
| pulled_through_i | 8 | 13.6 |
| pulled_through_i | 9 | 10.48 |
| pulled_through_i | 10 | 25.73 |
| values_i | 0 | 5.34 |
| values_i | 1 | 1.02 |
| values_i | 2 | 2.69 |
| values_i | 3 | 3.54 |
| values_i | 4 | 3.94 |
| values_i | 5 | 6.73 |
| values_i | 6 | 9.75 |
| values_i | 7 | 13.72 |
| values_i | 8 | 15.32 |
| values_i | 9 | 11.14 |
| values_i | 10 | 26.82 |
| friendly_to_myself_i | 0 | 8.12 |
| friendly_to_myself_i | 1 | 1.61 |
| friendly_to_myself_i | 2 | 4.56 |
| friendly_to_myself_i | 3 | 5.26 |
| friendly_to_myself_i | 4 | 6.19 |
| friendly_to_myself_i | 5 | 12.46 |
| friendly_to_myself_i | 6 | 10.32 |
| friendly_to_myself_i | 7 | 13.83 |
| friendly_to_myself_i | 8 | 15.2 |
| friendly_to_myself_i | 9 | 8.62 |
| friendly_to_myself_i | 10 | 13.83 |
| not_alone_i | 0 | 28.92 |
| not_alone_i | 1 | 4.49 |
| not_alone_i | 2 | 7.72 |
| not_alone_i | 3 | 7.32 |
| not_alone_i | 4 | 6.49 |
| not_alone_i | 5 | 10.27 |
| not_alone_i | 6 | 6.37 |
| not_alone_i | 7 | 6.89 |
| not_alone_i | 8 | 8.66 |
| not_alone_i | 9 | 5.85 |
| not_alone_i | 10 | 7.01 |
| woke_too_early_i | 0 | 24.54 |
| woke_too_early_i | 1 | 3.42 |
| woke_too_early_i | 2 | 8.99 |
| woke_too_early_i | 3 | 4.85 |
| woke_too_early_i | 4 | 3.14 |
| woke_too_early_i | 5 | 3.28 |
| woke_too_early_i | 6 | 5.14 |
| woke_too_early_i | 7 | 6.85 |
| woke_too_early_i | 8 | 10.7 |
| woke_too_early_i | 9 | 9.56 |
| woke_too_early_i | 10 | 19.54 |
| problems_staying_asleep_i | 0 | 19.97 |
| problems_staying_asleep_i | 1 | 5.14 |
| problems_staying_asleep_i | 2 | 6.42 |
| problems_staying_asleep_i | 3 | 6.28 |
| problems_staying_asleep_i | 4 | 3.42 |
| problems_staying_asleep_i | 5 | 4.42 |
| problems_staying_asleep_i | 6 | 4.99 |
| problems_staying_asleep_i | 7 | 8.13 |
| problems_staying_asleep_i | 8 | 12.13 |
| problems_staying_asleep_i | 9 | 9.99 |
| problems_staying_asleep_i | 10 | 19.12 |
| problems_falling_asleep_i | 0 | 26.39 |
| problems_falling_asleep_i | 1 | 7.56 |
| problems_falling_asleep_i | 2 | 9.27 |
| problems_falling_asleep_i | 3 | 7.13 |
| problems_falling_asleep_i | 4 | 4.99 |
| problems_falling_asleep_i | 5 | 3.57 |
| problems_falling_asleep_i | 6 | 5.14 |
| problems_falling_asleep_i | 7 | 6.28 |
| problems_falling_asleep_i | 8 | 7.28 |
| problems_falling_asleep_i | 9 | 7.56 |
| problems_falling_asleep_i | 10 | 14.84 |
| tired_i | 0 | 7.11 |
| tired_i | 1 | 2.31 |
| tired_i | 2 | 6.85 |
| tired_i | 3 | 6.52 |
| tired_i | 4 | 6.3 |
| tired_i | 5 | 9.35 |
| tired_i | 6 | 10.34 |
| tired_i | 7 | 11.97 |
| tired_i | 8 | 14.68 |
| tired_i | 9 | 9.3 |
| tired_i | 10 | 15.27 |
| handed_over_i | 0 | 53.9 |
| handed_over_i | 1 | 6.56 |
| handed_over_i | 2 | 6.59 |
| handed_over_i | 3 | 5.41 |
| handed_over_i | 4 | 3.38 |
| handed_over_i | 5 | 5.19 |
| handed_over_i | 6 | 3.56 |
| handed_over_i | 7 | 5.38 |
| handed_over_i | 8 | 3.54 |
| handed_over_i | 9 | 1.7 |
| handed_over_i | 10 | 4.79 |
| dont_make_fuss_i | 0 | 43.91 |
| dont_make_fuss_i | 1 | 6.75 |
| dont_make_fuss_i | 2 | 8.36 |
| dont_make_fuss_i | 3 | 6.75 |
| dont_make_fuss_i | 4 | 4.72 |
| dont_make_fuss_i | 5 | 7.88 |
| dont_make_fuss_i | 6 | 5.24 |
| dont_make_fuss_i | 7 | 5.59 |
| dont_make_fuss_i | 8 | 5.03 |
| dont_make_fuss_i | 9 | 1.65 |
| dont_make_fuss_i | 10 | 4.11 |
| pull_yourself_together_i | 0 | 41.93 |
| pull_yourself_together_i | 1 | 6.73 |
| pull_yourself_together_i | 2 | 7.72 |
| pull_yourself_together_i | 3 | 6.44 |
| pull_yourself_together_i | 4 | 4.67 |
| pull_yourself_together_i | 5 | 7.65 |
| pull_yourself_together_i | 6 | 5.69 |
| pull_yourself_together_i | 7 | 6.02 |
| pull_yourself_together_i | 8 | 5.5 |
| pull_yourself_together_i | 9 | 2.1 |
| pull_yourself_together_i | 10 | 5.55 |
| hold_on_i | 0 | 34.87 |
| hold_on_i | 1 | 6.04 |
| hold_on_i | 2 | 7.81 |
| hold_on_i | 3 | 6.75 |
| hold_on_i | 4 | 5.22 |
| hold_on_i | 5 | 8.9 |
| hold_on_i | 6 | 6.47 |
| hold_on_i | 7 | 7.51 |
| hold_on_i | 8 | 6.59 |
| hold_on_i | 9 | 3.35 |
| hold_on_i | 10 | 6.49 |
| ignore_pain_i | 0 | 7.96 |
| ignore_pain_i | 1 | 1.42 |
| ignore_pain_i | 2 | 5.15 |
| ignore_pain_i | 3 | 5.08 |
| ignore_pain_i | 4 | 6.19 |
| ignore_pain_i | 5 | 10.95 |
| ignore_pain_i | 6 | 11.76 |
| ignore_pain_i | 7 | 13.88 |
| ignore_pain_i | 8 | 15.04 |
| ignore_pain_i | 9 | 7.37 |
| ignore_pain_i | 10 | 15.23 |
| befriend_pain_i | 0 | 24.81 |
| befriend_pain_i | 1 | 3.85 |
| befriend_pain_i | 2 | 7.6 |
| befriend_pain_i | 3 | 7.79 |
| befriend_pain_i | 4 | 7.06 |
| befriend_pain_i | 5 | 9.84 |
| befriend_pain_i | 6 | 10.55 |
| befriend_pain_i | 7 | 11.02 |
| befriend_pain_i | 8 | 8.64 |
| befriend_pain_i | 9 | 3.07 |
| befriend_pain_i | 10 | 5.76 |
| no_solution_i | 0 | 33.47 |
| no_solution_i | 1 | 6.26 |
| no_solution_i | 2 | 9.47 |
| no_solution_i | 3 | 8.59 |
| no_solution_i | 4 | 5.17 |
| no_solution_i | 5 | 9.28 |
| no_solution_i | 6 | 5.59 |
| no_solution_i | 7 | 7.27 |
| no_solution_i | 8 | 6.44 |
| no_solution_i | 9 | 2.55 |
| no_solution_i | 10 | 5.9 |
| ended_activity_i | 0 | 49.55 |
| ended_activity_i | 1 | 7.06 |
| ended_activity_i | 2 | 7.55 |
| ended_activity_i | 3 | 6.52 |
| ended_activity_i | 4 | 4.67 |
| ended_activity_i | 5 | 5.71 |
| ended_activity_i | 6 | 4.89 |
| ended_activity_i | 7 | 5.12 |
| ended_activity_i | 8 | 3.59 |
| ended_activity_i | 9 | 1.53 |
| ended_activity_i | 10 | 3.8 |
| avoided_activity_i | 0 | 40.08 |
| avoided_activity_i | 1 | 5.26 |
| avoided_activity_i | 2 | 5.57 |
| avoided_activity_i | 3 | 5.67 |
| avoided_activity_i | 4 | 4.3 |
| avoided_activity_i | 5 | 7.03 |
| avoided_activity_i | 6 | 6.33 |
| avoided_activity_i | 7 | 7.72 |
| avoided_activity_i | 8 | 7.27 |
| avoided_activity_i | 9 | 2.76 |
| avoided_activity_i | 10 | 8 |

**Appendix B4**

*German ProCEss item set*

Wie sehr trafen die folgenden Aussagen seit der letzten Befragung auf Sie zu? (0 = trifft überhaupt nicht zu, 10 = trifft voll und ganz zu)

Katastrophisieren:

1. Ich habe gedacht: „Es wird nie mehr besser!“

2. Ich habe gedacht: „Ich halte es nicht mehr aus!“

Vermeidung:

3. Ich habe Aktivitäten wegen meiner Schmerzen abgebrochen.

4. Ich habe anstrengende Tätigkeiten wegen meiner Schmerzen an jemand anderen abgegeben.

5. Ich habe Aktivitäten, die Schmerzen hervorrufen, vermieden.

Depression:

6. Ich war gereizt.

7. Ich habe mich schuldig gefühlt.

8. Ich habe mich traurig gefühlt.

9. Ich habe mich antriebslos gefühlt.

10. Ich war erschöpft.

Akzeptanz:

11. Ich habe versucht, mich mit meinen Schmerzen anzufreunden.

12. Ich konnte annehmen, dass der Schmerz mein Leben begleiten wird.

Werteorientiertes Handeln:

13. Ich habe versucht, den Dingen, die mir wirklich wichtig sind, Vorrang zu geben.

Erwartungen:

14. Ich gehe davon aus, dass meine Schmerzen bis zur nächsten Befragung zunehmen.

Schmerzintensität:

15. Wie stark waren Ihre Schmerzen im Durchschnitt? (0 = keine Schmerzen, 10 = maximal vorstellbare Schmerzen)

Beeinträchtigung:

16. Wie sehr haben Sie sich durch Ihre Schmerzen beeinträchtigt gefühlt? (0 = überhaupt nicht, 10 = sehr stark)

Gedankenunterdrückung:

17. Ich habe gedacht: „Reiß‘ dich zusammen!“/“Stell‘ dich nicht so an!“

18. Ich habe versucht, meine Schmerzen nicht zu beachten.

Aufgabenausdauer:

19. Ich habe trotz meiner Schmerzen durchgezogen.

Positiver Affekt:

20. Ich war trotz meiner Schmerzen gut gelaunt.

Selbstwirksamkeit:

21. Ich habe mir zugetraut, etwas erledigen zu können, obwohl ich Schmerzen habe.

22. Ich war sicher, mein Leben zufriedenstellend führen zu können, obwohl ich Schmerzen habe.

Selbstmitgefühl:

23. Ich habe versucht, freundlich mit mir umzugehen.

24. Ich habe mir gesagt, dass ich mit meinen Problemen nicht allein bin.

Negativer Affekt:

25. Ich habe mich geschämt.

## Appendix B5.1

*Random intercepts per participant of the preliminary re-evaluation*

| ID | intercept | item |
|---|---|---|
| 1 | -2.464131952 | expectation |
| 2 | 1.30137052 | expectation |
| 3 | 2.162555342 | expectation |
| 4 | 0.9520836 | expectation |
| 5 | 2.152354667 | expectation |
| 6 | 2.170538035 | expectation |
| 7 | 1.650181927 | expectation |
| 8 | -2.823553128 | expectation |
| 9 | -2.278155214 | expectation |
| 10 | -2.823243796 | expectation |
| 1 | 3.596433329 | ended_activities |
| 2 | 2.045856888 | ended_activities |
| 3 | -0.530515349 | ended_activities |
| 4 | 0.074433295 | ended_activities |
| 5 | -1.512351948 | ended_activities |
| 6 | 2.498803487 | ended_activities |
| 7 | -0.737727287 | ended_activities |
| 8 | -2.491452136 | ended_activities |
| 9 | -0.62429861 | ended_activities |
| 10 | -2.319181669 | ended_activities |
| 1 | 4.106590707 | handed_over |
| 2 | 1.915506033 | handed_over |
| 3 | -0.254758464 | handed_over |
| 4 | 1.037533762 | handed_over |
| 5 | -1.449077597 | handed_over |
| 6 | -0.20198902 | handed_over |
| 7 | 1.225979908 | handed_over |
| 8 | -2.041429789 | handed_over |
| 9 | -2.208194291 | handed_over |
| 10 | -2.130161248 | handed_over |
| 1 | 1.809238053 | avoided_activities |
| 2 | 1.822971794 | avoided_activities |
| 3 | -0.632313571 | avoided_activities |
| 4 | 0.796399106 | avoided_activities |
| 5 | -1.198361196 | avoided_activities |
| 6 | 2.353159563 | avoided_activities |
| 7 | 0.034282249 | avoided_activities |
| 8 | -2.14250195 | avoided_activities |
| 9 | -0.471156189 | avoided_activities |
| 10 | -2.371717859 | avoided_activities |
| 1 | 3.915741937 | listless |
| 2 | -0.377098729 | listless |
| 3 | 2.407087997 | listless |
| 4 | -2.405141001 | listless |
| 5 | 1.074492455 | listless |
| 6 | -5.576520449 | listless |
| 7 | -3.855940538 | listless |
| 8 | 1.366330898 | listless |
| 9 | 3.2471338 | listless |
| 10 | 0.20391363 | listless |
| 1 | 0.538995257 | pull_together_no_fuss |
| 2 | -0.992607464 | pull_together_no_fuss |
| 3 | 0.784774825 | pull_together_no_fuss |
| 4 | -1.899744458 | pull_together_no_fuss |
| 5 | 2.680169501 | pull_together_no_fuss |
| 6 | 0.370041297 | pull_together_no_fuss |
| 7 | 3.269649549 | pull_together_no_fuss |
| 8 | -4.638652614 | pull_together_no_fuss |
| 9 | 4.183139881 | pull_together_no_fuss |
| 10 | -4.295765774 | pull_together_no_fuss |
| 1 | 3.410651746 | pain_accompanies |
| 2 | -0.697819754 | pain_accompanies |
| 3 | 2.281361529 | pain_accompanies |
| 4 | -2.226880663 | pain_accompanies |
| 5 | -3.665498033 | pain_accompanies |
| 6 | -0.104376817 | pain_accompanies |
| 7 | 2.350987406 | pain_accompanies |
| 8 | 0.161721054 | pain_accompanies |
| 9 | -0.511685461 | pain_accompanies |
| 10 | -0.998461008 | pain_accompanies |
| 1 | 3.784824593 | ashamed |
| 2 | 0.004206744 | ashamed |
| 3 | -1.303961241 | ashamed |
| 4 | -1.46176262 | ashamed |
| 5 | -1.311189916 | ashamed |
| 6 | -1.505546338 | ashamed |
| 7 | -1.151342563 | ashamed |
| 8 | -1.514529039 | ashamed |
| 9 | 5.973693688 | ashamed |
| 10 | -1.514393307 | ashamed |

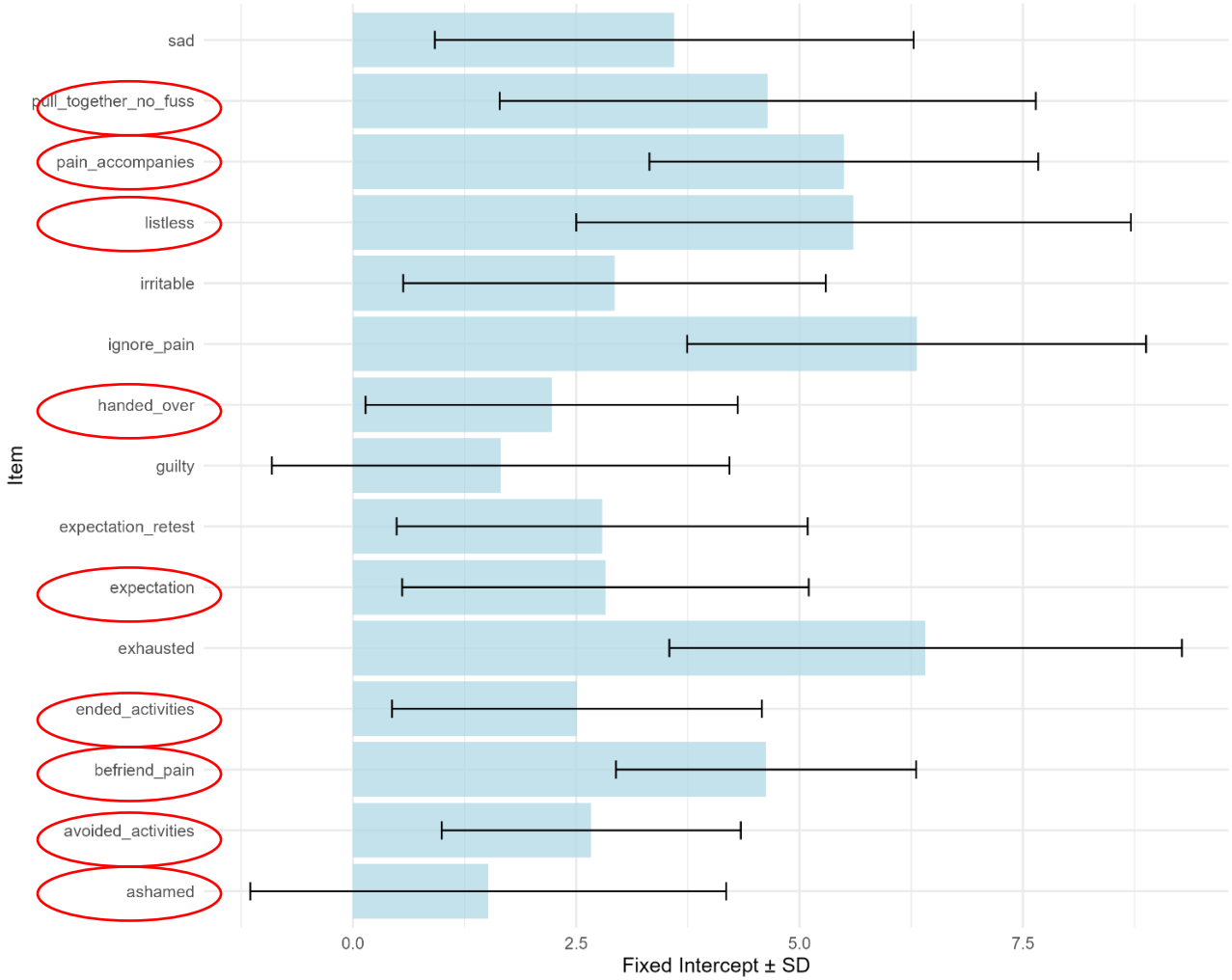
**Appendix B5.2**

*Fixed and Random Intercepts of preliminary evaluation of revised items*

| Item | Fixed Intercept | Standard Deviation Random Intercept |
|---|---|---|
| I assume that my pain will increase until the next survey. | 2.83 | 2.28 |
| I ended activities because of my pain. | 2.51 | 2.30 |
| Due to my pain I asked others to do strenuous activities for me. | 2.22 | 2.08 |
| I avoided activities that cause pain. | 2.67 | 1.67 |
| I felt listless. | 5.61 | 3.11 |
| I thought: “Pull yourself together!”/”Don’t make such a fuss!” | 4.65 | 3.00 |
| I was able to accept that the pain would accompany my life. | 5.50 | 2.18 |
| I felt ashamed. | 1.52 | 2.66 |

**Appendix B5.3**

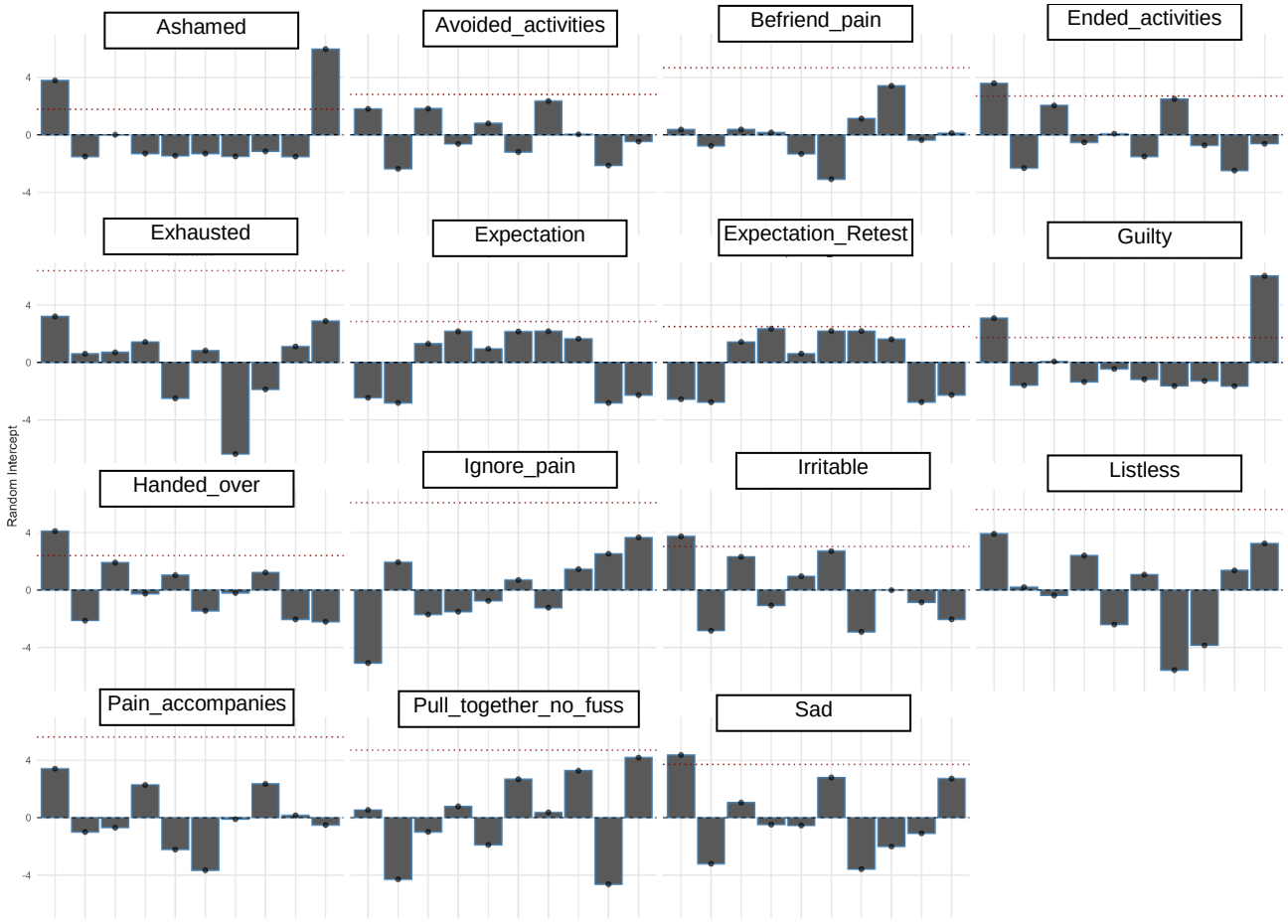
*Fixed intercepts of re-evaluated items*




*Note.* Revised Items are circled

**Appendix B5.4**

*Random intercepts of re-evaluated items*




*Note.* Revised items: pull_together_no_fuss (thought suppression), pain_accompanies (acceptance), listless (depressive symptoms), handed_over (avoidance), expectation, ended_activities (avoidance), avoided_activities (avoidance), ashamed (negative affect); red dashed line = fixed intercept

**Appendix B6**

*Response distributions in prelimnary re-evaluation*

| | | | | | |
|---|---|---|---|---|---|
| expectation | 0 | 32.93 | listless | 0 | 12.31 |
| expectation | 1 | 4.64 | listless | 1 | 6.08 |
| expectation | 2 | 5.76 | listless | 2 | 6.31 |
| expectation | 3 | 6.87 | listless | 3 | 4.48 |
| expectation | 4 | 9.35 | listless | 4 | 4.96 |
| expectation | 5 | 33.89 | listless | 5 | 5.92 |
| expectation | 6 | 5.04 | listless | 6 | 9.83 |
| expectation | 7 | 1.2 | listless | 7 | 11.83 |
| expectation | 8 | 0.32 | listless | 8 | 20.14 |
| ended_activities | 0 | 27.98 | listless | 9 | 4.48 |
| ended_activities | 1 | 9.03 | listless | 10 | 13.67 |
| ended_activities | 2 | 18.94 | pull_together_no_fuss | 0 | 15.67 |
| ended_activities | 3 | 7.43 | pull_together_no_fuss | 1 | 2.88 |
| ended_activities | 4 | 4.08 | pull_together_no_fuss | 2 | 5.68 |
| ended_activities | 5 | 19.74 | pull_together_no_fuss | 3 | 7.91 |
| ended_activities | 6 | 6.31 | pull_together_no_fuss | 4 | 5.52 |
| ended_activities | 7 | 4.48 | pull_together_no_fuss | 5 | 27.66 |
| ended_activities | 8 | 1.36 | pull_together_no_fuss | 6 | 6.08 |
| ended_activities | 9 | 0.32 | pull_together_no_fuss | 7 | 10.47 |
| ended_activities | 10 | 0.32 | pull_together_no_fuss | 8 | 7.51 |
| handed_over | 0 | 31.57 | pull_together_no_fuss | 9 | 3.68 |
| handed_over | 1 | 6.63 | pull_together_no_fuss | 10 | 6.95 |
| handed_over | 2 | 29.58 | pain_accompanies | 0 | 1.52 |
| handed_over | 3 | 5.76 | pain_accompanies | 1 | 2.4 |
| handed_over | 4 | 5.92 | pain_accompanies | 2 | 5.36 |
| handed_over | 5 | 5.84 | pain_accompanies | 3 | 10.55 |
| handed_over | 6 | 4.24 | pain_accompanies | 4 | 7.99 |
| handed_over | 7 | 5.92 | pain_accompanies | 5 | 27.58 |
| handed_over | 8 | 3.44 | pain_accompanies | 6 | 9.11 |
| handed_over | 9 | 0.88 | pain_accompanies | 7 | 5.84 |
| handed_over | 10 | 0.24 | pain_accompanies | 8 | 19.58 |
| avoided_activities | 0 | 22.78 | pain_accompanies | 9 | 5.2 |
| avoided_activities | 1 | 9.11 | pain_accompanies | 10 | 4.88 |
| avoided_activities | 2 | 20.14 | ashamed | 0 | 56.46 |
| avoided_activities | 3 | 9.35 | ashamed | 1 | 13.1 |
| avoided_activities | 4 | 6.55 | ashamed | 2 | 6.02 |
| avoided_activities | 5 | 21.98 | ashamed | 3 | 1.15 |
| avoided_activities | 6 | 5.2 | ashamed | 4 | 1.59 |
| avoided_activities | 7 | 3.2 | ashamed | 5 | 8.58 |
| avoided_activities | 8 | 1.44 | ashamed | 6 | 4.51 |
| avoided_activities | 10 | 0.24 | ashamed | 7 | 2.74 |
| | | | ashamed | 8 | 1.77 |
| | | | ashamed | 9 | 0.44 |
| | | | ashamed | 10 | 3.63 |

**Appendix B7.1**

*Evaluation outcomes of randomly selected half of the data*

| Construct/items | *Mean* | *Within SD* | *SD Random intercept* | *Min* | *Max* | *ICC* |
|---|---|---|---|---|---|---|
| **Catastrophising** | | | | | | |
| I thought: “It will never get better!” | 3.20 | 1.73 | 2.44 | 0 | 10 | 0.60 |
| I thought: “I can’t stand it any longer!” | 3.04 | 1.91 | 2.35 | 0 | 10 | 0.55 |
| **Avoidance** | | | | | | |
| I ended an activity because of my pain. | 2.37 | 2.01 | 2.04 | 0 | 10 | 0.45 |
| Due to my pain I asked others to do a strenuous activity for me. | 2.28 | 1.89 | 2.24 | 0 | 10 | 0.50 |
| I avoided an activity that causes pain. | 3.45 | 2.30 | 2.51 | 0 | 10 | 0.49 |
| **Depressive symptoms** | | | | | | |
| I felt irritable. | 2.88 | 1.75 | 2.24 | 0 | 10 | 0.57 |
| I felt guilty. | 2.05 | 1.26 | 2.38 | 0 | 10 | 0.68 |
| I felt sad. | 3.15 | 1.92 | 2.13 | 0 | 10 | 0.50 |
| I felt powerless. | 3.89 | 1.99 | 2.42 | 0 | 10 | 0.57 |
| I was exhausted. | 5.78 | 1.90 | 2.41 | 0 | 10 | 0.59 |
| **Thought suppression** | | | | | | |
| I thought: “Hold on!” | 3.44 | 2.02 | 2.56 | 0 | 10 | 0.58 |
| I thought: “Pull yourself together!” | 2.92 | 1.61 | 2.64 | 0 | 10 | 0.65 |
| I thought: “Don’t make such a fuss!” | 2.70 | 1.50 | 2.53 | 0 | 10 | 0.65 |
| I tried not to think about my pain. | 6.12 | 1.94 | 2.08 | 0 | 10 | 0.49 |
| **Task persistence (I pulled through despite my pain.)** | 6.72 | 2.01 | 2.14 | 0 | 10 | 0.47 |
| **Positive Affect (I felt cheerful despite my pain.)** | 5.92 | 1.95 | 1.81 | 0 | 10 | 0.43 |

| Construct/items | *Mean* | *Within SD* | *SD Random intercept* | *Min* | *Max* | *ICC* |
|---|---|---|---|---|---|---|
| **Acceptance** | | | | | | |
| I tried to befriend my pain. | 4.11 | 1.70 | 2.63 | 0 | 10 | 0.66 |
| I could accept that there is no solution for my pain. | 3.38 | 1.37 | 2.85 | 0 | 10 | 0.75 |
| **Values (I tried to prioritise those things really important to me.)** | 7.11 | 1.68 | 2.07 | 0 | 10 | 0.54 |
| **Expectations (I expected to experience pain in the next two hours.)** | 5.40 | 1.61 | 2.88 | 0 | 10 | 0.72 |
| **Self-efficacy** | | | | | | |
| I trusted myself to be able to do something even though I was in pain. | 6.65 | 2.07 | 1.71 | 0 | 10 | 0.36 |
| I was sure I could lead my life satisfactorily even though I was in pain. | 5.23 | 1.51 | 2.46 | 0 | 10 | 0.67 |
| **Self-compassion** | | | | | | |
| I tried to be friendly to myself. | 6.06 | 1.57 | 2.42 | 0 | 10 | 0.66 |
| I told myself that I am not alone with my problems. | 3.96 | 1.58 | 2.93 | 0 | 10 | 0.73 |
| **Intensity (How strong was your pain on average?)** | 4.77 | 1.36 | 1.97 | 0 | 10 | 0.65 |
| **Disability (How much did you feel disabled because of your pain?)** | 4.86 | 1.76 | 2.22 | 0 | 10 | 0.60 |

**Appendix B7.2**

*Evaluation outcomes with every second datapoint*

| Construct/items | *Mean* | *Within SD* | *SD Random intercept* | *Min* | *Max* | *ICC* |
|---|---|---|---|---|---|---|
| **Catastrophising** | | | | | | |
| I thought: “It will never get better!” | 3.13 | 1.75 | 2.41 | 0 | 10 | 0.59 |
| I thought: “I can’t stand it any longer!” | 2.99 | 1.90 | 2.37 | 0 | 10 | 0.55 |
| **Avoidance** | | | | | | |
| I ended an activity because of my pain. | 2.33 | 2.00 | 2.06 | 0 | 10 | 0.45 |
| Due to my pain I asked others to do a strenuous activity for me. | 2.27 | 1.99 | 2.20 | 0 | 10 | 0.48 |
| I avoided an activity that causes pain. | 3.43 | 2.41 | 2.43 | 0 | 10 | 0.46 |
| **Depressive symptoms** | | | | | | |
| I felt irritable. | 2.88 | 1.79 | 2.21 | 0 | 10 | 0.55 |
| I felt guilty. | 2.01 | 1.24 | 2.37 | 0 | 10 | 0.69 |
| I felt sad. | 3.01 | 1.93 | 2.11 | 0 | 10 | 0.49 |
| I felt powerless. | 3.92 | 2.06 | 2.40 | 0 | 10 | 0.56 |
| I was exhausted. | 5.70 | 1.97 | 2.38 | 0 | 10 | 0.56 |
| **Thought suppression** | | | | | | |
| I thought: “Hold on!” | 3.43 | 2.10 | 2.52 | 0 | 10 | 0.55 |
| I thought: “Pull yourself together!” | 2.90 | 1.72 | 2.58 | 0 | 10 | 0.62 |
| I thought: “Don’t make such a fuss!” | 2.68 | 1.54 | 2.54 | 0 | 10 | 0.65 |
| I tried not to think about my pain. | 6.15 | 1.95 | 2.02 | 0 | 10 | 0.47 |
| **Task persistence (I pulled through despite my pain.)** | 6.76 | 2.09 | 2.03 | 0 | 10 | 0.44 |
| **Positive Affect (I felt cheerful despite my pain.)** | 5.94 | 1.98 | 1.76 | 0 | 10 | 0.41 |

| Construct/items | *Mean* | *Within SD* | *SD Random intercept* | *Min* | *Max* | *ICC* |
|---|---|---|---|---|---|---|
| **Acceptance** | | | | | | |
| I tried to befriend my pain. | 4.14 | 1.65 | 2.65 | 0 | 10 | 0.67 |
| I could accept that there is no solution for my pain. | 3.35 | 1.43 | 2.81 | 0 | 10 | 0.75 |
| **Values (I tried to prioritise those things really important to me.)** | 7.13 | 1.67 | 2.12 | 0 | 10 | 0.56 |
| **Expectations (I expected to experience pain in the next two hours.)** | 5.45 | 1.66 | 2.80 | 0 | 10 | 0.71 |
| **Self-efficacy** | | | | | | |
| I trusted myself to be able to do something even though I was in pain. | 6.76 | 2.11 | 1.60 | 0 | 10 | 0.32 |
| I was sure I could lead my life satisfactorily even though I was in pain. | 5.26 | 1.51 | 2.44 | 0 | 10 | 0.65 |
| **Self-compassion** | | | | | | |
| I tried to be friendly to myself. | 6.12 | 1.63 | 2.38 | 0 | 10 | 0.64 |
| I told myself that I am not alone with my problems. | 4.00 | 1.56 | 2.93 | 0 | 10 | 0.73 |
| **Intensity (How strong was your pain on average?)** | 4.73 | 1.38 | 1.93 | 0 | 10 | 0.64 |
| **Disability (How much did you feel disabled because of your pain?)** | 4.84 | 1.78 | 2.18 | 0 | 10 | 0.58 |

**Appendix B7.3**

*Evaluation outcomes with one randomly selected datapoint per day*

| Construct/items | *Mean* | *Within SD* | *SD Random intercept* | *Min* | *Max* | *ICC* |
|---|---|---|---|---|---|---|
| **Catastrophising** | | | | | | |
| I thought: “It will never get better!” | 3.23 | 1.65 | 2.54 | 0 | 10 | 0.63 |
| I thought: “I can’t stand it any longer!” | 3.15 | 1.81 | 2.47 | 0 | 10 | 0.58 |
| **Avoidance** | | | | | | |
| I ended an activity because of my pain. | 2.38 | 1.95 | 2.03 | 0 | 10 | 0.43 |
| Due to my pain I asked others to do a strenuous activity for me. | 2.27 | 1.82 | 2.16 | 0 | 10 | 0.48 |
| I avoided an activity that causes pain. | 3.42 | 2.15 | 2.53 | 0 | 10 | 0.51 |
| **Depressive symptoms** | | | | | | |
| I felt irritable. | 2.93 | 1.78 | 2.17 | 0 | 10 | 0.53 |
| I felt guilty. | 2.05 | 1.18 | 2.34 | 0 | 10 | 0.68 |
| I felt sad. | 3.26 | 1.92 | 2.19 | 0 | 10 | 0.51 |
| I felt powerless. | 3.89 | 2.01 | 2.36 | 0 | 10 | 0.55 |
| I was exhausted. | 5.78 | 1.87 | 2.43 | 0 | 10 | 0.58 |
| **Thought suppression** | | | | | | |
| I thought: “Hold on!” | 3.51 | 2.01 | 2.53 | 0 | 10 | 0.55 |
| I thought: “Pull yourself together!” | 2.99 | 1.60 | 2.64 | 0 | 10 | 0.63 |
| I thought: “Don’t make such a fuss!” | 2.71 | 1.41 | 2.56 | 0 | 10 | 0.66 |
| I tried not to think about my pain. | 6.17 | 1.80 | 2.04 | 0 | 10 | 0.51 |
| **Task persistence (I pulled through despite my pain.)** | 6.79 | 2.01 | 2.07 | | | 0.45 |
| **Positive Affect (I felt cheerful despite my pain.)** | 5.91 | 1.94 | 1.75 | 0 | 10 | 0.42 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Acceptance** | | | | | | |
| I tried to befriend my pain. | 4.12 | 1.71 | 2.59 | 0 | 10 | 0.64 |
| I could accept that there is no solution for my pain. | 3.33 | 1.39 | 2.77 | 0 | 10 | 0.73 |
| **Values (I tried to prioritise those things really important to me.)** | 7.11 | 1.74 | 1.98 | 0 | 10 | 0.49 |
| **Expectations (I expected to experience pain in the next two hours.)** | 5.44 | 1.51 | 2.87 | 0 | 10 | 0.73 |
| **Self-efficacy** | | | | | | |
| I trusted myself to be able to do something even though I was in pain. | 6.64 | 2.05 | 1.60 | 0 | 10 | 0.33 |
| I was sure I could lead my life satisfactorily even though I was in pain. | 5.28 | 1.47 | 2.46 | 0 | 10 | 0.66 |
| **Self-compassion** | | | | | | |
| I tried to be friendly to myself. | 6.05 | 1.42 | 2.42 | 0 | 10 | 0.69 |
| I told myself that I am not alone with my problems. | 3.96 | 1.48 | 2.89 | 0 | 10 | 0.73 |
| **Intensity (How strong was your pain on average?)** | 4.82 | 1.31 | 1.98 | 0 | 10 | 0.67 |
| **Disability (How much did you feel disabled because of your pain?)** | 4.93 | 1.72 | 2.26 | 0 | 10 | 0.61 |

## Appendix B8.1

*Within standard deviations per participant of the main evaluation*

| ID | item | within_sd | ID | item | within_sd | ID | item | within_sd |
|---|---|---|---|---|---|---|---|---|
| 1 | avoided_activity_i | 1.675127713 | 23 | avoided_activity_i | 0.881345284 | 46 | avoided_activity_i | 2.09494897 |
| 1 | befriend_pain_i | 1.662484095 | 23 | befriend_pain_i | 0.917827731 | 46 | befriend_pain_i | 0.917074501 |
| 1 | cannot_stand_it_i | 1.867179627 | 23 | cannot_stand_it_i | 2.362235655 | 46 | cannot_stand_it_i | 2.272773892 |
| 1 | confident_doing_sth_i | 2.204776648 | 23 | confident_doing_sth_i | 2.48187623 | 46 | confident_doing_sth_i | 0.915548163 |
| 1 | disability_i | 1.942370916 | 23 | disability_i | 1.808513175 | 46 | disability_i | 0.822186521 |
| 1 | dont_make_fuss_i | 1.685781268 | 23 | dont_make_fuss_i | 2.325845734 | 46 | dont_make_fuss_i | 0 |
| 1 | ended_activity_i | 2.191396025 | 23 | ended_activity_i | 0.98690764 | 46 | ended_activity_i | 0.172733407 |
| 1 | exhausted_i | 0.998720409 | 23 | exhausted_i | 2.426163101 | 46 | exhausted_i | 1.018706159 |
| 1 | expectation_i | 1.636903904 | 23 | expectation_i | 1.736759609 | 46 | expectation_i | 0.240434727 |
| 1 | friendly_to_myself_i | 2.108117708 | 23 | friendly_to_myself_i | 1.121208405 | 46 | friendly_to_myself_i | 0.172733407 |
| 1 | guilty_i | 2.363764535 | 23 | guilty_i | 0 | 46 | guilty_i | 0.123091491 |
| 1 | handed_over_i | 2.506343189 | 23 | handed_over_i | 1.677220066 | 46 | handed_over_i | 1.262420807 |
| 1 | happy_i | 1.739540659 | 23 | happy_i | 1.92446597 | 46 | happy_i | 1.434587731 |
| 1 | hold_on_i | 1.848826268 | 23 | hold_on_i | 2.44287425 | 46 | hold_on_i | 3.212918272 |
| 1 | ignore_pain_i | 1.681603992 | 23 | ignore_pain_i | 1.61473853 | 46 | ignore_pain_i | 1.426767092 |
| 1 | intensity_i | 1.434563005 | 23 | intensity_i | 1.063614811 | 46 | intensity_i | 0.457264594 |
| 1 | irritable_i | 1.575602565 | 23 | irritable_i | 1.269970538 | 46 | irritable_i | 0.615457455 |
| 1 | never_better_i | 2.348840203 | 23 | never_better_i | 2.171976833 | 46 | never_better_i | 0 |
| 1 | no_solution_i | 0.601575085 | 23 | no_solution_i | 1.184697756 | 46 | no_solution_i | 0.749203151 |
| 1 | not_alone_i | 1.616332877 | 23 | not_alone_i | 1.58113883 | 46 | not_alone_i | 0.266637528 |
| 1 | powerless_i | 1.659019113 | 23 | powerless_i | 2.032702986 | 46 | powerless_i | 2.416387332 |
| 1 | problems_falling_asleep_i | 1.507556723 | 23 | problems_falling_asleep_i | 2.442055766 | 46 | problems_falling_asleep_i | 0.717740563 |
| 1 | problems_staying_asleep_i | 2.227921983 | 23 | problems_staying_asleep_i | 3.144981572 | 46 | problems_staying_asleep_i | 0.426401433 |
| 1 | pull_yourself_together_i | 1.808028887 | 23 | pull_yourself_together_i | 2.220252707 | 46 | pull_yourself_together_i | 1.112757134 |
| 1 | pulled_through_i | 2.424653147 | 23 | pulled_through_i | 2.462298908 | 46 | pulled_through_i | 0.813636689 |
| 1 | sad_i | 2.127941022 | 23 | sad_i | 0.184059224 | 46 | sad_i | 1.969996391 |
| 1 | satisfying_life_i | 1.408929022 | 23 | satisfying_life_i | 1.277214339 | 46 | satisfying_life_i | 0.540439258 |
| 1 | tired_i | 1.246991264 | 23 | tired_i | 2.54380854 | 46 | tired_i | 0.248069469 |
| 1 | values_i | 2.212881762 | 23 | values_i | 2.178928956 | 46 | values_i | 0.123091491 |
| 1 | woke_too_early_i | 2.766684921 | 23 | woke_too_early_i | 3.585323619 | 46 | woke_too_early_i | 0.717740563 |
| 2 | avoided_activity_i | 2.821313457 | 24 | avoided_activity_i | 1.940354854 | 47 | avoided_activity_i | 2.758656262 |
| 2 | befriend_pain_i | 1.752538387 | 24 | befriend_pain_i | 0.828943893 | 47 | befriend_pain_i | 0.985852514 |
| 2 | cannot_stand_it_i | 3.059778129 | 24 | cannot_stand_it_i | 1.223803846 | 47 | cannot_stand_it_i | 0.635502193 |
| 2 | confident_doing_sth_i | 2.911210303 | 24 | confident_doing_sth_i | 1.804727251 | 47 | confident_doing_sth_i | 2.31245625 |
| 2 | disability_i | 2.196097688 | 24 | disability_i | 1.603567451 | 47 | disability_i | 2.101882596 |
| 2 | dont_make_fuss_i | 2.380568703 | 24 | dont_make_fuss_i | 0.470861115 | 47 | dont_make_fuss_i | 0 |
| 2 | ended_activity_i | 2.646300911 | 24 | ended_activity_i | 1.98896083 | 47 | ended_activity_i | 2.053872763 |
| 2 | exhausted_i | 3.087478336 | 24 | exhausted_i | 2.067721845 | 47 | exhausted_i | 1.761454423 |
| 2 | expectation_i | 2.184811277 | 24 | expectation_i | 0.655044625 | 47 | expectation_i | 0.170213933 |
| 2 | friendly_to_myself_i | 2.592345238 | 24 | friendly_to_myself_i | 0.91329151 | 47 | friendly_to_myself_i | 1.208689638 |
| 2 | guilty_i | 2.217246471 | 24 | guilty_i | 0.62749757 | 47 | guilty_i | 0 |
| 2 | handed_over_i | 3.36093368 | 24 | handed_over_i | 1.978118912 | 47 | handed_over_i | 1.60681986 |
| 2 | happy_i | 2.099079398 | 24 | happy_i | 1.689551033 | 47 | happy_i | 1.701107422 |
| 2 | hold_on_i | 2.748587445 | 24 | hold_on_i | 0.573791836 | 47 | hold_on_i | 1.520708674 |
| 2 | ignore_pain_i | 2.603591467 | 24 | ignore_pain_i | 0.97773472 | 47 | ignore_pain_i | 1.024180865 |
| 2 | intensity_i | 1.105847158 | 24 | intensity_i | 1.103919378 | 47 | intensity_i | 1.199941468 |
| 2 | irritable_i | 2.267886774 | 24 | irritable_i | 1.822513808 | 47 | irritable_i | 0 |
| 2 | never_better_i | 1.998677511 | 24 | never_better_i | 0.79746141 | 47 | never_better_i | 0 |
| 2 | no_solution_i | 1.766139597 | 24 | no_solution_i | 0.861356769 | 47 | no_solution_i | 0 |
| 2 | not_alone_i | 2.396950733 | 24 | not_alone_i | 0.668584032 | 47 | not_alone_i | 0.677462341 |
| 2 | powerless_i | 2.743387801 | 24 | powerless_i | 1.376230074 | 47 | powerless_i | 1.162027232 |
| 2 | problems_falling_asleep_i | 3.928528138 | 24 | problems_falling_asleep_i | 3.203927514 | 47 | problems_falling_asleep_i | 3.22772084 |
| 2 | problems_staying_asleep_i | 3.43996124 | 24 | problems_staying_asleep_i | 2.774341309 | 47 | problems_staying_asleep_i | 3.202271921 |
| 2 | pull_yourself_together_i | 2.501453834 | 24 | pull_yourself_together_i | 0.304430503 | 47 | pull_yourself_together_i | 0.121267813 |
| 2 | pulled_through_i | 2.72423753 | 24 | pulled_through_i | 1.726869669 | 47 | pulled_through_i | 2.676065344 |
| 2 | sad_i | 2.531713186 | 24 | sad_i | 1.373623223 | 47 | sad_i | 0 |
| 2 | satisfying_life_i | 1.92872741 | 24 | satisfying_life_i | 1.148029769 | 47 | satisfying_life_i | 1.718246345 |
| 2 | tired_i | 3.239799107 | 24 | tired_i | 1.688944807 | 47 | tired_i | 1.65612705 |
| 2 | values_i | 2.964803226 | 24 | values_i | 1.827563887 | 47 | values_i | 1.721118121 |
| 2 | woke_too_early_i | 2.592724864 | 24 | woke_too_early_i | 2.662876094 | 47 | woke_too_early_i | 3.23615934 |
| 3 | avoided_activity_i | 1.807694544 | 25 | avoided_activity_i | 1.706963822 | 48 | avoided_activity_i | 2.440884951 |
| 3 | befriend_pain_i | 1.602423029 | 25 | befriend_pain_i | 1.594844636 | 48 | befriend_pain_i | 2.192650174 |
| 3 | cannot_stand_it_i | 0.12803688 | 25 | cannot_stand_it_i | 1.290994449 | 48 | cannot_stand_it_i | 2.682606268 |
| 3 | confident_doing_sth_i | 4.58495997 | 25 | confident_doing_sth_i | 1.205217416 | 48 | confident_doing_sth_i | 2.270307409 |
| 3 | disability_i | 1.903548599 | 25 | disability_i | 1.360219129 | 48 | disability_i | 1.593015145 |
| 3 | dont_make_fuss_i | 0.25607376 | 25 | dont_make_fuss_i | 2.443398469 | 48 | dont_make_fuss_i | 2.315298648 |
| 3 | ended_activity_i | 1.152331919 | 25 | ended_activity_i | 1.406985374 | 48 | ended_activity_i | 2.655013013 |
| 3 | exhausted_i | 2.478431551 | 25 | exhausted_i | 1.071557415 | 48 | exhausted_i | 3.076370606 |
| 3 | expectation_i | 2.599075077 | 25 | expectation_i | 1.237644822 | 48 | expectation_i | 1.648192961 |
| 3 | friendly_to_myself_i | 1.648645743 | 25 | friendly_to_myself_i | 1.055331934 | 48 | friendly_to_myself_i | 2.186243586 |
| 3 | guilty_i | 0.538668669 | 25 | guilty_i | 0.966903284 | 48 | guilty_i | 1.855221516 |
| 3 | handed_over_i | 0.309238444 | 25 | handed_over_i | 1.431850578 | 48 | handed_over_i | 2.602767937 |
| 3 | happy_i | 3.845585078 | 25 | happy_i | 1.24080935 | 48 | happy_i | 2.255974599 |

| ID | item | within_sd | ID | item | within_sd | ID | item | within_sd |
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| 3 | hold_on_i | 1.550603619 | 25 | hold_on_i | 1.669331203 | 48 | hold_on_i | 2.653031084 |
| 3 | ignore_pain_i | 3.475519382 | 25 | ignore_pain_i | 1.796292478 | 48 | ignore_pain_i | 2.41452356 |
| 3 | intensity_i | 1.917278353 | 25 | intensity_i | 0.513351158 | 48 | intensity_i | 1.668808287 |
| 3 | irritable_i | 2.690298295 | 25 | irritable_i | 1.254950979 | 48 | irritable_i | 2.621450872 |
| 3 | never_better_i | 0.909572649 | 25 | never_better_i | 1.020188372 | 48 | never_better_i | 2.324996936 |
| 3 | no_solution_i | 1.195848922 | 25 | no_solution_i | 1.594844636 | 48 | no_solution_i | 2.3839518 |
| 3 | not_alone_i | 0 | 25 | not_alone_i | 0.668624576 | 48 | not_alone_i | 2.09184216 |
| 3 | powerless_i | 2.392040536 | 25 | powerless_i | 2.092751262 | 48 | powerless_i | 3.058460208 |
| 3 | problems_falling_asleep_i | 3.741657387 | 25 | problems_falling_asleep_i | 0.483045892 | 48 | problems_falling_asleep_i | 2.203303305 |
| 3 | problems_staying_asleep_i | 4.486089611 | 25 | problems_staying_asleep_i | 0.699205899 | 48 | problems_staying_asleep_i | 2.500908926 |
| 3 | pull_yourself_together_i | 0.685525605 | 25 | pull_yourself_together_i | 2.008218409 | 48 | pull_yourself_together_i | 2.429725327 |
| 3 | pulled_through_i | 4.472807947 | 25 | pulled_through_i | 1.189496516 | 48 | pulled_through_i | 2.770597903 |
| 3 | sad_i | 2.277473435 | 25 | sad_i | 1.104358566 | 48 | sad_i | 3.188139182 |
| 3 | satisfying_life_i | 4.496446685 | 25 | satisfying_life_i | 0.795576003 | 48 | satisfying_life_i | 1.784405465 |
| 3 | tired_i | 2.57446477 | 25 | tired_i | 0.665685553 | 48 | tired_i | 3.021547399 |
| 3 | values_i | 2.478541789 | 25 | values_i | 1.081756016 | 48 | values_i | 1.595398116 |
| 3 | woke_too_early_i | 3.39905449 | 25 | woke_too_early_i | 0.699205899 | 48 | woke_too_early_i | 0.522232968 |
| 4 | avoided_activity_i | 2.625598305 | 26 | avoided_activity_i | 2.359193975 | 49 | avoided_activity_i | 2.993341971 |
| 4 | befriend_pain_i | 2.608278507 | 26 | befriend_pain_i | 2.56447829 | 49 | befriend_pain_i | 2.082435704 |
| 4 | cannot_stand_it_i | 1.557220008 | 26 | cannot_stand_it_i | 1.651389274 | 49 | cannot_stand_it_i | 1.937112244 |
| 4 | confident_doing_sth_i | 1.647889543 | 26 | confident_doing_sth_i | 2.714622557 | 49 | confident_doing_sth_i | 2.427506635 |
| 4 | disability_i | 2.331738867 | 26 | disability_i | 2.061273375 | 49 | disability_i | 2.11769105 |
| 4 | dont_make_fuss_i | 0.121267813 | 26 | dont_make_fuss_i | 0.650337657 | 49 | dont_make_fuss_i | 3.660469705 |
| 4 | ended_activity_i | 0.990184488 | 26 | ended_activity_i | 2.839087858 | 49 | ended_activity_i | 2.338330272 |
| 4 | exhausted_i | 1.215480337 | 26 | exhausted_i | 2.837734902 | 49 | exhausted_i | 2.773067588 |
| 4 | expectation_i | 1.408303483 | 26 | expectation_i | 2.450534702 | 49 | expectation_i | 1.948001935 |
| 4 | friendly_to_myself_i | 1.495310199 | 26 | friendly_to_myself_i | 2.315490258 | 49 | friendly_to_myself_i | 2.198885207 |
| 4 | guilty_i | 0 | 26 | guilty_i | 1.317105548 | 49 | guilty_i | 0 |
| 4 | handed_over_i | 0.5106418 | 26 | handed_over_i | 2.444886615 | 49 | handed_over_i | 1.904195772 |
| 4 | happy_i | 1.737554517 | 26 | happy_i | 1.702532676 | 49 | happy_i | 1.958340153 |
| 4 | hold_on_i | 3.075006156 | 26 | hold_on_i | 1.539046326 | 49 | hold_on_i | 3.838506821 |
| 4 | ignore_pain_i | 3.08764993 | 26 | ignore_pain_i | 2.598396449 | 49 | ignore_pain_i | 2.178015151 |
| 4 | intensity_i | 1.433559272 | 26 | intensity_i | 1.372877499 | 49 | intensity_i | 1.835153525 |
| 4 | irritable_i | 0.398361438 | 26 | irritable_i | 2.180887985 | 49 | irritable_i | 1.492448943 |
| 4 | never_better_i | 2.029198625 | 26 | never_better_i | 2.213282068 | 49 | never_better_i | 2.68077199 |
| 4 | no_solution_i | 1.212587623 | 26 | no_solution_i | 1.69590332 | 49 | no_solution_i | 1.780908368 |
| 4 | not_alone_i | 2.220257521 | 26 | not_alone_i | 1.851778459 | 49 | not_alone_i | 1.752470783 |
| 4 | powerless_i | 0.771530297 | 26 | powerless_i | 2.205982649 | 49 | powerless_i | 2.215873677 |
| 4 | problems_falling_asleep_i | 0 | 26 | problems_falling_asleep_i | 3.745367509 | 49 | problems_falling_asleep_i | 0.666666667 |
| 4 | problems_staying_asleep_i | 1.864744682 | 26 | problems_staying_asleep_i | 2.758824226 | 49 | problems_staying_asleep_i | 2.934469477 |
| 4 | pull_yourself_together_i | 1.864600219 | 26 | pull_yourself_together_i | 0.932707712 | 49 | pull_yourself_together_i | 3.589514645 |
| 4 | pulled_through_i | 0.269539327 | 26 | pulled_through_i | 1.244342034 | 49 | pulled_through_i | 2.214788582 |
| 4 | sad_i | 0 | 26 | sad_i | 2.283985521 | 49 | sad_i | 2.839030848 |
| 4 | satisfying_life_i | 1.877913306 | 26 | satisfying_life_i | 2.5419169 | 49 | satisfying_life_i | 1.718395943 |
| 4 | tired_i | 1.780972005 | 26 | tired_i | 3.050270064 | 49 | tired_i | 2.290553343 |
| 4 | values_i | 0.293326416 | 26 | values_i | 1.328524354 | 49 | values_i | 1.558167069 |
| 4 | woke_too_early_i | 1.775250729 | 26 | woke_too_early_i | 4.55521679 | 49 | woke_too_early_i | 3.140240614 |
| 5 | avoided_activity_i | 3.148871017 | 27 | avoided_activity_i | 2.085120446 | 50 | avoided_activity_i | 3.672402274 |
| 5 | befriend_pain_i | 1.499603332 | 27 | befriend_pain_i | 1.316725573 | 50 | befriend_pain_i | 1.211523199 |
| 5 | cannot_stand_it_i | 1.666860556 | 27 | cannot_stand_it_i | 1.874989177 | 50 | cannot_stand_it_i | 2.947619639 |
| 5 | confident_doing_sth_i | 0.875061379 | 27 | confident_doing_sth_i | 1.720672626 | 50 | confident_doing_sth_i | 1.668860735 |
| 5 | disability_i | 1.759539986 | 27 | disability_i | 1.600324642 | 50 | disability_i | 2.505570717 |
| 5 | dont_make_fuss_i | 1.636766879 | 27 | dont_make_fuss_i | 2.112424593 | 50 | dont_make_fuss_i | 0.248069469 |
| 5 | ended_activity_i | 2.729909547 | 27 | ended_activity_i | 1.940595035 | 50 | ended_activity_i | 2.235315328 |
| 5 | exhausted_i | 1.834290569 | 27 | exhausted_i | 0.639602149 | 50 | exhausted_i | 1.102226767 |
| 5 | expectation_i | 2.252503161 | 27 | expectation_i | 1.997075784 | 50 | expectation_i | 3.239851017 |
| 5 | friendly_to_myself_i | 1.399932007 | 27 | friendly_to_myself_i | 1.331803776 | 50 | friendly_to_myself_i | 1.001681279 |
| 5 | guilty_i | 2.136101511 | 27 | guilty_i | 1.334361076 | 50 | guilty_i | 0 |
| 5 | handed_over_i | 1.955885774 | 27 | handed_over_i | 2.118486963 | 50 | handed_over_i | 3.2697624 |
| 5 | happy_i | 1.562127798 | 27 | happy_i | 1.525433726 | 50 | happy_i | 1.77224868 |
| 5 | hold_on_i | 2.000859149 | 27 | hold_on_i | 1.754770862 | 50 | hold_on_i | 1.818309655 |
| 5 | ignore_pain_i | 1.897979666 | 27 | ignore_pain_i | 1.464626188 | 50 | ignore_pain_i | 1.462347954 |
| 5 | intensity_i | 1.234635879 | 27 | intensity_i | 1.589637711 | 50 | intensity_i | 1.361030435 |
| 5 | irritable_i | 1.874217623 | 27 | irritable_i | 1.736450328 | 50 | irritable_i | 1.073500743 |
| 5 | never_better_i | 1.656358037 | 27 | never_better_i | 1.490663584 | 50 | never_better_i | 2.828257142 |
| 5 | no_solution_i | 1.345714156 | 27 | no_solution_i | 1.500541028 | 50 | no_solution_i | 1.436475387 |
| 5 | not_alone_i | 1.670346722 | 27 | not_alone_i | 1.741771005 | 50 | not_alone_i | 2.314980478 |
| 5 | powerless_i | 1.989395471 | 27 | powerless_i | 2.413974467 | 50 | powerless_i | 2.274651284 |
| 5 | problems_falling_asleep_i | 3.876567783 | 27 | problems_falling_asleep_i | 1.870828693 | 50 | problems_falling_asleep_i | 3.573047252 |
| 5 | problems_staying_asleep_i | 3.278719262 | 27 | problems_staying_asleep_i | 2.692582404 | 50 | problems_staying_asleep_i | 2.043961296 |
| 5 | pull_yourself_together_i | 1.683983718 | 27 | pull_yourself_together_i | 2.240057397 | 50 | pull_yourself_together_i | 0.390389352 |
| 5 | pulled_through_i | 2.159185854 | 27 | pulled_through_i | 2.276859879 | 50 | pulled_through_i | 1.973989518 |
| 5 | sad_i | 2.209780672 | 27 | sad_i | 1.264782718 | 50 | sad_i | 2.075729714 |
| 5 | satisfying_life_i | 0.743738182 | 27 | satisfying_life_i | 1.463739207 | 50 | satisfying_life_i | 1.601831884 |
| 5 | tired_i | 2.33956384 | 27 | tired_i | 0.596254543 | 50 | tired_i | 1.116958439 |

| ID | item | within_sd | ID | item | within_sd | ID | item | within_sd |
|---|---|---|---|---|---|---|---|---|
| 5 | values_i | 1.36396163 | 27 | values_i | 1.995368013 | 50 | values_i | 1.02914266 |
| 5 | woke_too_early_i | 1.6414763 | 27 | woke_too_early_i | 2.397915762 | 50 | woke_too_early_i | 3.047767854 |
| 6 | avoided_activity_i | 2.7254773 | 28 | avoided_activity_i | 2.630014682 | 51 | avoided_activity_i | 2.242632039 |
| 6 | befriend_pain_i | 2.921267119 | 28 | befriend_pain_i | 0.935165312 | 51 | befriend_pain_i | 1.337792183 |
| 6 | cannot_stand_it_i | 2.383133225 | 28 | cannot_stand_it_i | 1.983419888 | 51 | cannot_stand_it_i | 1.522483391 |
| 6 | confident_doing_sth_i | 3.038926558 | 28 | confident_doing_sth_i | 1.436077589 | 51 | confident_doing_sth_i | 1.560479811 |
| 6 | disability_i | 1.907887606 | 28 | disability_i | 1.758975798 | 51 | disability_i | 1.871614235 |
| 6 | dont_make_fuss_i | 2.300274824 | 28 | dont_make_fuss_i | 2.068195521 | 51 | dont_make_fuss_i | 1.515784581 |
| 6 | ended_activity_i | 2.893598942 | 28 | ended_activity_i | 2.003568245 | 51 | ended_activity_i | 2.193695997 |
| 6 | exhausted_i | 2.241509196 | 28 | exhausted_i | 2.202060018 | 51 | exhausted_i | 1.511451838 |
| 6 | expectation_i | 1.844956107 | 28 | expectation_i | 1.582840176 | 51 | expectation_i | 1.422822314 |
| 6 | friendly_to_myself_i | 3.014560801 | 28 | friendly_to_myself_i | 1.420349008 | 51 | friendly_to_myself_i | 1.532993099 |
| 6 | guilty_i | 2.635069424 | 28 | guilty_i | 1.08213423 | 51 | guilty_i | 1.857788865 |
| 6 | handed_over_i | 2.768940679 | 28 | handed_over_i | 1.75219472 | 51 | handed_over_i | 2.639761375 |
| 6 | happy_i | 2.517846746 | 28 | happy_i | 1.979187779 | 51 | happy_i | 2.154271681 |
| 6 | hold_on_i | 2.452355482 | 28 | hold_on_i | 2.068996216 | 51 | hold_on_i | 1.619225292 |
| 6 | ignore_pain_i | 2.615337688 | 28 | ignore_pain_i | 1.618027324 | 51 | ignore_pain_i | 1.596014938 |
| 6 | intensity_i | 1.621302439 | 28 | intensity_i | 1.365729619 | 51 | intensity_i | 1.925571218 |
| 6 | irritable_i | 2.561962593 | 28 | irritable_i | 1.248104152 | 51 | irritable_i | 1.847168307 |
| 6 | never_better_i | 2.46854665 | 28 | never_better_i | 1.309307341 | 51 | never_better_i | 1.821028978 |
| 6 | no_solution_i | 3.14082691 | 28 | no_solution_i | 1.793477947 | 51 | no_solution_i | 1.36125225 |
| 6 | not_alone_i | 3.038637639 | 28 | not_alone_i | 2.146594395 | 51 | not_alone_i | 1.761824432 |
| 6 | powerless_i | 2.083843953 | 28 | powerless_i | 2.242493806 | 51 | powerless_i | 1.976798942 |
| 6 | problems_falling_asleep_i | 3.036145882 | 28 | problems_falling_asleep_i | 2.050498831 | 51 | problems_falling_asleep_i | 1.80403588 |
| 6 | problems_staying_asleep_i | 3.443043052 | 28 | problems_staying_asleep_i | 2.570225789 | 51 | problems_staying_asleep_i | 2.618118686 |
| 6 | pull_yourself_together_i | 2.357948469 | 28 | pull_yourself_together_i | 2.127606184 | 51 | pull_yourself_together_i | 1.540791646 |
| 6 | pulled_through_i | 2.546667157 | 28 | pulled_through_i | 2.601520498 | 51 | pulled_through_i | 2.362931739 |
| 6 | sad_i | 2.117022028 | 28 | sad_i | 2.116483665 | 51 | sad_i | 2.027847736 |
| 6 | satisfying_life_i | 2.91927535 | 28 | satisfying_life_i | 1.076763804 | 51 | satisfying_life_i | 1.439257057 |
| 6 | tired_i | 1.688675289 | 28 | tired_i | 2.546625258 | 51 | tired_i | 1.369863664 |
| 6 | values_i | 2.556645355 | 28 | values_i | 1.561705284 | 51 | values_i | 1.869921889 |
| 6 | woke_too_early_i | 3.717281509 | 28 | woke_too_early_i | 3.604500554 | 51 | woke_too_early_i | 3.098386677 |
| 7 | avoided_activity_i | 3.830614978 | 29 | avoided_activity_i | 2.134254793 | 52 | avoided_activity_i | 2.207490855 |
| 7 | befriend_pain_i | 1.423216651 | 29 | befriend_pain_i | 0.79746141 | 52 | befriend_pain_i | 3.110242934 |
| 7 | cannot_stand_it_i | 2.46221445 | 29 | cannot_stand_it_i | 1.284632873 | 52 | cannot_stand_it_i | 3.85188961 |
| 7 | confident_doing_sth_i | 1.694997308 | 29 | confident_doing_sth_i | 0.877260083 | 52 | confident_doing_sth_i | 2.935821456 |
| 7 | disability_i | 2.267732155 | 29 | disability_i | 1.266367496 | 52 | disability_i | 3.090564237 |
| 7 | dont_make_fuss_i | 2.365215853 | 29 | dont_make_fuss_i | 0.782227052 | 52 | dont_make_fuss_i | 1.6687487 |
| 7 | ended_activity_i | 2.922273522 | 29 | ended_activity_i | 1.679977568 | 52 | ended_activity_i | 1.859125925 |
| 7 | exhausted_i | 2.401584712 | 29 | exhausted_i | 1.054092553 | 52 | exhausted_i | 1.159737073 |
| 7 | expectation_i | 1.050203117 | 29 | expectation_i | 0.877551871 | 52 | expectation_i | 1.104531611 |
| 7 | friendly_to_myself_i | 1.510462848 | 29 | friendly_to_myself_i | 0.883657159 | 52 | friendly_to_myself_i | 2.693135012 |
| 7 | guilty_i | 2.524286792 | 29 | guilty_i | 0.72091141 | 52 | guilty_i | 4.341995692 |
| 7 | handed_over_i | 2.515773651 | 29 | handed_over_i | 2.089154693 | 52 | handed_over_i | 2.612356171 |
| 7 | happy_i | 2.021462224 | 29 | happy_i | 1.102991324 | 52 | happy_i | 3.732631737 |
| 7 | hold_on_i | 2.195775164 | 29 | hold_on_i | 0.959497223 | 52 | hold_on_i | 3.379993367 |
| 7 | ignore_pain_i | 1.315354983 | 29 | ignore_pain_i | 0.887704023 | 52 | ignore_pain_i | 3.366759487 |
| 7 | intensity_i | 1.474653578 | 29 | intensity_i | 0.966674612 | 52 | intensity_i | 2.260721808 |
| 7 | irritable_i | 2.350225842 | 29 | irritable_i | 1.654486987 | 52 | irritable_i | 4.222453915 |
| 7 | never_better_i | 2.216404836 | 29 | never_better_i | 0.759308171 | 52 | never_better_i | 4.028143798 |
| 7 | no_solution_i | 0.64779847 | 29 | no_solution_i | 0.650337657 | 52 | no_solution_i | 3.508174977 |
| 7 | not_alone_i | 1.555121467 | 29 | not_alone_i | 0.668584032 | 52 | not_alone_i | 2.714187812 |
| 7 | powerless_i | 2.181269472 | 29 | powerless_i | 1.378089092 | 52 | powerless_i | 2.211083194 |
| 7 | problems_falling_asleep_i | 4.366539438 | 29 | problems_falling_asleep_i | 1.452966315 | 52 | problems_falling_asleep_i | 0.687551651 |
| 7 | problems_staying_asleep_i | 3.951089864 | 29 | problems_staying_asleep_i | 1.224744871 | 52 | problems_staying_asleep_i | 3.466724941 |
| 7 | pull_yourself_together_i | 2.378600028 | 29 | pull_yourself_together_i | 0.684851821 | 52 | pull_yourself_together_i | 1.886078383 |
| 7 | pulled_through_i | 2.171240593 | 29 | pulled_through_i | 0.919437928 | 52 | pulled_through_i | 3.70886834 |
| 7 | sad_i | 2.480029362 | 29 | sad_i | 1.124598125 | 52 | sad_i | 3.541106398 |
| 7 | satisfying_life_i | 1.474317168 | 29 | satisfying_life_i | 0.646784951 | 52 | satisfying_life_i | 2.487219315 |
| 7 | tired_i | 2.679840969 | 29 | tired_i | 0.912730692 | 52 | tired_i | 0.908377019 |
| 7 | values_i | 2.228457275 | 29 | values_i | 0.655044625 | 52 | values_i | 3.586204553 |
| 7 | woke_too_early_i | 3.142893218 | 29 | woke_too_early_i | 1.118033989 | 52 | woke_too_early_i | 4.750119616 |
| 8 | avoided_activity_i | 3.924896466 | 30 | avoided_activity_i | 1.038924963 | 53 | avoided_activity_i | 3.599575204 |
| 8 | befriend_pain_i | 2.001123429 | 30 | befriend_pain_i | 1.648035748 | 53 | befriend_pain_i | 3.545507544 |
| 8 | cannot_stand_it_i | 2.742616645 | 30 | cannot_stand_it_i | 1.181873681 | 53 | cannot_stand_it_i | 4.090869256 |
| 8 | confident_doing_sth_i | 3.842758132 | 30 | confident_doing_sth_i | 0.972718127 | 53 | confident_doing_sth_i | 2.370170086 |
| 8 | disability_i | 2.280965311 | 30 | disability_i | 1.396477286 | 53 | disability_i | 2.1444796 |
| 8 | dont_make_fuss_i | 3.060166971 | 30 | dont_make_fuss_i | 1.188152494 | 53 | dont_make_fuss_i | 4.808275897 |
| 8 | ended_activity_i | 3.171461852 | 30 | ended_activity_i | 1.280868846 | 53 | ended_activity_i | 4.335664647 |
| 8 | exhausted_i | 2.530041605 | 30 | exhausted_i | 1.708986519 | 53 | exhausted_i | 2.751184124 |
| 8 | expectation_i | 1.859487656 | 30 | expectation_i | 1.416666667 | 53 | expectation_i | 0.798388719 |
| 8 | friendly_to_myself_i | 1.136970657 | 30 | friendly_to_myself_i | 1.253566341 | 53 | friendly_to_myself_i | 3.940605312 |
| 8 | guilty_i | 0 | 30 | guilty_i | 1.295596939 | 53 | guilty_i | 1.325193126 |
| 8 | handed_over_i | 3.422944944 | 30 | handed_over_i | 1.157703666 | 53 | handed_over_i | 4.270152835 |
| 8 | happy_i | 2.277426995 | 30 | happy_i | 1.912521397 | 53 | happy_i | 3.254218745 |

| ID | item | within_sd | ID | item | within_sd | ID | item | within_sd |
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| 8 | hold_on_i | 2.384785638 | 30 | hold_on_i | 1.467150218 | 53 | hold_on_i | 4.255189754 |
| 8 | ignore_pain_i | 1.806621583 | 30 | ignore_pain_i | 1.181768751 | 53 | ignore_pain_i | 1.393286577 |
| 8 | intensity_i | 1.569220739 | 30 | intensity_i | 1.100031565 | 53 | intensity_i | 1.097830309 |
| 8 | irritable_i | 0.247675604 | 30 | irritable_i | 1.724516841 | 53 | irritable_i | 3.229018327 |
| 8 | never_better_i | 1.943204678 | 30 | never_better_i | 1.407797869 | 53 | never_better_i | 3.68388737 |
| 8 | no_solution_i | 1.837099316 | 30 | no_solution_i | 1.511857892 | 53 | no_solution_i | 3.083283937 |
| 8 | not_alone_i | 1.164883682 | 30 | not_alone_i | 1.139892608 | 53 | not_alone_i | 0.166633129 |
| 8 | powerless_i | 2.966408088 | 30 | powerless_i | 1.768047529 | 53 | powerless_i | 1.900968725 |
| 8 | problems_falling_asleep_i | 4.129714936 | 30 | problems_falling_asleep_i | 2.544155513 | 53 | problems_falling_asleep_i | 2.886751346 |
| 8 | problems_staying_asleep_i | 4.445631155 | 30 | problems_staying_asleep_i | 2.049390153 | 53 | problems_staying_asleep_i | 0.866025404 |
| 8 | pull_yourself_together_i | 2.944219659 | 30 | pull_yourself_together_i | 1.422257874 | 53 | pull_yourself_together_i | 4.999919516 |
| 8 | pulled_through_i | 3.196416886 | 30 | pulled_through_i | 1.66189794 | 53 | pulled_through_i | 1.679920473 |
| 8 | sad_i | 2.442354977 | 30 | sad_i | 1.660031435 | 53 | sad_i | 3.786771425 |
| 8 | satisfying_life_i | 1.84542827 | 30 | satisfying_life_i | 1.17809033 | 53 | satisfying_life_i | 3.105197823 |
| 8 | tired_i | 2.135544421 | 30 | tired_i | 2.075700303 | 53 | tired_i | 2.661673729 |
| 8 | values_i | 3.409167347 | 30 | values_i | 1.157703666 | 53 | values_i | 1.702761398 |
| 8 | woke_too_early_i | 4.480259733 | 30 | woke_too_early_i | 1.250454463 | 53 | woke_too_early_i | 3.369875459 |
| 9 | avoided_activity_i | 1.747556809 | 31 | avoided_activity_i | 3.143137023 | 54 | avoided_activity_i | 2.898086801 |
| 9 | befriend_pain_i | 1.736936715 | 31 | befriend_pain_i | 1.58905817 | 54 | befriend_pain_i | 0.458078667 |
| 9 | cannot_stand_it_i | 1.563261114 | 31 | cannot_stand_it_i | 0.131306433 | 54 | cannot_stand_it_i | 2.4908576 |
| 9 | confident_doing_sth_i | 1.843908891 | 31 | confident_doing_sth_i | 1.984589754 | 54 | confident_doing_sth_i | 2.413984756 |
| 9 | disability_i | 1.631175792 | 31 | disability_i | 2.322266557 | 54 | disability_i | 1.776285804 |
| 9 | dont_make_fuss_i | 1.952544335 | 31 | dont_make_fuss_i | 0 | 54 | dont_make_fuss_i | 0.525835271 |
| 9 | ended_activity_i | 1.640242507 | 31 | ended_activity_i | 2.328250449 | 54 | ended_activity_i | 2.05471602 |
| 9 | exhausted_i | 2.20803617 | 31 | exhausted_i | 2.615741819 | 54 | exhausted_i | 1.57351717 |
| 9 | expectation_i | 1.707411561 | 31 | expectation_i | 1.880665468 | 54 | expectation_i | 1.427099163 |
| 9 | friendly_to_myself_i | 1.631175792 | 31 | friendly_to_myself_i | 0.899182932 | 54 | friendly_to_myself_i | 1.231862955 |
| 9 | guilty_i | 1.469078654 | 31 | guilty_i | 0 | 54 | guilty_i | 1.105376824 |
| 9 | handed_over_i | 1.952544335 | 31 | handed_over_i | 2.847186871 | 54 | handed_over_i | 0 |
| 9 | happy_i | 1.228084724 | 31 | happy_i | 1.573371886 | 54 | happy_i | 1.10784584 |
| 9 | hold_on_i | 1.921040208 | 31 | hold_on_i | 1.014116932 | 54 | hold_on_i | 2.061354004 |
| 9 | ignore_pain_i | 1.566871005 | 31 | ignore_pain_i | 2.252175127 | 54 | ignore_pain_i | 1.142808352 |
| 9 | intensity_i | 1.059127666 | 31 | intensity_i | 1.441330971 | 54 | intensity_i | 1.324423784 |
| 9 | irritable_i | 1.601111902 | 31 | irritable_i | 0.131306433 | 54 | irritable_i | 1.937126484 |
| 9 | never_better_i | 2.404033804 | 31 | never_better_i | 0.877389573 | 54 | never_better_i | 1.899813048 |
| 9 | no_solution_i | 2.009230114 | 31 | no_solution_i | 2.848249056 | 54 | no_solution_i | 1.284629606 |
| 9 | not_alone_i | 2.300270188 | 31 | not_alone_i | 2.909192307 | 54 | not_alone_i | 1.31863483 |
| 9 | powerless_i | 2.161815517 | 31 | powerless_i | 2.841497437 | 54 | powerless_i | 1.000546299 |
| 9 | problems_falling_asleep_i | 2.493628244 | 31 | problems_falling_asleep_i | 4.389516732 | 54 | problems_falling_asleep_i | 1.513574937 |
| 9 | problems_staying_asleep_i | 2.533413077 | 31 | problems_staying_asleep_i | 4.276179871 | 54 | problems_staying_asleep_i | 2.683281573 |
| 9 | pull_yourself_together_i | 1.975842808 | 31 | pull_yourself_together_i | 0 | 54 | pull_yourself_together_i | 0.402858638 |
| 9 | pulled_through_i | 1.305680765 | 31 | pulled_through_i | 2.193387742 | 54 | pulled_through_i | 2.160499841 |
| 9 | sad_i | 1.401774501 | 31 | sad_i | 2.499909254 | 54 | sad_i | 1.155173679 |
| 9 | satisfying_life_i | 1.74957622 | 31 | satisfying_life_i | 1.502166212 | 54 | satisfying_life_i | 0.662830493 |
| 9 | tired_i | 2.314959945 | 31 | tired_i | 2.224608016 | 54 | tired_i | 1.544247213 |
| 9 | values_i | 1.273258199 | 31 | values_i | 1.444789541 | 54 | values_i | 1.503729426 |
| 9 | woke_too_early_i | 2.423371056 | 31 | woke_too_early_i | 4.274091382 | 54 | woke_too_early_i | 2.136266922 |
| 10 | avoided_activity_i | 2.855654374 | 32 | avoided_activity_i | 3.428158194 | 55 | avoided_activity_i | 1.816004499 |
| 10 | befriend_pain_i | 1.166845672 | 32 | befriend_pain_i | 1.18214177 | 55 | befriend_pain_i | 2.224662038 |
| 10 | cannot_stand_it_i | 1.233919118 | 32 | cannot_stand_it_i | 1.901379765 | 55 | cannot_stand_it_i | 3.175123006 |
| 10 | confident_doing_sth_i | 2.03309091 | 32 | confident_doing_sth_i | 1.530986657 | 55 | confident_doing_sth_i | 3.823463275 |
| 10 | disability_i | 1.128909248 | 32 | disability_i | 1.751759983 | 55 | disability_i | 2.490314262 |
| 10 | dont_make_fuss_i | 1.042637392 | 32 | dont_make_fuss_i | 1.77645078 | 55 | dont_make_fuss_i | 3.922467837 |
| 10 | ended_activity_i | 3.227583188 | 32 | ended_activity_i | 3.470600751 | 55 | ended_activity_i | 0.291729983 |
| 10 | exhausted_i | 1.772457054 | 32 | exhausted_i | 2.04812044 | 55 | exhausted_i | 1.488780116 |
| 10 | expectation_i | 1.255064927 | 32 | expectation_i | 0.500453515 | 55 | expectation_i | 2.813835252 |
| 10 | friendly_to_myself_i | 1.133340705 | 32 | friendly_to_myself_i | 1.287475148 | 55 | friendly_to_myself_i | 1.5454867 |
| 10 | guilty_i | 0.852168103 | 32 | guilty_i | 0.378250182 | 55 | guilty_i | 2.592239182 |
| 10 | handed_over_i | 3.548094197 | 32 | handed_over_i | 3.800093927 | 55 | handed_over_i | 0 |
| 10 | happy_i | 1.212404558 | 32 | happy_i | 1.85670903 | 55 | happy_i | 1.667005824 |
| 10 | hold_on_i | 1.477271413 | 32 | hold_on_i | 1.536803984 | 55 | hold_on_i | 3.309504715 |
| 10 | ignore_pain_i | 1.112978798 | 32 | ignore_pain_i | 1.376933827 | 55 | ignore_pain_i | 1.827936159 |
| 10 | intensity_i | 0.789181232 | 32 | intensity_i | 1.361913888 | 55 | intensity_i | 1.503618823 |
| 10 | irritable_i | 1.605324786 | 32 | irritable_i | 1.868401881 | 55 | irritable_i | 1.541291072 |
| 10 | never_better_i | 1.377859296 | 32 | never_better_i | 0.867508549 | 55 | never_better_i | 2.211524771 |
| 10 | no_solution_i | 0.629774993 | 32 | no_solution_i | 1.665274676 | 55 | no_solution_i | 2.176741915 |
| 10 | not_alone_i | 1.101377584 | 32 | not_alone_i | 0.624417454 | 55 | not_alone_i | 2.57774579 |
| 10 | powerless_i | 1.737107901 | 32 | powerless_i | 1.649579682 | 55 | powerless_i | 1.890626374 |
| 10 | problems_falling_asleep_i | 0.70064905 | 32 | problems_falling_asleep_i | 2.381748785 | 55 | problems_falling_asleep_i | 1.902379462 |
| 10 | problems_staying_asleep_i | 1.863525496 | 32 | problems_staying_asleep_i | 4.229764661 | 55 | problems_staying_asleep_i | 1.133893419 |
| 10 | pull_yourself_together_i | 0.825274315 | 32 | pull_yourself_together_i | 1.621841246 | 55 | pull_yourself_together_i | 4.144142015 |
| 10 | pulled_through_i | 1.305953209 | 32 | pulled_through_i | 1.598263577 | 55 | pulled_through_i | 1.140864855 |
| 10 | sad_i | 1.552546618 | 32 | sad_i | 2.240054986 | 55 | sad_i | 1.884745718 |
| 10 | satisfying_life_i | 1.652255996 | 32 | satisfying_life_i | 1.063614811 | 55 | satisfying_life_i | 1.888178326 |
| 10 | tired_i | 1.63395211 | 32 | tired_i | 2.385172994 | 55 | tired_i | 1.742699852 |

| ID | item | within_sd | ID | item | within_sd | ID | item | within_sd |
|---|---|---|---|---|---|---|---|---|
| 10 | values_i | 0.94689838 | 32 | values_i | 0.727350062 | 55 | values_i | 2.163527459 |
| 10 | woke_too_early_i | 3.238967288 | 32 | woke_too_early_i | 3.780331876 | 55 | woke_too_early_i | 1.133893419 |
| 11 | avoided_activity_i | 3.748083654 | 33 | avoided_activity_i | 3.560925896 | 56 | avoided_activity_i | 2.713136766 |
| 11 | befriend_pain_i | 2.052061768 | 33 | befriend_pain_i | 1.527367095 | 56 | befriend_pain_i | 2.001425583 |
| 11 | cannot_stand_it_i | 1.790914088 | 33 | cannot_stand_it_i | 2.696302711 | 56 | cannot_stand_it_i | 2.808716591 |
| 11 | confident_doing_sth_i | 3.691717248 | 33 | confident_doing_sth_i | 1.833662685 | 56 | confident_doing_sth_i | 2.168897661 |
| 11 | disability_i | 0.89802651 | 33 | disability_i | 1.527367095 | 56 | disability_i | 1.939307273 |
| 11 | dont_make_fuss_i | 3.345523027 | 33 | dont_make_fuss_i | 2.26803028 | 56 | dont_make_fuss_i | 2.092065035 |
| 11 | ended_activity_i | 4.091002704 | 33 | ended_activity_i | 2.446332165 | 56 | ended_activity_i | 2.687234668 |
| 11 | exhausted_i | 1.161994154 | 33 | exhausted_i | 1.274991712 | 56 | exhausted_i | 1.929756029 |
| 11 | expectation_i | 1.861568636 | 33 | expectation_i | 1.268914862 | 56 | expectation_i | 2.098220618 |
| 11 | friendly_to_myself_i | 0.827088738 | 33 | friendly_to_myself_i | 1.50185071 | 56 | friendly_to_myself_i | 1.654044466 |
| 11 | guilty_i | 0.125988158 | 33 | guilty_i | 2.244047413 | 56 | guilty_i | 2.305961907 |
| 11 | handed_over_i | 4.581569972 | 33 | handed_over_i | 0.787891456 | 56 | handed_over_i | 2.480829274 |
| 11 | happy_i | 1.641593271 | 33 | happy_i | 2.081549961 | 56 | happy_i | 2.329876266 |
| 11 | hold_on_i | 4.340240271 | 33 | hold_on_i | 1.90967534 | 56 | hold_on_i | 2.967917072 |
| 11 | ignore_pain_i | 2.134974407 | 33 | ignore_pain_i | 0.999516791 | 56 | ignore_pain_i | 1.868640007 |
| 11 | intensity_i | 0.530194295 | 33 | intensity_i | 1.396337514 | 56 | intensity_i | 1.369215828 |
| 11 | irritable_i | 1.764704878 | 33 | irritable_i | 2.036384026 | 56 | irritable_i | 1.830557964 |
| 11 | never_better_i | 2.984942584 | 33 | never_better_i | 2.319524356 | 56 | never_better_i | 2.326307449 |
| 11 | no_solution_i | 1.019271549 | 33 | no_solution_i | 0.719970477 | 56 | no_solution_i | 2.252368683 |
| 11 | not_alone_i | 0.800345547 | 33 | not_alone_i | 1.338396185 | 56 | not_alone_i | 1.946646995 |
| 11 | powerless_i | 2.472687467 | 33 | powerless_i | 1.961587644 | 56 | powerless_i | 2.458989017 |
| 11 | problems_falling_asleep_i | 2.333333333 | 33 | problems_falling_asleep_i | 2.497617913 | 56 | problems_falling_asleep_i | 0.316227766 |
| 11 | problems_staying_asleep_i | 0 | 33 | problems_staying_asleep_i | 4.191828786 | 56 | problems_staying_asleep_i | 2.798809271 |
| 11 | pull_yourself_together_i | 4.174263428 | 33 | pull_yourself_together_i | 2.416229346 | 56 | pull_yourself_together_i | 2.377087637 |
| 11 | pulled_through_i | 0.68372942 | 33 | pulled_through_i | 3.156543698 | 56 | pulled_through_i | 2.588129189 |
| 11 | sad_i | 0.24580453 | 33 | sad_i | 2.09727221 | 56 | sad_i | 2.102471618 |
| 11 | satisfying_life_i | 0 | 33 | satisfying_life_i | 0.970332878 | 56 | satisfying_life_i | 2.000929843 |
| 11 | tired_i | 0.563890371 | 33 | tired_i | 1.16718415 | 56 | tired_i | 2.23051528 |
| 11 | values_i | 0.176731432 | 33 | values_i | 2.517667044 | 56 | values_i | 1.745743122 |
| 11 | woke_too_early_i | 0 | 33 | woke_too_early_i | 2.699206233 | 56 | woke_too_early_i | 2.503331114 |
| 12 | avoided_activity_i | 0.661631089 | 34 | avoided_activity_i | 2.691478394 | 57 | avoided_activity_i | 2.203906475 |
| 12 | befriend_pain_i | 1.750177414 | 34 | befriend_pain_i | 2.953564478 | 57 | befriend_pain_i | 2.038629498 |
| 12 | cannot_stand_it_i | 0.31428116 | 34 | cannot_stand_it_i | 2.817858467 | 57 | cannot_stand_it_i | 1.995626078 |
| 12 | confident_doing_sth_i | 3.826833188 | 34 | confident_doing_sth_i | 3.156818203 | 57 | confident_doing_sth_i | 2.525656921 |
| 12 | disability_i | 1.303459408 | 34 | disability_i | 2.649009139 | 57 | disability_i | 2.385842014 |
| 12 | dont_make_fuss_i | 0.925008095 | 34 | dont_make_fuss_i | 2.925851339 | 57 | dont_make_fuss_i | 2.028568341 |
| 12 | ended_activity_i | 1.041511288 | 34 | ended_activity_i | 2.549326891 | 57 | ended_activity_i | 2.309216494 |
| 12 | exhausted_i | 3.17399206 | 34 | exhausted_i | 2.921067276 | 57 | exhausted_i | 1.709883012 |
| 12 | expectation_i | 1.428809365 | 34 | expectation_i | 2.31972388 | 57 | expectation_i | 2.058707828 |
| 12 | friendly_to_myself_i | 2.055199675 | 34 | friendly_to_myself_i | 3.150054575 | 57 | friendly_to_myself_i | 1.595363059 |
| 12 | guilty_i | 0.840249886 | 34 | guilty_i | 3.073345823 | 57 | guilty_i | 2.013805718 |
| 12 | handed_over_i | 0.260377822 | 34 | handed_over_i | 2.365643759 | 57 | handed_over_i | 2.075616569 |
| 12 | happy_i | 3.570038972 | 34 | happy_i | 3.41384129 | 57 | happy_i | 1.616860229 |
| 12 | hold_on_i | 1.596313696 | 34 | hold_on_i | 2.877288286 | 57 | hold_on_i | 2.283414383 |
| 12 | ignore_pain_i | 3.746106492 | 34 | ignore_pain_i | 2.683629036 | 57 | ignore_pain_i | 2.102347164 |
| 12 | intensity_i | 1.218405508 | 34 | intensity_i | 2.298677029 | 57 | intensity_i | 1.688812796 |
| 12 | irritable_i | 2.045793677 | 34 | irritable_i | 3.114332609 | 57 | irritable_i | 2.482504854 |
| 12 | never_better_i | 1.204171592 | 34 | never_better_i | 3.018551807 | 57 | never_better_i | 2.083098879 |
| 12 | no_solution_i | 1.683626933 | 34 | no_solution_i | 2.91675491 | 57 | no_solution_i | 1.839928461 |
| 12 | not_alone_i | 2.9654153 | 34 | not_alone_i | 3.287505484 | 57 | not_alone_i | 1.789426175 |
| 12 | powerless_i | 2.63279679 | 34 | powerless_i | 3.115791795 | 57 | powerless_i | 2.114376559 |
| 12 | problems_falling_asleep_i | 2.121320344 | 34 | problems_falling_asleep_i | 3.67052139 | 57 | problems_falling_asleep_i | 3.373096171 |
| 12 | problems_staying_asleep_i | 2.828427125 | 34 | problems_staying_asleep_i | 2.700168345 | 57 | problems_staying_asleep_i | 2.311805451 |
| 12 | pull_yourself_together_i | 1.226056481 | 34 | pull_yourself_together_i | 2.700427317 | 57 | pull_yourself_together_i | 2.082791916 |
| 12 | pulled_through_i | 3.775246208 | 34 | pulled_through_i | 3.158589872 | 57 | pulled_through_i | 2.77901649 |
| 12 | sad_i | 1.291296224 | 34 | sad_i | 3.040825553 | 57 | sad_i | 2.446965168 |
| 12 | satisfying_life_i | 3.81505523 | 34 | satisfying_life_i | 3.109950944 | 57 | satisfying_life_i | 2.058707828 |
| 12 | tired_i | 3.193542579 | 34 | tired_i | 2.940751375 | 57 | tired_i | 1.179174217 |
| 12 | values_i | 3.93407093 | 34 | values_i | 3.18068911 | 57 | values_i | 2.133941995 |
| 12 | woke_too_early_i | 1.995530721 | 34 | woke_too_early_i | 2.327698825 | 57 | woke_too_early_i | 0.994428926 |
| 13 | avoided_activity_i | 4.423848608 | 35 | avoided_activity_i | 2.705929625 | 58 | avoided_activity_i | 1.904795725 |
| 13 | befriend_pain_i | 0.654653671 | 35 | befriend_pain_i | 2.1882003 | 58 | befriend_pain_i | 0 |
| 13 | cannot_stand_it_i | 0.738503151 | 35 | cannot_stand_it_i | 2.479363448 | 58 | cannot_stand_it_i | 2.958588642 |
| 13 | confident_doing_sth_i | 1.609665128 | 35 | confident_doing_sth_i | 2.664511974 | 58 | confident_doing_sth_i | 1.144013214 |
| 13 | disability_i | 0.867742007 | 35 | disability_i | 2.336508759 | 58 | disability_i | 1.24303253 |
| 13 | dont_make_fuss_i | 0.5 | 35 | dont_make_fuss_i | 2.375601757 | 58 | dont_make_fuss_i | 0.345189577 |
| 13 | ended_activity_i | 4.570327868 | 35 | ended_activity_i | 2.598799607 | 58 | ended_activity_i | 2.878491669 |
| 13 | exhausted_i | 1.812653934 | 35 | exhausted_i | 2.679402544 | 58 | exhausted_i | 1.821855056 |
| 13 | expectation_i | 0.125 | 35 | expectation_i | 2.463009549 | 58 | expectation_i | 0.133630621 |
| 13 | friendly_to_myself_i | 0.509580827 | 35 | friendly_to_myself_i | 2.460336998 | 58 | friendly_to_myself_i | 1.216765993 |
| 13 | guilty_i | 0.125 | 35 | guilty_i | 2.091874721 | 58 | guilty_i | 0.929844282 |
| 13 | handed_over_i | 4.512658562 | 35 | handed_over_i | 2.66110008 | 58 | handed_over_i | 1.271950134 |
| 13 | happy_i | 1.140871291 | 35 | happy_i | 2.217073191 | 58 | happy_i | 2.615078653 |

| ID | item | within_sd | ID | item | within_sd | ID | item | within_sd |
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| 13 | hold_on_i | 0.55990362 | 35 | hold_on_i | 2.539166875 | 58 | hold_on_i | 1.838883766 |
| 13 | ignore_pain_i | 0.687184271 | 35 | ignore_pain_i | 2.453068254 | 58 | ignore_pain_i | 1.33630621 |
| 13 | intensity_i | 0.745355992 | 35 | intensity_i | 2.100095475 | 58 | intensity_i | 1.268883342 |
| 13 | irritable_i | 0.550748048 | 35 | irritable_i | 2.442701779 | 58 | irritable_i | 0.133630621 |
| 13 | never_better_i | 0.302108989 | 35 | never_better_i | 2.564335106 | 58 | never_better_i | 1.285281312 |
| 13 | no_solution_i | 0.975772994 | 35 | no_solution_i | 2.425713341 | 58 | no_solution_i | 0 |
| 13 | not_alone_i | 0.550748048 | 35 | not_alone_i | 2.596628815 | 58 | not_alone_i | 0 |
| 13 | powerless_i | 0.610547178 | 35 | powerless_i | 2.242084378 | 58 | powerless_i | 2.272292166 |
| 13 | problems_falling_asleep_i | 3.238655414 | 35 | problems_falling_asleep_i | 3.023715784 | 58 | problems_falling_asleep_i | 4.153311931 |
| 13 | problems_staying_asleep_i | 4.110960958 | 35 | problems_staying_asleep_i | 1.927248223 | 58 | problems_staying_asleep_i | 4.994441355 |
| 13 | pull_yourself_together_i | 0.478713554 | 35 | pull_yourself_together_i | 2.540647008 | 58 | pull_yourself_together_i | 0.755928946 |
| 13 | pulled_through_i | 1.16794148 | 35 | pulled_through_i | 2.577130965 | 58 | pulled_through_i | 0.867897893 |
| 13 | sad_i | 1.00593477 | 35 | sad_i | 2.498997293 | 58 | sad_i | 2.329859814 |
| 13 | satisfying_life_i | 0.687184271 | 35 | satisfying_life_i | 2.47898435 | 58 | satisfying_life_i | 1.044310498 |
| 13 | tired_i | 2.043609377 | 35 | tired_i | 2.434994455 | 58 | tired_i | 1.439245834 |
| 13 | values_i | 0.417855447 | 35 | values_i | 2.817551506 | 58 | values_i | 3.158990468 |
| 13 | woke_too_early_i | 4.270050741 | 35 | woke_too_early_i | 1.832250763 | 58 | woke_too_early_i | 4.183300133 |
| 14 | avoided_activity_i | 1.973472385 | 36 | avoided_activity_i | 1.32327837 | 59 | avoided_activity_i | 3.519103708 |
| 14 | befriend_pain_i | 1.190967161 | 36 | befriend_pain_i | 1.123074273 | 59 | befriend_pain_i | 0.848030568 |
| 14 | cannot_stand_it_i | 2.305047515 | 36 | cannot_stand_it_i | 1.521093518 | 59 | cannot_stand_it_i | 0.889878147 |
| 14 | confident_doing_sth_i | 1.948684436 | 36 | confident_doing_sth_i | 0.816496581 | 59 | confident_doing_sth_i | 2.891939088 |
| 14 | disability_i | 1.805799739 | 36 | disability_i | 1.645863346 | 59 | disability_i | 1.321033637 |
| 14 | dont_make_fuss_i | 1.872683755 | 36 | dont_make_fuss_i | 1.135905511 | 59 | dont_make_fuss_i | 0.267261242 |
| 14 | ended_activity_i | 1.642609108 | 36 | ended_activity_i | 0.764738671 | 59 | ended_activity_i | 3.232897056 |
| 14 | exhausted_i | 2.369615869 | 36 | exhausted_i | 1.801178926 | 59 | exhausted_i | 3.837570592 |
| 14 | expectation_i | 0.125 | 36 | expectation_i | 0.261153582 | 59 | expectation_i | 2.240999313 |
| 14 | friendly_to_myself_i | 1.755871669 | 36 | friendly_to_myself_i | 0.820922069 | 59 | friendly_to_myself_i | 1.094110562 |
| 14 | guilty_i | 1.521587386 | 36 | guilty_i | 0.69922622 | 59 | guilty_i | 0.133630621 |
| 14 | handed_over_i | 0.875 | 36 | handed_over_i | 1.219687884 | 59 | handed_over_i | 1.252011369 |
| 14 | happy_i | 2.784550276 | 36 | happy_i | 1.464120475 | 59 | happy_i | 2.211466576 |
| 14 | hold_on_i | 1.991798661 | 36 | hold_on_i | 2.395737192 | 59 | hold_on_i | 0.668153105 |
| 14 | ignore_pain_i | 1.568539914 | 36 | ignore_pain_i | 1.501065265 | 59 | ignore_pain_i | 3.430951555 |
| 14 | intensity_i | 1.090634736 | 36 | intensity_i | 1.232550845 | 59 | intensity_i | 1.279077387 |
| 14 | irritable_i | 2.061552813 | 36 | irritable_i | 1.385591425 | 59 | irritable_i | 2.028050052 |
| 14 | never_better_i | 2.073787655 | 36 | never_better_i | 2.348840203 | 59 | never_better_i | 0.593252098 |
| 14 | no_solution_i | 1.356933986 | 36 | no_solution_i | 1.370745374 | 59 | no_solution_i | 1.179780961 |
| 14 | not_alone_i | 1.917960226 | 36 | not_alone_i | 1.374937029 | 59 | not_alone_i | 0.133630621 |
| 14 | powerless_i | 2.780271698 | 36 | powerless_i | 1.841317961 | 59 | powerless_i | 3.090622599 |
| 14 | problems_falling_asleep_i | 3.37997669 | 36 | problems_falling_asleep_i | 0.904534034 | 59 | problems_falling_asleep_i | 1.166666667 |
| 14 | problems_staying_asleep_i | 1.712255291 | 36 | problems_staying_asleep_i | 2.119176512 | 59 | problems_staying_asleep_i | 0.833333333 |
| 14 | pull_yourself_together_i | 1.892379769 | 36 | pull_yourself_together_i | 1.634949702 | 59 | pull_yourself_together_i | 0.534522484 |
| 14 | pulled_through_i | 2.795218068 | 36 | pulled_through_i | 0.938882541 | 59 | pulled_through_i | 1.710073288 |
| 14 | sad_i | 3.01381574 | 36 | sad_i | 1.60561674 | 59 | sad_i | 0.781066537 |
| 14 | satisfying_life_i | 1.890281641 | 36 | satisfying_life_i | 1.11431054 | 59 | satisfying_life_i | 1.384515481 |
| 14 | tired_i | 1.490628796 | 36 | tired_i | 1.994237222 | 59 | tired_i | 4.222965967 |
| 14 | values_i | 2.418872146 | 36 | values_i | 0.866640435 | 59 | values_i | 1.854356051 |
| 14 | woke_too_early_i | 1.732050808 | 36 | woke_too_early_i | 4.105428778 | 59 | woke_too_early_i | 1.166666667 |
| 15 | avoided_activity_i | 1.896448833 | 37 | avoided_activity_i | 1.084263455 | 60 | avoided_activity_i | 1.31601066 |
| 15 | befriend_pain_i | 1.294756846 | 37 | befriend_pain_i | 1.606119888 | 60 | befriend_pain_i | 2.583721748 |
| 15 | cannot_stand_it_i | 0.503444358 | 37 | cannot_stand_it_i | 2.103078474 | 60 | cannot_stand_it_i | 1.208099972 |
| 15 | confident_doing_sth_i | 2.283985521 | 37 | confident_doing_sth_i | 1.45876941 | 60 | confident_doing_sth_i | 3.040505185 |
| 15 | disability_i | 1.413851454 | 37 | disability_i | 2.303851491 | 60 | disability_i | 1.561198307 |
| 15 | dont_make_fuss_i | 0 | 37 | dont_make_fuss_i | 1.007142948 | 60 | dont_make_fuss_i | 0.240771706 |
| 15 | ended_activity_i | 1.043841815 | 37 | ended_activity_i | 0.871403809 | 60 | ended_activity_i | 1.609726404 |
| 15 | exhausted_i | 1.250703847 | 37 | exhausted_i | 3.120058818 | 60 | exhausted_i | 2.195671165 |
| 15 | expectation_i | 1.019271549 | 37 | expectation_i | 2.41443432 | 60 | expectation_i | 2.596804384 |
| 15 | friendly_to_myself_i | 0.737760689 | 37 | friendly_to_myself_i | 0.372506216 | 60 | friendly_to_myself_i | 1.80307117 |
| 15 | guilty_i | 0 | 37 | guilty_i | 2.17665781 | 60 | guilty_i | 3.106451774 |
| 15 | handed_over_i | 1.213298897 | 37 | handed_over_i | 1.064966002 | 60 | handed_over_i | 0.601929265 |
| 15 | happy_i | 1.761655647 | 37 | happy_i | 2.426281261 | 60 | happy_i | 2.085757328 |
| 15 | hold_on_i | 1.900494452 | 37 | hold_on_i | 2.692748792 | 60 | hold_on_i | 0.240771706 |
| 15 | ignore_pain_i | 2.049440122 | 37 | ignore_pain_i | 2.441009083 | 60 | ignore_pain_i | 0.921700123 |
| 15 | intensity_i | 1.01018875 | 37 | intensity_i | 1.925786425 | 60 | intensity_i | 0.974307632 |
| 15 | irritable_i | 0.573791836 | 37 | irritable_i | 2.427758064 | 60 | irritable_i | 2.320632833 |
| 15 | never_better_i | 0.214669395 | 37 | never_better_i | 1.747941515 | 60 | never_better_i | 0 |
| 15 | no_solution_i | 0.480548415 | 37 | no_solution_i | 1.611371521 | 60 | no_solution_i | 2.601724132 |
| 15 | not_alone_i | 0.527774409 | 37 | not_alone_i | 2.734917678 | 60 | not_alone_i | 2.617323754 |
| 15 | powerless_i | 0.947954383 | 37 | powerless_i | 2.988542723 | 60 | powerless_i | 2.138431674 |
| 15 | problems_falling_asleep_i | 2.483630619 | 37 | problems_falling_asleep_i | 2.162817093 | 60 | problems_falling_asleep_i | 1.61245155 |
| 15 | problems_staying_asleep_i | 2.305028827 | 37 | problems_staying_asleep_i | 2.988868236 | 60 | problems_staying_asleep_i | 3.663083649 |
| 15 | pull_yourself_together_i | 0.125988158 | 37 | pull_yourself_together_i | 1.69000556 | 60 | pull_yourself_together_i | 0.963086825 |
| 15 | pulled_through_i | 2.882047119 | 37 | pulled_through_i | 1.150035063 | 60 | pulled_through_i | 1.06941515 |
| 15 | sad_i | 0.125988158 | 37 | sad_i | 3.095096298 | 60 | sad_i | 2.333272439 |
| 15 | satisfying_life_i | 0.825229413 | 37 | satisfying_life_i | 1.067127397 | 60 | satisfying_life_i | 1.40983635 |
| 15 | tired_i | 1.517941852 | 37 | tired_i | 2.81299741 | 60 | tired_i | 2.408779056 |

| ID | item | within_sd | ID | item | within_sd | ID | item | within_sd |
|---|---|---|---|---|---|---|---|---|
| 15 | values_i | 1.127780742 | 37 | values_i | 1.087093204 | 60 | values_i | 0.979543537 |
| 15 | woke_too_early_i | 0.732695097 | 37 | woke_too_early_i | 1.763834207 | 60 | woke_too_early_i | 3.945077485 |
| 16 | avoided_activity_i | 1.161801314 | 38 | avoided_activity_i | 2.041816369 | 61 | avoided_activity_i | 3.735519546 |
| 16 | befriend_pain_i | 1.738741516 | 38 | befriend_pain_i | 0.827349408 | 61 | befriend_pain_i | 2.78053969 |
| 16 | cannot_stand_it_i | 1.24122464 | 38 | cannot_stand_it_i | 1.107864696 | 61 | cannot_stand_it_i | 3.533415367 |
| 16 | confident_doing_sth_i | 1.291369139 | 38 | confident_doing_sth_i | 0.991310333 | 61 | confident_doing_sth_i | 2.665941931 |
| 16 | disability_i | 0.76952099 | 38 | disability_i | 0.93296438 | 61 | disability_i | 2.679047347 |
| 16 | dont_make_fuss_i | 1.269549593 | 38 | dont_make_fuss_i | 1.10477289 | 61 | dont_make_fuss_i | 2.668206077 |
| 16 | ended_activity_i | 1.494304621 | 38 | ended_activity_i | 1.761652782 | 61 | ended_activity_i | 2.550835801 |
| 16 | exhausted_i | 0.577140743 | 38 | exhausted_i | 2.088485246 | 61 | exhausted_i | 3.41925494 |
| 16 | expectation_i | 1.241809158 | 38 | expectation_i | 1.009412443 | 61 | expectation_i | 1.954061792 |
| 16 | friendly_to_myself_i | 1.115597297 | 38 | friendly_to_myself_i | 1.429074358 | 61 | friendly_to_myself_i | 2.645568713 |
| 16 | guilty_i | 0.901941142 | 38 | guilty_i | 0.20259881 | 61 | guilty_i | 2.985067507 |
| 16 | handed_over_i | 0.76621324 | 38 | handed_over_i | 1.610203881 | 61 | handed_over_i | 3.299831646 |
| 16 | happy_i | 1.233600698 | 38 | happy_i | 1.362179577 | 61 | happy_i | 2.823726253 |
| 16 | hold_on_i | 1.1259571 | 38 | hold_on_i | 2.670578954 | 61 | hold_on_i | 2.621354151 |
| 16 | ignore_pain_i | 1.413700329 | 38 | ignore_pain_i | 1.677523325 | 61 | ignore_pain_i | 2.245876522 |
| 16 | intensity_i | 0.404976302 | 38 | intensity_i | 0.618624423 | 61 | intensity_i | 2.453431 |
| 16 | irritable_i | 0.905955141 | 38 | irritable_i | 0.997985899 | 61 | irritable_i | 3.928343679 |
| 16 | never_better_i | 1.434339382 | 38 | never_better_i | 1.837350029 | 61 | never_better_i | 3.329055226 |
| 16 | no_solution_i | 1.575160968 | 38 | no_solution_i | 0.76044041 | 61 | no_solution_i | 3.07648083 |
| 16 | not_alone_i | 1.165854303 | 38 | not_alone_i | 0.915988103 | 61 | not_alone_i | 2.77749757 |
| 16 | powerless_i | 1.634843747 | 38 | powerless_i | 1.275208588 | 61 | powerless_i | 3.902495176 |
| 16 | problems_falling_asleep_i | 0.707106781 | 38 | problems_falling_asleep_i | 2.774341309 | 61 | problems_falling_asleep_i | 3.207134903 |
| 16 | problems_staying_asleep_i | 0.755928946 | 38 | problems_staying_asleep_i | 0.900336637 | 61 | problems_staying_asleep_i | 2.984084768 |
| 16 | pull_yourself_together_i | 1.206537586 | 38 | pull_yourself_together_i | 1.795478336 | 61 | pull_yourself_together_i | 2.833205453 |
| 16 | pulled_through_i | 1.790557397 | 38 | pulled_through_i | 1.11076677 | 61 | pulled_through_i | 2.456972726 |
| 16 | sad_i | 0.932403296 | 38 | sad_i | 0.742501075 | 61 | sad_i | 3.791230665 |
| 16 | satisfying_life_i | 1.268691885 | 38 | satisfying_life_i | 0.891723627 | 61 | satisfying_life_i | 2.611753441 |
| 16 | tired_i | 0.823723008 | 38 | tired_i | 1.907836218 | 61 | tired_i | 3.687293759 |
| 16 | values_i | 1.498911071 | 38 | values_i | 1.079346997 | 61 | values_i | 2.503041628 |
| 16 | woke_too_early_i | 0.534522484 | 38 | woke_too_early_i | 2.640018365 | 61 | woke_too_early_i | 2.768874621 |
| 17 | avoided_activity_i | 2.949961683 | 39 | avoided_activity_i | 2.238695912 | 62 | avoided_activity_i | 1.425838958 |
| 17 | befriend_pain_i | 1.692987996 | 39 | befriend_pain_i | 1.66345235 | 62 | befriend_pain_i | 0.720570657 |
| 17 | cannot_stand_it_i | 2.367817007 | 39 | cannot_stand_it_i | 1.041864522 | 62 | cannot_stand_it_i | 1.59090586 |
| 17 | confident_doing_sth_i | 2.286522719 | 39 | confident_doing_sth_i | 1.906094869 | 62 | confident_doing_sth_i | 1.136141996 |
| 17 | disability_i | 1.435369487 | 39 | disability_i | 1.743502508 | 62 | disability_i | 1.209602766 |
| 17 | dont_make_fuss_i | 1.575946242 | 39 | dont_make_fuss_i | 1.541231893 | 62 | dont_make_fuss_i | 1.158805979 |
| 17 | ended_activity_i | 2.927467975 | 39 | ended_activity_i | 1.678878823 | 62 | ended_activity_i | 1.710372221 |
| 17 | exhausted_i | 1.252390628 | 39 | exhausted_i | 1.449902132 | 62 | exhausted_i | 1.477250983 |
| 17 | expectation_i | 1.115725772 | 39 | expectation_i | 0.759084883 | 62 | expectation_i | 0.815110573 |
| 17 | friendly_to_myself_i | 1.137784315 | 39 | friendly_to_myself_i | 1.259608031 | 62 | friendly_to_myself_i | 0.968756611 |
| 17 | guilty_i | 0.907836498 | 39 | guilty_i | 0.244338889 | 62 | guilty_i | 1.13912374 |
| 17 | handed_over_i | 3.117520133 | 39 | handed_over_i | 1.635207391 | 62 | handed_over_i | 1.382680228 |
| 17 | happy_i | 1.867362817 | 39 | happy_i | 1.275663731 | 62 | happy_i | 1.222804571 |
| 17 | hold_on_i | 1.666305267 | 39 | hold_on_i | 1.72799861 | 62 | hold_on_i | 1.221139002 |
| 17 | ignore_pain_i | 1.305016153 | 39 | ignore_pain_i | 1.575335677 | 62 | ignore_pain_i | 0.978280643 |
| 17 | intensity_i | 0.844304651 | 39 | intensity_i | 1.182565953 | 62 | intensity_i | 0.952750784 |
| 17 | irritable_i | 1.680840489 | 39 | irritable_i | 2.047049481 | 62 | irritable_i | 1.502447874 |
| 17 | never_better_i | 2.089737205 | 39 | never_better_i | 1.634377407 | 62 | never_better_i | 0.894224901 |
| 17 | no_solution_i | 0.638115947 | 39 | no_solution_i | 0.122169444 | 62 | no_solution_i | 0.7599781 |
| 17 | not_alone_i | 1.272081536 | 39 | not_alone_i | 1.937046295 | 62 | not_alone_i | 1.073297459 |
| 17 | powerless_i | 1.802885636 | 39 | powerless_i | 1.008108241 | 62 | powerless_i | 1.247702547 |
| 17 | problems_falling_asleep_i | 2.449489743 | 39 | problems_falling_asleep_i | 2.46797672 | 62 | problems_falling_asleep_i | 1.990888335 |
| 17 | problems_staying_asleep_i | 0 | 39 | problems_staying_asleep_i | 0.809039835 | 62 | problems_staying_asleep_i | 3.289100457 |
| 17 | pull_yourself_together_i | 1.588313348 | 39 | pull_yourself_together_i | 1.570447337 | 62 | pull_yourself_together_i | 1.242799251 |
| 17 | pulled_through_i | 1.752915529 | 39 | pulled_through_i | 1.593746259 | 62 | pulled_through_i | 1.413733761 |
| 17 | sad_i | 1.614401736 | 39 | sad_i | 0.957249943 | 62 | sad_i | 1.736744721 |
| 17 | satisfying_life_i | 0.801406748 | 39 | satisfying_life_i | 1.88545817 | 62 | satisfying_life_i | 0.877117519 |
| 17 | tired_i | 1.048783637 | 39 | tired_i | 1.615730004 | 62 | tired_i | 1.553071394 |
| 17 | values_i | 1.683905209 | 39 | values_i | 1.225390956 | 62 | values_i | 1.218172367 |
| 17 | woke_too_early_i | 0 | 39 | woke_too_early_i | 2.500908926 | 62 | woke_too_early_i | 2.625054112 |
| 18 | avoided_activity_i | 0.728048518 | 40 | avoided_activity_i | 2.153615495 | 63 | avoided_activity_i | 1.356933986 |
| 18 | befriend_pain_i | 1.575079146 | 40 | befriend_pain_i | 1.22626724 | 63 | befriend_pain_i | 2.4718655 |
| 18 | cannot_stand_it_i | 2.550366951 | 40 | cannot_stand_it_i | 2.470679688 | 63 | cannot_stand_it_i | 2.061492659 |
| 18 | confident_doing_sth_i | 1.975809995 | 40 | confident_doing_sth_i | 1.624750943 | 63 | confident_doing_sth_i | 4.548569459 |
| 18 | disability_i | 2.085992838 | 40 | disability_i | 1.757212654 | 63 | disability_i | 1.311956615 |
| 18 | dont_make_fuss_i | 0.989839088 | 40 | dont_make_fuss_i | 1.819017188 | 63 | dont_make_fuss_i | 0.912327392 |
| 18 | ended_activity_i | 1.462462927 | 40 | ended_activity_i | 2.191601417 | 63 | ended_activity_i | 0.461837256 |
| 18 | exhausted_i | 1.705663981 | 40 | exhausted_i | 2.228595388 | 63 | exhausted_i | 2.348378367 |
| 18 | expectation_i | 1.988354071 | 40 | expectation_i | 1.646756996 | 63 | expectation_i | 2.623913229 |
| 18 | friendly_to_myself_i | 1.976224805 | 40 | friendly_to_myself_i | 1.374146714 | 63 | friendly_to_myself_i | 1.539090512 |
| 18 | guilty_i | 1.327514626 | 40 | guilty_i | 1.492371589 | 63 | guilty_i | 2.329450426 |
| 18 | handed_over_i | 0.428493357 | 40 | handed_over_i | 2.052589961 | 63 | handed_over_i | 0.881917104 |
| 18 | happy_i | 2.050323179 | 40 | happy_i | 1.390422527 | 63 | happy_i | 4.251867004 |

| ID | item | within_sd | ID | item | within_sd | ID | item | within_sd |
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| 18 | hold_on_i | 1.768578201 | 40 | hold_on_i | 1.22743013 | 63 | hold_on_i | 2.678869031 |
| 18 | ignore_pain_i | 1.80391196 | 40 | ignore_pain_i | 1.419789892 | 63 | ignore_pain_i | 3.638419332 |
| 18 | intensity_i | 1.907563319 | 40 | intensity_i | 1.69257014 | 63 | intensity_i | 1.477258158 |
| 18 | irritable_i | 2.301223243 | 40 | irritable_i | 2.260086163 | 63 | irritable_i | 2.119214814 |
| 18 | never_better_i | 1.833954192 | 40 | never_better_i | 2.245422619 | 63 | never_better_i | 1.11980724 |
| 18 | no_solution_i | 1.493336749 | 40 | no_solution_i | 1.500585195 | 63 | no_solution_i | 0.709732512 |
| 18 | not_alone_i | 2.013479168 | 40 | not_alone_i | 1.563970993 | 63 | not_alone_i | 2.357022604 |
| 18 | powerless_i | 1.754774907 | 40 | powerless_i | 2.275330539 | 63 | powerless_i | 2.350067544 |
| 18 | problems_falling_asleep_i | 3.142089635 | 40 | problems_falling_asleep_i | 2.482667187 | 63 | problems_falling_asleep_i | 3.142893218 |
| 18 | problems_staying_asleep_i | 3.82812558 | 40 | problems_staying_asleep_i | 1.990888335 | 63 | problems_staying_asleep_i | 2.983286778 |
| 18 | pull_yourself_together_i | 1.131274246 | 40 | pull_yourself_together_i | 1.650484804 | 63 | pull_yourself_together_i | 0.302108989 |
| 18 | pulled_through_i | 2.394209773 | 40 | pulled_through_i | 1.062882426 | 63 | pulled_through_i | 4.643624021 |
| 18 | sad_i | 2.919034948 | 40 | sad_i | 1.953531729 | 63 | sad_i | 2.503123049 |
| 18 | satisfying_life_i | 1.729209049 | 40 | satisfying_life_i | 1.25256541 | 63 | satisfying_life_i | 4.519989772 |
| 18 | tired_i | 2.052187957 | 40 | tired_i | 2.610633688 | 63 | tired_i | 2.171640354 |
| 18 | values_i | 2.000819504 | 40 | values_i | 0.942136253 | 63 | values_i | 0.454256763 |
| 18 | woke_too_early_i | 3.474583036 | 40 | woke_too_early_i | 2.522624896 | 63 | woke_too_early_i | 2.529822128 |
| 19 | avoided_activity_i | 3.092613799 | 41 | avoided_activity_i | 3.611718906 | 64 | avoided_activity_i | 2.088872418 |
| 19 | befriend_pain_i | 2.291036431 | 41 | befriend_pain_i | 1.687857009 | 64 | befriend_pain_i | 0 |
| 19 | cannot_stand_it_i | 2.683892138 | 41 | cannot_stand_it_i | 0.705494555 | 64 | cannot_stand_it_i | 1.114975066 |
| 19 | confident_doing_sth_i | 2.553372919 | 41 | confident_doing_sth_i | 1.524200907 | 64 | confident_doing_sth_i | 0.610473255 |
| 19 | disability_i | 1.983547278 | 41 | disability_i | 1.905695941 | 64 | disability_i | 1.465076137 |
| 19 | dont_make_fuss_i | 1.638314921 | 41 | dont_make_fuss_i | 0.76694117 | 64 | dont_make_fuss_i | 0.12803688 |
| 19 | ended_activity_i | 2.645751311 | 41 | ended_activity_i | 1.806876673 | 64 | ended_activity_i | 1.69021614 |
| 19 | exhausted_i | 2.089154693 | 41 | exhausted_i | 2.040176179 | 64 | exhausted_i | 1.276307858 |
| 19 | expectation_i | 1.763689054 | 41 | expectation_i | 2.201072579 | 64 | expectation_i | 1.478812106 |
| 19 | friendly_to_myself_i | 1.173831412 | 41 | friendly_to_myself_i | 1.393269833 | 64 | friendly_to_myself_i | 1.394955784 |
| 19 | guilty_i | 1.053849647 | 41 | guilty_i | 0.678721243 | 64 | guilty_i | 0.985135424 |
| 19 | handed_over_i | 2.292153628 | 41 | handed_over_i | 3.474515323 | 64 | handed_over_i | 1.323185426 |
| 19 | happy_i | 1.51557877 | 41 | happy_i | 1.670595783 | 64 | happy_i | 0.847045653 |
| 19 | hold_on_i | 3.140342521 | 41 | hold_on_i | 1.741527851 | 64 | hold_on_i | 2.358104268 |
| 19 | ignore_pain_i | 2.123792992 | 41 | ignore_pain_i | 1.796534506 | 64 | ignore_pain_i | 0.825151087 |
| 19 | intensity_i | 1.434881099 | 41 | intensity_i | 1.549994991 | 64 | intensity_i | 1.119621326 |
| 19 | irritable_i | 1.951012971 | 41 | irritable_i | 1.086430515 | 64 | irritable_i | 1.323185426 |
| 19 | never_better_i | 3.060827273 | 41 | never_better_i | 0.891180621 | 64 | never_better_i | 0.81381514 |
| 19 | no_solution_i | 2.241214286 | 41 | no_solution_i | 1.361174137 | 64 | no_solution_i | 0.12803688 |
| 19 | not_alone_i | 2.252608433 | 41 | not_alone_i | 1.895237575 | 64 | not_alone_i | 0 |
| 19 | powerless_i | 2.680360386 | 41 | powerless_i | 2.033314666 | 64 | powerless_i | 1.187365178 |
| 19 | problems_falling_asleep_i | 2.905932629 | 41 | problems_falling_asleep_i | 2.37027041 | 64 | problems_falling_asleep_i | 2.527125568 |
| 19 | problems_staying_asleep_i | 2.884826203 | 41 | problems_staying_asleep_i | 4.083225107 | 64 | problems_staying_asleep_i | 1.422226168 |
| 19 | pull_yourself_together_i | 2.500486384 | 41 | pull_yourself_together_i | 0.773392944 | 64 | pull_yourself_together_i | 0.284384101 |
| 19 | pulled_through_i | 2.103808752 | 41 | pulled_through_i | 0.896392586 | 64 | pulled_through_i | 1.329571195 |
| 19 | sad_i | 2.428706963 | 41 | sad_i | 1.739148551 | 64 | sad_i | 1.526093624 |
| 19 | satisfying_life_i | 1.770787589 | 41 | satisfying_life_i | 0.950536516 | 64 | satisfying_life_i | 0.588598409 |
| 19 | tired_i | 2.01377743 | 41 | tired_i | 2.4166863 | 64 | tired_i | 1.308233698 |
| 19 | values_i | 2.447084642 | 41 | values_i | 1.138085276 | 64 | values_i | 1.192416841 |
| 19 | woke_too_early_i | 2.806737925 | 41 | woke_too_early_i | 3.856517506 | 64 | woke_too_early_i | 1.880924982 |
| 20 | avoided_activity_i | 1.729538767 | 42 | avoided_activity_i | 0 | 65 | avoided_activity_i | 4.153706665 |
| 20 | befriend_pain_i | 1.039323451 | 42 | befriend_pain_i | 3.798521458 | 65 | befriend_pain_i | 1.721705422 |
| 20 | cannot_stand_it_i | 1.960602293 | 42 | cannot_stand_it_i | 0 | 65 | cannot_stand_it_i | 3.986124736 |
| 20 | confident_doing_sth_i | 1.818450793 | 42 | confident_doing_sth_i | 0.583583651 | 65 | confident_doing_sth_i | 3.030226141 |
| 20 | disability_i | 1.563008371 | 42 | disability_i | 0.769441226 | 65 | disability_i | 2.206749238 |
| 20 | dont_make_fuss_i | 1.541064316 | 42 | dont_make_fuss_i | 0 | 65 | dont_make_fuss_i | 2.583389868 |
| 20 | ended_activity_i | 2.026515059 | 42 | ended_activity_i | 0.122169444 | 65 | ended_activity_i | 3.472121964 |
| 20 | exhausted_i | 1.698535886 | 42 | exhausted_i | 1.117882278 | 65 | exhausted_i | 1.833035213 |
| 20 | expectation_i | 2.069446471 | 42 | expectation_i | 2.491959027 | 65 | expectation_i | 1.472497763 |
| 20 | friendly_to_myself_i | 1.340560125 | 42 | friendly_to_myself_i | 1.683989577 | 65 | friendly_to_myself_i | 1.9714149 |
| 20 | guilty_i | 1.694121693 | 42 | guilty_i | 0.85518611 | 65 | guilty_i | 2.28558102 |
| 20 | handed_over_i | 1.173170279 | 42 | handed_over_i | 0 | 65 | handed_over_i | 2.67735871 |
| 20 | happy_i | 1.196007852 | 42 | happy_i | 1.470499904 | 65 | happy_i | 2.224102175 |
| 20 | hold_on_i | 1.508910731 | 42 | hold_on_i | 0 | 65 | hold_on_i | 1.428690956 |
| 20 | ignore_pain_i | 1.832740352 | 42 | ignore_pain_i | 4.578626134 | 65 | ignore_pain_i | 2.602576742 |
| 20 | intensity_i | 1.16718415 | 42 | intensity_i | 1.467420965 | 65 | intensity_i | 1.230547418 |
| 20 | irritable_i | 1.718891902 | 42 | irritable_i | 0 | 65 | irritable_i | 2.575850691 |
| 20 | never_better_i | 1.425780573 | 42 | never_better_i | 0.122169444 | 65 | never_better_i | 3.405903832 |
| 20 | no_solution_i | 2.607403061 | 42 | no_solution_i | 1.581925271 | 65 | no_solution_i | 1.683452334 |
| 20 | not_alone_i | 2.004825097 | 42 | not_alone_i | 2.277353952 | 65 | not_alone_i | 1.583068487 |
| 20 | powerless_i | 1.603739591 | 42 | powerless_i | 0.78342162 | 65 | powerless_i | 2.168188242 |
| 20 | problems_falling_asleep_i | 2.314550249 | 42 | problems_falling_asleep_i | 3.784471195 | 65 | problems_falling_asleep_i | 0.603022689 |
| 20 | problems_staying_asleep_i | 1.597989809 | 42 | problems_staying_asleep_i | 2.529822128 | 65 | problems_staying_asleep_i | 0 |
| 20 | pull_yourself_together_i | 1.437422546 | 42 | pull_yourself_together_i | 0 | 65 | pull_yourself_together_i | 2.395910884 |
| 20 | pulled_through_i | 1.704923249 | 42 | pulled_through_i | 0.724951066 | 65 | pulled_through_i | 3.068566654 |
| 20 | sad_i | 1.338396185 | 42 | sad_i | 0.977586909 | 65 | sad_i | 2.13582227 |
| 20 | satisfying_life_i | 1.295104122 | 42 | satisfying_life_i | 0.4900641 | 65 | satisfying_life_i | 1.720917156 |
| 20 | tired_i | 1.702513062 | 42 | tired_i | 1.130955016 | 65 | tired_i | 1.519658606 |

| ID | item | within_sd | ID | item | within_sd | ID | item | within_sd |
|---|---|---|---|---|---|---|---|---|
| 20 | values_i | 1.527367095 | 42 | values_i | 0.952750784 | 65 | values_i | 1.97221771 |
| 20 | woke_too_early_i | 1.752549164 | 42 | woke_too_early_i | 0 | 65 | woke_too_early_i | 2.110579412 |
| 21 | avoided_activity_i | 3.440909724 | 43 | avoided_activity_i | 1.30188911 | 66 | avoided_activity_i | 2.091218179 |
| 21 | befriend_pain_i | 0.970638501 | 43 | befriend_pain_i | 1.107859389 | 66 | befriend_pain_i | 1.479935739 |
| 21 | cannot_stand_it_i | 2.702683905 | 43 | cannot_stand_it_i | 1.524972334 | 66 | cannot_stand_it_i | 1.353231477 |
| 21 | confident_doing_sth_i | 2.304798947 | 43 | confident_doing_sth_i | 0 | 66 | confident_doing_sth_i | 1.594059485 |
| 21 | disability_i | 2.258305018 | 43 | disability_i | 1.673878804 | 66 | disability_i | 1.056117709 |
| 21 | dont_make_fuss_i | 1.853172679 | 43 | dont_make_fuss_i | 0 | 66 | dont_make_fuss_i | 1.045023728 |
| 21 | ended_activity_i | 1.195892053 | 43 | ended_activity_i | 0 | 66 | ended_activity_i | 2.551292008 |
| 21 | exhausted_i | 2.4739437 | 43 | exhausted_i | 2.44124409 | 66 | exhausted_i | 0.920119583 |
| 21 | expectation_i | 1.568241206 | 43 | expectation_i | 3.390777191 | 66 | expectation_i | 1.075365174 |
| 21 | friendly_to_myself_i | 1.919934491 | 43 | friendly_to_myself_i | 0.726069617 | 66 | friendly_to_myself_i | 1.21000106 |
| 21 | guilty_i | 1.660557672 | 43 | guilty_i | 0.94284348 | 66 | guilty_i | 0.910953802 |
| 21 | handed_over_i | 3.052913451 | 43 | handed_over_i | 0 | 66 | handed_over_i | 3.47766768 |
| 21 | happy_i | 1.641263643 | 43 | happy_i | 2.219803541 | 66 | happy_i | 1.292979069 |
| 21 | hold_on_i | 2.226901042 | 43 | hold_on_i | 2.09365745 | 66 | hold_on_i | 1.376543423 |
| 21 | ignore_pain_i | 3.06685682 | 43 | ignore_pain_i | 1.82520825 | 66 | ignore_pain_i | 1.474254582 |
| 21 | intensity_i | 1.950437916 | 43 | intensity_i | 1.623721005 | 66 | intensity_i | 0.663570901 |
| 21 | irritable_i | 1.922216235 | 43 | irritable_i | 2.408343184 | 66 | irritable_i | 1.866150445 |
| 21 | never_better_i | 2.734822096 | 43 | never_better_i | 0.547562475 | 66 | never_better_i | 1.202173634 |
| 21 | no_solution_i | 1.063171265 | 43 | no_solution_i | 0 | 66 | no_solution_i | 0.826851246 |
| 21 | not_alone_i | 1.517287869 | 43 | not_alone_i | 0.912604125 | 66 | not_alone_i | 1.007200186 |
| 21 | powerless_i | 2.107291619 | 43 | powerless_i | 2.568523217 | 66 | powerless_i | 1.312305042 |
| 21 | problems_falling_asleep_i | 1.58113883 | 43 | problems_falling_asleep_i | 3.240370349 | 66 | problems_falling_asleep_i | 2.600699207 |
| 21 | problems_staying_asleep_i | 0.421637021 | 43 | problems_staying_asleep_i | 3.586239132 | 66 | problems_staying_asleep_i | 3.238967288 |
| 21 | pull_yourself_together_i | 2.515295117 | 43 | pull_yourself_together_i | 1.922672259 | 66 | pull_yourself_together_i | 1.23091491 |
| 21 | pulled_through_i | 2.096168334 | 43 | pulled_through_i | 1.041511288 | 66 | pulled_through_i | 2.199650322 |
| 21 | sad_i | 2.419601428 | 43 | sad_i | 3.53334289 | 66 | sad_i | 1.477728995 |
| 21 | satisfying_life_i | 1.1431702 | 43 | satisfying_life_i | 0 | 66 | satisfying_life_i | 0.880241543 |
| 21 | tired_i | 2.169066842 | 43 | tired_i | 2.09756197 | 66 | tired_i | 0.818350151 |
| 21 | values_i | 2.54933782 | 43 | values_i | 0.465652512 | 66 | values_i | 1.503763732 |
| 21 | woke_too_early_i | 2.798809271 | 43 | woke_too_early_i | 3.574601765 | 66 | woke_too_early_i | 3.327570777 |
| 22 | avoided_activity_i | 1.480570969 | 44 | avoided_activity_i | 1.575426042 | 67 | avoided_activity_i | 2.54397936 |
| 22 | befriend_pain_i | 1.725842135 | 44 | befriend_pain_i | 3.775025784 | 67 | befriend_pain_i | 1.767766953 |
| 22 | cannot_stand_it_i | 2.352724109 | 44 | cannot_stand_it_i | 0.74106702 | 67 | cannot_stand_it_i | 2.542902609 |
| 22 | confident_doing_sth_i | 2.74381688 | 44 | confident_doing_sth_i | 2.009268143 | 67 | confident_doing_sth_i | 1.47693535 |
| 22 | disability_i | 2.901197882 | 44 | disability_i | 1.796474994 | 67 | disability_i | 1.335385744 |
| 22 | dont_make_fuss_i | 2.400329544 | 44 | dont_make_fuss_i | 0.96835165 | 67 | dont_make_fuss_i | 0.854771199 |
| 22 | ended_activity_i | 3.112713133 | 44 | ended_activity_i | 0.25607376 | 67 | ended_activity_i | 0.640324644 |
| 22 | exhausted_i | 2.098156307 | 44 | exhausted_i | 2.270504626 | 67 | exhausted_i | 1.267058872 |
| 22 | expectation_i | 1.797990089 | 44 | expectation_i | 2.22406117 | 67 | expectation_i | 0.718087357 |
| 22 | friendly_to_myself_i | 2.104273295 | 44 | friendly_to_myself_i | 2.580083448 | 67 | friendly_to_myself_i | 2.11467042 |
| 22 | guilty_i | 2.60784345 | 44 | guilty_i | 1.180673143 | 67 | guilty_i | 0.23570226 |
| 22 | handed_over_i | 2.197777511 | 44 | handed_over_i | 0.179556223 | 67 | handed_over_i | 2.974033424 |
| 22 | happy_i | 2.185209657 | 44 | happy_i | 2.312238761 | 67 | happy_i | 1.368020056 |
| 22 | hold_on_i | 2.02693724 | 44 | hold_on_i | 1.527882924 | 67 | hold_on_i | 2.715370957 |
| 22 | ignore_pain_i | 1.720924728 | 44 | ignore_pain_i | 3.646466963 | 67 | ignore_pain_i | 1.491499125 |
| 22 | intensity_i | 2.021005511 | 44 | intensity_i | 1.686007993 | 67 | intensity_i | 1.299753197 |
| 22 | irritable_i | 2.651297518 | 44 | irritable_i | 1.14805609 | 67 | irritable_i | 1.542752758 |
| 22 | never_better_i | 1.761082743 | 44 | never_better_i | 0.840244565 | 67 | never_better_i | 3.185820502 |
| 22 | no_solution_i | 1.0229016 | 44 | no_solution_i | 3.116060986 | 67 | no_solution_i | 0.353553391 |
| 22 | not_alone_i | 1.640845173 | 44 | not_alone_i | 3.442263838 | 67 | not_alone_i | 0.50795703 |
| 22 | powerless_i | 3.114164832 | 44 | powerless_i | 1.578198461 | 67 | powerless_i | 1.609282055 |
| 22 | problems_falling_asleep_i | 4.633867421 | 44 | problems_falling_asleep_i | 1.99240984 | 67 | problems_falling_asleep_i | 1.314257481 |
| 22 | problems_staying_asleep_i | 4.863593883 | 44 | problems_staying_asleep_i | 3.529099808 | 67 | problems_staying_asleep_i | 3.519426606 |
| 22 | pull_yourself_together_i | 2.670406981 | 44 | pull_yourself_together_i | 1.663658487 | 67 | pull_yourself_together_i | 1.326788514 |
| 22 | pulled_through_i | 2.652096495 | 44 | pulled_through_i | 3.716158778 | 67 | pulled_through_i | 1.283624441 |
| 22 | sad_i | 2.960903435 | 44 | sad_i | 1.907706545 | 67 | sad_i | 2.417617589 |
| 22 | satisfying_life_i | 1.234622932 | 44 | satisfying_life_i | 1.45722245 | 67 | satisfying_life_i | 0.262034295 |
| 22 | tired_i | 3.269271416 | 44 | tired_i | 2.154801476 | 67 | tired_i | 1.537672468 |
| 22 | values_i | 2.726465811 | 44 | values_i | 1.273521858 | 67 | values_i | 1.844874047 |
| 22 | woke_too_early_i | 5.125692858 | 44 | woke_too_early_i | 3.446561747 | 67 | woke_too_early_i | 3.679385654 |
| | | | 45 | avoided_activity_i | 4.45879864 | 68 | avoided_activity_i | 1.746640169 |
| | | | 45 | befriend_pain_i | 2.273989041 | 68 | befriend_pain_i | 2.194633464 |
| | | | 45 | cannot_stand_it_i | 1.732863786 | 68 | cannot_stand_it_i | 2.471770443 |
| | | | 45 | confident_doing_sth_i | 3.766846799 | 68 | confident_doing_sth_i | 2.46491674 |
| | | | 45 | disability_i | 2.069613442 | 68 | disability_i | 1.998119417 |
| | | | 45 | dont_make_fuss_i | 2.695551145 | 68 | dont_make_fuss_i | 1.849100574 |
| | | | 45 | ended_activity_i | 3.967270524 | 68 | ended_activity_i | 1.787242454 |
| | | | 45 | exhausted_i | 1.615194452 | 68 | exhausted_i | 1.983010546 |
| | | | 45 | expectation_i | 2.363198733 | 68 | expectation_i | 2.454983168 |
| | | | 45 | friendly_to_myself_i | 1.620045457 | 68 | friendly_to_myself_i | 2.006568162 |
| | | | 45 | guilty_i | 2.791767143 | 68 | guilty_i | 1.958849849 |
| | | | 45 | handed_over_i | 3.371438802 | 68 | handed_over_i | 1.926923087 |
| | | | 45 | happy_i | 2.281585809 | 68 | happy_i | 2.19163367 |

| ID | item | within_sd | ID | item | within_sd | ID | item | within_sd |
|---|---|---|---|---|---|---|---|---|
| | | | 45 | hold_on_i | 3.789002406 | 68 | hold_on_i | 2.23158013 |
| | | | 45 | ignore_pain_i | 2.691068767 | 68 | ignore_pain_i | 2.678350033 |
| | | | 45 | intensity_i | 1.755703554 | 68 | intensity_i | 1.826771122 |
| | | | 45 | irritable_i | 1.987384761 | 68 | irritable_i | 2.714598979 |
| | | | 45 | never_better_i | 2.203436131 | 68 | never_better_i | 2.279086569 |
| | | | 45 | no_solution_i | 0.333266258 | 68 | no_solution_i | 1.852824167 |
| | | | 45 | not_alone_i | 0.166633129 | 68 | not_alone_i | 1.641412681 |
| | | | 45 | powerless_i | 2.027179504 | 68 | powerless_i | 2.419765104 |
| | | | 45 | problems_falling_asleep_i | 3.370999312 | 68 | problems_falling_asleep_i | 3.018461713 |
| | | | 45 | problems_staying_asleep_i | 3.668043819 | 68 | problems_staying_asleep_i | 3.098386677 |
| | | | 45 | pull_yourself_together_i | 3.087196901 | 68 | pull_yourself_together_i | 2.150508479 |
| | | | 45 | pulled_through_i | 3.927717119 | 68 | pulled_through_i | 2.346009249 |
| | | | 45 | sad_i | 1.850009517 | 68 | sad_i | 2.260869041 |
| | | | 45 | satisfying_life_i | 0.118678166 | 68 | satisfying_life_i | 1.985852216 |
| | | | 45 | tired_i | 1.984649339 | 68 | tired_i | 1.889324978 |
| | | | 45 | values_i | 2.990191881 | 68 | values_i | 2.059272081 |
| | | | 45 | woke_too_early_i | 2.427119505 | 68 | woke_too_early_i | 3.438345856 |

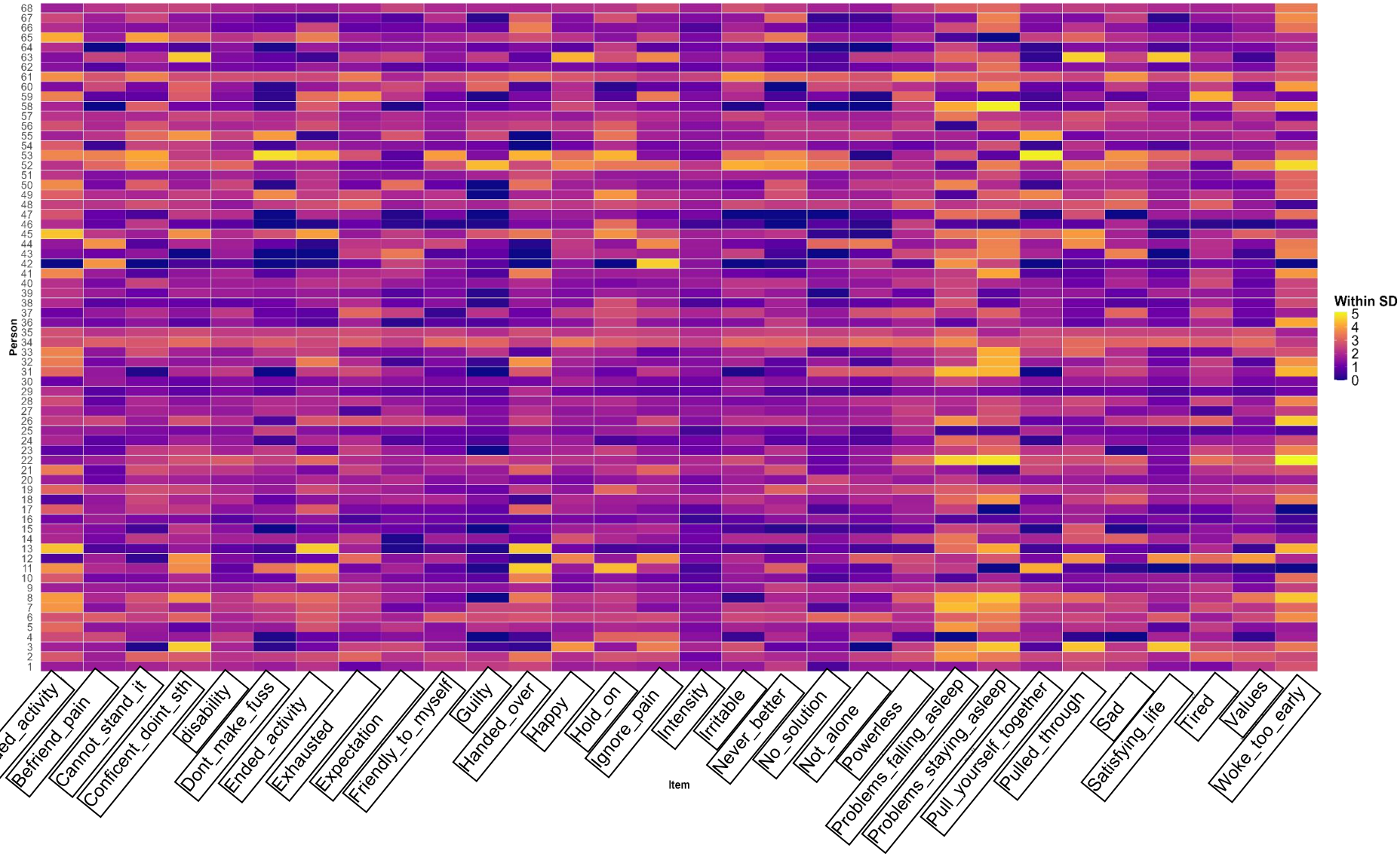
## Appendix B8.2

*Within standard deviations per participant of the preliminary re-evaluation*

| ID | item | within_sd | ID | item | within_sd | ID | item | within_sd |
|---|---|---|---|---|---|---|---|---|
| 1 | ashamed | 1.182186578 | 4 | ashamed | 0.224947625 | 7 | ashamed | 0.483045892 |
| 1 | avoided | 1.554682026 | 4 | avoided | 1.500327669 | 7 | avoided | 2.253311001 |
| 1 | befriend_pain | 0.727064033 | 4 | befriend_pain | 0.648313173 | 7 | befriend_pain | 1.196183094 |
| 1 | cannot_stand_it | 1.338831417 | 4 | cannot_stand_it | 2.032055738 | 7 | cannot_stand_it | 0.574000509 |
| 1 | confident_do_sth | 1.447695959 | 4 | confident_do_sth | 1.092183021 | 7 | confident_do_sth | 1.211912861 |
| 1 | disability | 1.024177608 | 4 | disability | 1.760859042 | 7 | disability | 1.510204044 |
| 1 | end_activity | 1.225912807 | 4 | end_activity | 1.091547446 | 7 | end_activity | 1.459225426 |
| 1 | exhausted | 0.701296297 | 4 | exhausted | 2.240705479 | 7 | exhausted | 1.839720903 |
| 1 | expectations | 0.733357643 | 4 | expectations | 1.410507969 | 7 | expectations | 1.71318015 |
| 1 | friendly_to_myself | 0.57969624 | 4 | friendly_to_myself | 1.16156646 | 7 | friendly_to_myself | 1.213843473 |
| 1 | guilty | 1.44178048 | 4 | guilty | 1.700648255 | 7 | guilty | 0.483045892 |
| 1 | hand_over | 1.707130613 | 4 | hand_over | 2.003279176 | 7 | hand_over | 2.614064524 |
| 1 | ignore_pain | 1.653498194 | 4 | ignore_pain | 1.114199771 | 7 | ignore_pain | 1.352530533 |
| 1 | intensity | 0.112149909 | 4 | intensity | 1.47997271 | 7 | intensity | 1.303840481 |
| 1 | irritable | 0.932560255 | 4 | irritable | 2.012395086 | 7 | irritable | 1.823854786 |
| 1 | listless | 0.803649059 | 4 | listless | 1.955377763 | 7 | listless | 1.48059068 |
| 1 | never_better | 2.170065267 | 4 | never_better | 1.504773037 | 7 | never_better | 0.588807451 |
| 1 | not_alone | 1.502034418 | 4 | not_alone | 0.747731553 | 7 | not_alone | 1.032795559 |
| 1 | pain_accompanies | 1.102283367 | 4 | pain_accompanies | 0.616067911 | 7 | pain_accompanies | 0.918886618 |
| 1 | pos_affect | 0.908118667 | 4 | pos_affect | 1.578155149 | 7 | pos_affect | 1.535574479 |
| 1 | pull_together_no_fuss | 1.188257878 | 4 | pull_together_no_fuss | 1.189144359 | 7 | pull_together_no_fuss | 1.387964798 |
| 1 | sad | 2.491952702 | 4 | sad | 2.389108992 | 7 | sad | 1.276401623 |
| 1 | satisfying_life | 1.325090758 | 4 | satisfying_life | 0.736510268 | 7 | satisfying_life | 1.157381389 |
| 1 | task_persist | 1.357965384 | 4 | task_persist | 1.756304529 | 7 | task_persist | 1.346303991 |
| 1 | values | 1.285434625 | 4 | values | 1.05468673 | 7 | values | 0.96673316 |
| 10 | ashamed | 0 | 5 | ashamed | 0.502836455 | 8 | ashamed | 0 |
| 10 | avoided | 0.802582827 | 5 | avoided | 1.586974875 | 8 | avoided | 1.235504369 |
| 10 | befriend_pain | 2.196067081 | 5 | befriend_pain | 1.232718722 | 8 | befriend_pain | 1.02024987 |
| 10 | cannot_stand_it | 0.769377275 | 5 | cannot_stand_it | 0.977706623 | 8 | cannot_stand_it | 0.347993115 |
| 10 | confident_do_sth | 1.505484479 | 5 | confident_do_sth | 0.900905571 | 8 | confident_do_sth | 0.458492972 |
| 10 | disability | 2.627447403 | 5 | disability | 0.97178918 | 8 | disability | 1.92203655 |
| 10 | end_activity | 0.63216588 | 5 | end_activity | 1.734603574 | 8 | end_activity | 0.093658581 |
| 10 | exhausted | 1.980583405 | 5 | exhausted | 0.86884916 | 8 | exhausted | 1.176544561 |
| 10 | expectations | 0 | 5 | expectations | 0.731709116 | 8 | expectations | 0 |
| 10 | friendly_to_myself | 1.58414766 | 5 | friendly_to_myself | 0.952241351 | 8 | friendly_to_myself | 1.021276527 |
| 10 | guilty | 0.362379195 | 5 | guilty | 1.04429399 | 8 | guilty | 0 |
| 10 | hand_over | 0.441027771 | 5 | hand_over | 1.232077583 | 8 | hand_over | 0.694422967 |
| 10 | ignore_pain | 1.692906987 | 5 | ignore_pain | 1.153376837 | 8 | ignore_pain | 1.125559427 |
| 10 | intensity | 1.643056207 | 5 | intensity | 0.935414347 | 8 | intensity | 0.73883555 |
| 10 | irritable | 0.441027771 | 5 | irritable | 1.051532504 | 8 | irritable | 2.172716167 |
| 10 | listless | 2.052649498 | 5 | listless | 0.782229948 | 8 | listless | 1.620993502 |
| 10 | never_better | 0.826196546 | 5 | never_better | 0.807772765 | 8 | never_better | 2.145770637 |
| 10 | not_alone | 1.481386342 | 5 | not_alone | 0.985514555 | 8 | not_alone | 0.9821019 |
| 10 | pain_accompanies | 1.871464921 | 5 | pain_accompanies | 1.240896051 | 8 | pain_accompanies | 1.40686652 |
| 10 | pos_affect | 1.608414231 | 5 | pos_affect | 1.350246969 | 8 | pos_affect | 1.08155988 |
| 10 | pull_together_no_fuss | 0.75738126 | 5 | pull_together_no_fuss | 0.849815924 | 8 | pull_together_no_fuss | 0 |
| 10 | sad | 0.992831449 | 5 | sad | 1.177445541 | 8 | sad | 2.07918466 |
| 10 | satisfying_life | 1.342937025 | 5 | satisfying_life | 1.177244205 | 8 | satisfying_life | 0.963589586 |
| 10 | task_persist | 2.587940474 | 5 | task_persist | 1.178518751 | 8 | task_persist | 0.160779424 |
| 10 | values | 1.693123347 | 5 | values | 0.927014157 | 8 | values | 0.781371769 |
| 2 | ashamed | 0.693643191 | 6 | ashamed | 0 | 9 | ashamed | 2.220375406 |
| 2 | avoided | 1.495205363 | 6 | avoided | 0.187547378 | 9 | avoided | 2.900255135 |
| 2 | befriend_pain | 1.071233394 | 6 | befriend_pain | 0.444829957 | 9 | befriend_pain | 0.666619188 |
| 2 | cannot_stand_it | 1.138250889 | 6 | cannot_stand_it | 0.119945684 | 9 | cannot_stand_it | 0.533455572 |
| 2 | confident_do_sth | 1.104134211 | 6 | confident_do_sth | 0.390907447 | 9 | confident_do_sth | 1.792862775 |
| 2 | disability | 1.104496281 | 6 | disability | 0.468910746 | 9 | disability | 1.217367087 |
| 2 | end_activity | 1.274892097 | 6 | end_activity | 0.119945684 | 9 | end_activity | 2.649516971 |
| 2 | exhausted | 0.907195752 | 6 | exhausted | 0.189790176 | 9 | exhausted | 1.046014404 |
| 2 | expectations | 0.966312491 | 6 | expectations | 0 | 9 | expectations | 0.710071602 |
| 2 | friendly_to_myself | 1.038060197 | 6 | friendly_to_myself | 0.471105216 | 9 | friendly_to_myself | 1.02260451 |
| 2 | guilty | 0.873285911 | 6 | guilty | 0.085125653 | 9 | guilty | 1.925510714 |
| 2 | hand_over | 1.219264269 | 6 | hand_over | 0.255376959 | 9 | hand_over | 0.09166985 |
| 2 | ignore_pain | 1.084464342 | 6 | ignore_pain | 0.27183062 | 9 | ignore_pain | 0.183339699 |
| 2 | intensity | 0.935619143 | 6 | intensity | 0 | 9 | intensity | 0.895159402 |
| 2 | irritable | 1.340378561 | 6 | irritable | 0.085125653 | 9 | irritable | 1.201527775 |
| 2 | listless | 1.418917898 | 6 | listless | 0.255376959 | 9 | listless | 1.075818288 |
| 2 | never_better | 1.002662057 | 6 | never_better | 0.085125653 | 9 | never_better | 0.409090549 |
| 2 | not_alone | 0.946031365 | 6 | not_alone | 1.459057225 | 9 | not_alone | 0.130188911 |
| 2 | pain_accompanies | 1.047709051 | 6 | pain_accompanies | 0.489820205 | 9 | pain_accompanies | 0.129090251 |
| 2 | pos_affect | 1.157179491 | 6 | pos_affect | 0.260198721 | 9 | pos_affect | 1.78026658 |
| 2 | pull_together_no_fuss | 1.152216252 | 6 | pull_together_no_fuss | 0.119945684 | 9 | pull_together_no_fuss | 1.980067315 |
| 2 | sad | 1.207787164 | 6 | sad | 0 | 9 | sad | 2.270329042 |
| 2 | satisfying_life | 1.075765042 | 6 | satisfying_life | 0.417535854 | 9 | satisfying_life | 0.458349249 |
| 2 | task_persist | 1.183204692 | 6 | task_persist | 0.247808548 | 9 | task_persist | 2.312995925 |
| 2 | values | 0.893801123 | 6 | values | 0.421319101 | 9 | values | 1.984486191 |
| 3 | ashamed | 0.446373731 | | | | | | |
| 3 | avoided | 0.278847459 | | | | | | |
| 3 | befriend_pain | 0.446373731 | | | | | | |
| 3 | cannot_stand_it | 0.803803397 | | | | | | |
| 3 | confident_do_sth | 0.771030602 | | | | | | |
| 3 | disability | 0.537416447 | | | | | | |
| 3 | end_activity | 0.151882868 | | | | | | |
| 3 | exhausted | 1.359929943 | | | | | | |
| 3 | expectations | 0.234641417 | | | | | | |
| 3 | friendly_to_myself | 0.67392193 | | | | | | |
| 3 | guilty | 0.619364355 | | | | | | |
| 3 | hand_over | 0.215081014 | | | | | | |
| 3 | ignore_pain | 0.579972508 | | | | | | |
| 3 | intensity | 0.560335951 | | | | | | |
| 3 | irritable | 0.75388593 | | | | | | |
| 3 | listless | 0.354595811 | | | | | | |
| 3 | never_better | 0.903262623 | | | | | | |
| 3 | not_alone | 0.727644174 | | | | | | |
| 3 | pain_accompanies | 0.686627041 | | | | | | |
| 3 | pos_affect | 0.738052809 | | | | | | |
| 3 | pull_together_no_fuss | 0.838855555 | | | | | | |
| 3 | sad | 1.224644412 | | | | | | |
| 3 | satisfying_life | 0.70914825 | | | | | | |
| 3 | task_persist | 0.948346053 | | | | | | |
| 3 | values | 0.709885208 | | | | | | |

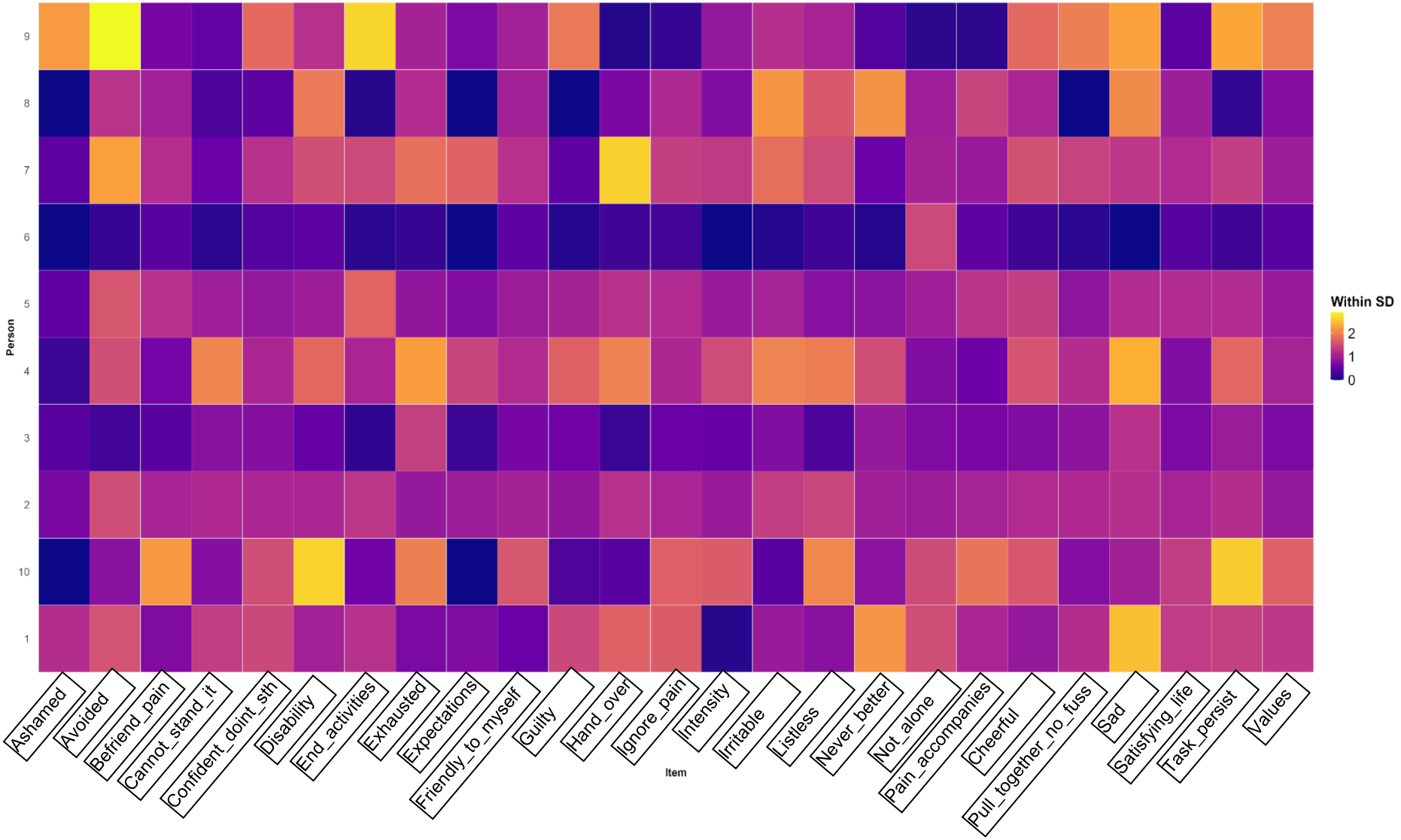
**Appendix B8.3**

*Heatmap of intraindividual standard deviations per item of the main evaluation*



**Appendix B8.4**

*Heatmap of intraindividual standard deviations of the preliminary re-evaluation, all items*



**Appendix C: Supplement Matching Matrix**

**Appendix C1**

*DELPHISTAR protocol for CBT Matching Matrix mixed-methods study*

**This reporting guideline is meant for studies using Delphi techniques in the health and social sciences.** These also include all Delphi variants and modifications that meet the following criteria:

1. Survey of several people with specialized knowledge (e.g., operational knowledge, experiential knowledge, functional knowledge, contextual knowledge);
2. Structured communication process that involves a group of people with relevant expertise;
3. Carrying out at least two survey rounds or the option to respond at least two times;
4. Feedback: the (interim) results are presented to the respondents starting in the second round;
5. Basis is a quantitative questionnaire with the possibility to contribute or supplement arguments for the respective position;
6. All answers, quantitative and qualitative, are systematically analyzed (quantitative: e.g., descriptive statistics, qualitative: e.g., thematic analysis).

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| I Title and Abstract | | 1 | Identification as a Delphi procedure in the title | Title | Matching cognitive behavioural interventions to psychological processes to personalise chronic pain treatments: an adapted group Delphi study with clinical and science experts |
| | | 2 | Identification as a Delphi procedure in the abstract | Abstract | (...) In this group Delphi study, a Matching Matrix linking CBT modules to process-based treatment targets was developed using an adapted group Delphi technique and online surveys.<br>(...) |
| | | 3 | Structured abstract | Abstract | See Abstract |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| II Context | Formal | 4 | Information about the sources of funding | Funding information | This work was not externally funded |
| | | 5 | Information about the team of authors and/or researchers (e.g., discipline, institution) | Author list | All authors are affiliated with RPTU University Kaiserslautern-Landau, psychology department, clinical psychology |
| | | 6 | Information about method consulting | | No outside consulting in regard to method took place. |
| | | 7 | Information about the project background | OSF Project | DOI: 10.17605/OSF.IO/9TUQR |
| | | 8 | Information about the study protocol | Methods | The present study was preregistered (https://doi.org/10.17605/OSF.IO/MNUQA) and approved by the university's local ethics committee (#LEK-589). |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | **Content** | 9 | Justification of the chosen method (Delphi procedure) to answer the research question | Design | The aim of the present study was to develop a Matching Matrix assigning two CBT modules (“first choice” and “second choice”) to 23 treatment targets (i. e. items assessing facets of chronic pain processes, see Study Materials). To bridge the science-practice gap and bring in multiple perspectives, the development process was designed to take place in close collaboration with clinicians as well as science experts. For this purpose, the Delphi technique represents a suitable method. (…) |
| | | 10 | Aim of the Delphi procedure (e.g., consensus, forecasting) | Design | See above |
| **III Method** | **Body & Inte-gration of know-ledge** | 11 | Identification and elucidation of relevant expertise, spheres of experience, and perspectives | Sample | In Delphi studies, expertise is usually used as an inclusion criterion (Powell, 2003; Trevelyan & Robinson, 2015). However, the concept of expertise remains poorly defined (Baker et al., 2006). Therefore, relevant indicators for clinical expertise were |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | | (e.g., theory, practice, affected groups, disciplines) | | retrieved from relevant literature (Baker et al., 2006; Hill et al., 2017; Kurniawan et al., 2023; Overholser, 2010), assessed via self-report, and will be reported in detail in the sample description, in accordance with recommendations (Trevelyan & Robinson, 2015). These indicators for example included years of professional experience, number of treated chronic pain patients, or self-ratings of empathic skills for clinicians, and taking part in national and international collaborations and self-rated communication skills for science experts. (…) |
| | | 12 | Handling of knowledge, expertise and perspectives which are missing or have been deliberately not integrated | Not in manuscript | The issue of data saturation is discussed in the Discussion section. Patients' perspectives are missing from the study and will hopefully find their way into the personalisation process, at least by using data-informed indication processes (e. g. target selection by person-specific network analysis). |
| | | 13 | Basic definition of expert[1] | Sample | Knowledge of CBT interventions and having treated at least one chronic pain patient were defined as inclusion criteria. |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | | | | These criteria allowed the inclusion of different professions whilst ensuring the necessary knowledge to match CBT interventions to specific treatment targets. CBT knowledge was assessed on a 7-point scale (1 = no knowledge, 7 = in-depth knowledge). Participants who indicated knowledge below 4 ("basic knowledge") were excluded from analyses. |
| | **Delphi varia-tions** | 14 | Identification of the type of Delphi procedure and potential modifications (e.g., classic Delphi, real-time Delphi, group Delphi) | Design | A group Delphi approach was adopted, whereby separate groups of clinicians were invited to openly discuss and provide anonymous responses to an online survey (Niederberger et al., 2024). Following common recommendations, the number of Delphi rounds was set a priori to two (Diamond et al., 2014; Trevelyan & Robinson, 2015), resulting in Study Phases 1 and 2. In Study Phase 3, a focus group was conducted with science experts to cross-validate the results of the Delphi groups. |
| | | 15 | Justification of the Delphi variation and | Not in manuscri pt | The goal of the study was not to develop a scale or similar, but to develop a matching matrix |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | | modifications, including during the Delphi process, if applicable | | based on clinicians' and researchers' recommendations. Therefore, there was no item pool that was discussed or generated, but instead recommendations were explored and later on assessed regarding the final agreement. Due to economic restrictions, the sample was divided into five focus groups for the first round. |
| | **Sample of experts** | 16 | Selection criteria for the experts (per round if there are different expert groups) | Sample | See DELPHISTAR 12 & 13<br><br>Science experts were contacted via e-mail based on their expertise in chronic pain as well as (personalising) CBT interventions. |
| | | 17 | Identification of the experts | Samples | Prof. Dr. Julia Glombiewski (JAG), Prof. Dr. Lance McCracken, Prof. Dr. Katja Boersma, and Dr. Marlies den Hollander. |
| | | 18 | Information about recruiting and any subsequent recruiting of experts | Sample | Clinicians were recruited via the university outpatient clinic and local inpatient clinics with dedicated pain treatment units. In inpatient clinics, the whole practitioner team was invited to participate, therefore different professions are represented. |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | | | | Only participants who agreed to be contacted again in phase 1 were invited to the second Delphi round (phase 2). Science experts were contacted via e-mail based on their expertise in chronic pain as well as (personalising) CBT interventions. |
| | **Survey** | 19 | Elucidation of the content development for the questionnaire [2] | Not applicable | No questionnaire was used |
| | | 20 | Description of the questionnaire (content and structure) | Not applicable/content of Delphi: Treatment Targets | The set of potential targets was based on the German “Prozesse Chronischer Schmerzen ErfaSSen” (ProCEss; English: “Assessing chronic pain processes”) item set. The ProCEss item set has been qualitatively validated (Hofmann, Glombiewski, Prasch, et al., 2026) and demonstrates overall sufficient psychometric properties (Hofmann, Glombiewski, Heider, et al., 2026). Of the ProCEss item set, 23 items assessing specific manifestations of the processes catastrophising, avoidance behaviour, |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | | | | depressive symptoms, acceptance, values-based action, expectations, thought suppression, task persistency, positive affect, negative affect, self-efficacy, and self-compassion, were used in this study (for items, also see Table 2). The original German version of the ProCEss item set as well as relevant evaluative data can be found on the ProCEss repository (https://rptu.de/s/vpcgks). |
| | **Delphi rounds** | 21 | Number of Delphi rounds | Design | 2 |
| | | 22 | Information about the aims of the individual Delphi rounds | Phase 1: clinicians first Delphi round<br><br>Phase 2: clinicians second Delphi round | The aim of *phase 1* was to develop an initial Matching Matrix based on clinicians' recommendations.<br>The aim of *phase 2* was to assess the agreement of the clinicians with the Matching Matrix developed based on phase 1.<br>The aim of *phase 3* was to validate the clinicians' selections by a focus group with psychological science experts. |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | | | Phase 3: science expert focus group | |
| | | 23 | Disclosure and justification of the criterion for discontinuation | Design | Following common recommendations, the number of Delphi rounds was set a priori to two. |
| | **Feed-back** | 24 | Information about what data was reported back per round | Phase 1: clinicians first Delphi round<br><br>Phase 2: clinicians second Delphi round | From the second group, the two most frequently selected modules per item were presented.<br>After providing sociodemographic and expertise information, the clinicians were presented with the results of phase 1 one match at a time. |
| | | 25 | Information on how the results of the previous Delphi round were fed back to the experts surveyed (e.g., via | | See above |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | | frequencies, mean values, measures of dispersion, listing of comments) | | |
| | | 26 | Information on whether feedback was differentiated by specific groups (e.g., by field of expertise, institutional affiliation) | | The results were aggregated across all groups of round 1. Results of rounds 1 and 2 as well as the researchers' focus group are reported individually in the manuscript as well as in the supplemental materials. |
| | | 27 | Information about how dissent and unclear results were handled | Phase 2: clinicians second Delphi round<br><br>Phase 3: science expert focus group<br><br>Overall Results | In the event of a tie between modules for either the first or second choice, all tied modules were displayed, and participants were asked to rank them from first to third.<br><br>If no clear majority emerged for a given item in Phase 2, the decision could be overruled by the focus group of researchers. That means, a module was considered accepted if a majority was reached either among the clinicians or among the researchers. |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | | | | The remaining eight target-module matches (17.39 %), all of which involved second-choice modules, were subject to discussion within the study team. These were selected based on the frequency of module selections in phase 1 and the qualitative comments from both phases 2 and 3. |
| | **Data analysis** | 28 | Disclosure of the quantitative and qualitative analytical strategy | Phase 2: clinicians second Delphi round<br><br>Phase 3: science expert focus group | These qualitative comments were used in cases that did not meet the pre-defined selection criteria to complete the matching matrix.<br>The qualitative comments transcribed were used in cases that did not meet the pre-defined selection criteria to complete the matching matrix. |
| | | 29 | Definition and measurement of consensus | | Consensus was not set as a goal for this study. The set criteria were described above (majority, agreement). Agreement scores were reported descriptively. |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | 30 | Information on group-specific analysis or weighting of experts (e.g., theory vs. practice, discipline-specific analysis) | | Data was not weighted by group. |
| IV Results | **Delphi process** | 31 | Illustration of the Delphi process (e.g., in a flow chart) | Design | The complete procedure is depicted in Figure 1. |
| | | 32 | Information about special aspects during the Delphi process (e.g., deviations from the intended approach with justification) | Not applicable | |
| | | 33 | Number of experts per round (both invited and participating) | Figure 1 | The number of experts participating in the first Delphi round was 25, and the number of experts in the second round was 16. This corresponds to a |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | | | | response rate 64 % in the second round. |
| | **Results** | 34 | Presentation of the results for each Delphi round and the final results | Results of phase 1: clinicians first Delphi round<br><br>Results of phase 2: clinicians second Delphi round<br><br>Results of phase 3: science expert focus group<br><br>Overall results | For the 23 first-choice selections, 66.40 % of items met the criterion of at least a simple majority agreement. (…) Regarding the second-choice selections, the criterion of at least a simple majority was met for 46.84 % of the 23 items.<br><br>Regarding the mean agreement rating of > 5 on a 7-point scale, all first-choice modules met this threshold. Among the second-choice modules, three did not meet the selection criterion.<br><br>Regarding the primary criterion of this focus group – namely, a majority agreement (i. e. at least three out of four researchers) – the criterion was met for 31 out of 46 matches (67.391 %). 22 item-module-matches received unanimous agreement from all four researchers.<br><br>The final matching matrix is presented in Table 2. Of all 46 item-module-matches, 21 (46.65 %) fulfilled all three primary |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | | | | criteria: a majority of clinicians in phase 1, a mean agreement of ≥ 5 in phase 2, and a majority of researchers. For an additional 17 matches (36.96 %), at least one majority – either among clinicians or researchers – was present, and these matches were therefore also included in the final matrix. Of these 17 matches, there were two that were included in the final matrix despite missing two criteria. The remaining eight item-module-matches (17.39 %), all of which involved second-choice modules, were subject to discussion within the study team. These were selected based on the frequency of module selections in phase 1 and the qualitative comments from both phases 2 and 3. |
| V Discussion | **Quality of findings** | 35 | Highlighting the findings from the Delphi study | Discussion | The aim of this mixed-methods study was to develop a structured Matching Matrix linking two CBT modules to individual, chronic pain-related processes, thereby addressing a central challenge in personalised psychotherapy: how to support clinical decision-making in the absence of |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | | | | robust, component-level empirical data. Using a group Delphi approach with clinicians and a focus group with science experts, a complete matrix covering 23 target processes was generated. Notably, first-choice module selections showed high robustness, as all first-choice selections met the predefined criteria and required no further discussion by the study team. This suggests that clinicians and science experts share a substantial degree of implicit agreement regarding core intervention–target relationships in chronic pain treatment. (…) |
| | | 36 | Validity of the results (e.g., transferability of the findings) | Conclusion | The procedure used to develop this Matching Matrix is replicable, suitable to bridge the science-practice gap, and can guide future efforts to personalise psychotherapy, also beyond the context of chronic pain. |
| | | 37 | Reliability of the results (e.g., split half, inter-rater reliability) | Not applicable | |

| Topic | Section | Item | Checklist Item | Location where item is reported | Exemplary answer |
|---|---|---|---|---|---|
| | | 38 | Reflection on potential limitations (e.g., distortion, skewing, bias) | Strengths and limitations | Too extensive for this form, please read manuscript |

[1] "Experts" are the participants; this can be people from academia, practice, or representatives of lived experience (e.g., patients, family members).

[2] The term "questionnaire" stands for the survey instrument regardless of whether quantitative or qualitative items are integrated or weighted.

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**Appendix C2**

*ProCEss item set, corresponding psychopathological models and process definitions*

| Process | Model | Definition | Item(s) |
|---|---|---|---|
| Catastrophising | | Catastrophising describes the tendency to perceive negative aspects of a situation or possible consequences in an excessive manner, and to ruminate about or anticipate them (Dorsch Lexikon der Psychologie) | I thought: “It will never get better!” |
| | | | I thought: “I cannot stand it any longer!” |
| Avoidance | Fear-Avoidance/Avoidance-Endurance (Hasenbring & Verbunt, 2010; Vlaeyen & Linton, 2000) | Avoidance constitutes a behaviour aiming at prevention, reduction, or termination of the exposure to certain experiences (in pain context: experience of pain) (McCracken, 2005) | I stopped activities because of my pain. |
| | | | Due to my pain I asked others to do strenuous activities for me. |
| | | | I avoided activities that cause pain. |
| Depression | | A depressive episode is marked by subdued mood and listlessness with a reduction of activity. Even in light forms feelings of guilt and thoughts about the own worthlessness can occur (BfArM, 2023) | I felt irritable. |
| | | | I felt guilty. |
| | | | I felt sad. |
| | | | I felt listless. |

| Process | Model | Definition | Item(s) |
|---|---|---|---|
| Thought Suppression | | Thought suppression denotes a cognitive reactive pattern that forcefully ends the perception of pain or the disruption of daily activities by pain (Hasenbring & Verbunt, 2010; Oxford University Press) | I thought: “Pull yourself together!”/”Don’t make such a fuss!”<br>I tried not to think about my pain. |
| Task persistence | | Task persistence describes a physical over-activity that can lead to over-use of bodily structures (Hasenbring & Verbunt, 2010) | I pulled through despite my pain. |
| Positive affect | Avoidance-Endurance (Hasenbring & Verbunt, 2010) | Positive affect marks an emotional state of pleasant mood or feelings that promotes approach-oriented behaviour or causes the experience of relaxation, contentment, or serenity (Finan & Garland, 2015) | I felt cheerful despite my pain. |
| Negative affect | | Negative Affect is a general dimension of subjective distress and unpleasurable engagement that subsumes a variety of aversive mood states, including anger, contempt, disgust, guilt, fear, and nervousness. | I felt ashamed. |

| Process | Model | Definition | Item(s) |
|---|---|---|---|
| | | (Watson & Clark, p. 1063)<br><br>Ashamed is an item of the PANAS (Breyer & Bluemke, 2016) | |
| Acceptance | Psychological Flexibility Model (McCracken & Morley, 2014) | Acceptance is an embracing attitude that leads to goal-oriented behaviour within the personal frame of control as well as distancing oneself from attempts to control unwanted feelings or unchangeable circumstances (McCracken & Morley, 2014) | I tried to befriend my pain.<br><br>I was able to accept that the pain would accompany my life. |
| Values | | Values are subjectively desirable states that influence behaviour. They include beliefs about what is right and wrong and what is important in life (Oxford University Press; Spektrum Lexikon der Psychologie) | I tried to prioritise those things really important to me. |
| Expectations | Predictive Coding (Wiech, 2016) | Expectations describe beliefs about what will happen based on previous experiences and likelihood (Oxford University Press; Wiech, 2016) | I assume that my pain will increase until the next survey. |

| Process | Model | Definition | Item(s) |
|---|---|---|---|
| Pain self-efficacy (Nicholas, 2007) | Others | Self-efficacy constitutes the belief to be able to handle even difficult situations successfully and to possess the required abilities (Bandura, 1977) | I trusted myself to be able to do something even though I was in pain. |
| | | | I was sure that I could live my life satisfactorily, even though I was in pain. |
| Self-compassion (Neff 2003b; 2011) | | Self-compassion describes a non-judging understanding for one's own suffering, shortcomings, or failure. It can be divided in the three facets of self-kindness, sense of common humanity, and mindfulness (Neff, 2003b; 2011) | I tried to be friendly to myself. |
| | | | I have told myself that I am not alone with my problems. |

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**Appendix C3**

*Predefined module pool for the matching matrix*

| Module name | Goal | Exemplary working unit(s) | Adapted from |
|---|---|---|---|
| Exposure in vivo | Correcting beliefs and reducing the recurrence of fear of movement, enhancing activity levels by reducing avoidance behaviour | Developing a movement hierarch by fear level<br>Performing movements of the hierarchy without avoiding or protection | Nicholas et al. (2003) |
| Relaxation | Reducing stress and tension that could aggravate pain experience | Practicing breathing techniques, Progressive Muscle Relaxation etc. | Kleinstäuber, Bleichhardt et al. (2018)<br>Kleinstäuber, Thomas et al. (2018)<br>Nicholas et al. (2003) |
| Activity and rest (based on pacing) | Balancing activity and rest to enhance flexibility and feelings of control | Activity protocol<br>Activity and rest plan<br>Short practices (e.g. stretching) | Main et al. (2015)<br>Nicholas et al. (2003) |
| Cognitive coping with pain | Reducing rigid, dysfunctional thought patterns<br>Building flexible, functional thought patterns | Thought protocol<br>Cognitive restructuring<br>Metacognitive techniques (e.g. labelling) | Kleinstäuber, Bleichhardt et al. (2018)<br>Kleinstäuber, Thomas et al. (2018)<br>Nicholas et al. (2003) |

| Module name | Goal | Exemplary working unit(s) | Adapted from |
|---|---|---|---|
| Attention control | Enhancing coping with pain, enhancing level of functioning | Anti-pain diary<br>Distraction alphabet | Kleinstäuber, Bleichhardt et al. (2018)<br>Kleinstäuber, Thomas et al. (2018)<br>McCracken (2005)<br>Nicholas et al. (2003) |
| Activating resources | Relief, balancing inconvenient and pleasant experiences | Positive diary<br>Reflecting on healthy areas in the body | Kleinstäuber, Bleichhardt et al. (2018)<br>Kleinstäuber, Thomas et al. (2018) |
| Acceptance | Regaining mental resources, relief | Peace treaty with oneself<br>Disengaging from thoughts | McCracken (2005) |
| Values-based action | Enhancing quality of life, regaining control | Prioritising values<br>Reviewing life | McCracken (2005) |
| Self-compassion | Enhancing well-being and feelings of self-worth | Self-compassion break<br>Letter to oneself | Germer & Neff (2013)<br>Germer & Neff (2019) |

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**Appendix C4**

*Sociodemographic and Expertise results of study phase 1*

**Assessed variables:** age, gender (female, male, diverse), country of birth, nationality/nationalities, mother tongue(s), highest school leaving certificate, and vocational training qualification.

**The expertise variables assessed for the clinicians in phases 1 and 2 were:** employment relationship(s), profession(s), specialisation(s) (e. g. Acceptance and Commitment Therapy, ACT), setting(s), professional experience in years, and number of treated chronic pain patients (categorical: 0, 1-2, 3-10, 11-20, 21-50, > 50). The following variables were all assessed using a 7-point Likert scale (1 = very poor, 7 = very good): empathic skills, flexibility at work, self-reflection skills, and overall treatment competence for chronic pain. Patient- as well as colleague-feedback was rated on a 7-point Likert scale ranging from 1 = very negative to 7 = very positive. Lastly, clinicians indicated whether they were members in occupational unions, and whether there had been an ethics complaint against them.

**Appendix C4.1**

*Sociodemographic information of clinicians in phase 1 after exclusions*

| Age | Gender | Country of birth | Mother tongue* | Secondary school qualification | Professional qualification | Employment* | Professional group affiliation* |
|---|---|---|---|---|---|---|---|
| *M* = 38.36<br>*SD* = 12.52<br>Range: 24-62 | Female = 19<br>Male = 3 | Germany = 21<br>Other (Polen) = 1 | German = 22 | Sedondary school leaving certificate = 1<br>A-Level = 19 + 2 | Apprenticeship = 1<br>Master's degree/Diploma = 13 + 1<br>Doctoral degree = 6<br>Other: Staatsexamen = 1 | Full-time = 7<br>Part-time = 13 + 1<br>Self-employed = 4 | Specialist nurse = 1<br>Assistant doctor = 1<br>Specialist doctor = 2<br>2 Psychosomatics<br>1 Psychotherapy<br>Licensed psychotherapist = 8 (CBT, 1 without specialised knowledge)<br>Psychotherapist in training = 9 (CBT)<br>Research associate = 4<br>Professor = 1<br>Other: CBT co-therapist = 1 |

*Note.* N = 22; *Multiple selection possible

**Appendix C4.2**

*Expertise information of clinicians in phase 1 after exclusions*

| | | | |
|---|---|---|---|
| **Specialisations*** | None = 15 | | |
| | Yes = 7 | | |
| **Setting*** | Outpatient = 4 | | |
| | University outpatient clinic = 10 | | |
| | Day clinic = 3 | | |
| | Inpatient = 14 | | |
| | Other = 2 (Uni) | | |
| **Number treated pain patients** | 7 x 3-10 | | |
| | 3 x 11-20 | | |
| | 2 x 21-50 | | |
| | 10 x > 50 | | |
| **Professional association membership** | No = 11 + 1 (due to indication of compulsory membership) | | |
| | Yes = 10 | | |
| **Ethics complaint** | No = 21 | | |
| | Yes = 1 | | |
| | ***Mean*** | ***SD*** | **Range** |
| **Professional experience in years** | 11.36 | 10.04 | 1-30 |
| **Empathic skills (1-7)** | 6.27 | .83 | 4-7 |
| **Flexibility (1-7)** | 5.77 | 0.87 | 4-7 |
| **Self reflection (1-7)** | 5.86 | 0.94 | 4-7 |
| **Pain treatment skills (1-7)** | 5.05 | 1.25 | 3-7 |
| **CBT knowledge (1-7)** | 5.68 | 0.72 | 4-7 |
| **Patient feedback (1-7)** | 6.18 | 0.73 | 4-7 |
| **Colleague feedback (1-7)** | 6.14 | 0.56 | 5-7 |

*Note.* *Multiple selection possible

**Appendix C5**

*Sociodemographic and Expertise results of study phase 2*

**Appendix C5.1**

*Sociodemographic information of clinicians in phase 2 after exclusions*

| Age | Gender | Country of birth | Mother tongue* | School qualification | Professional qualification | Employment* | Professional group affiliation* |
|---|---|---|---|---|---|---|---|
| *M* = 37,733<br>*SD* = 12,87<br>Range: 26-62 | Female = 14<br>Male = 1<br>Non-binary = 0 | Germany = 14<br>Other = 1 (Belarus) | German = 14 + 1x Russian + 1x French<br>Other = 1 (Russian) | Secondary school leaving certificate = 1<br>A-Level = 14 | Apprenticeship = 1<br>Master´s degree/Diploma = 10<br>Doctoral degree = 4 | Full-time = 5<br>Part-time = 8 + 1<br>Self-employed = 3 | Specialist nurse= 1<br>Assistant doctor = 1<br>Specialist doctor = 2 (2 Psychosomatics)<br>Licensed psychotherapist = 5 (KVT)<br>Psychotherapist in training = 7 (KVT)<br>Research associate = 2 |

Note. N = 15; * multiple selection possible

**Appendix C5.2**

*Expertise information of clinicians in phase 2 after exclusions*

| | | | |
|---|---|---|---|
| **Specialisations*** | None = 10 | | |
| | Yes = 5 | | |
| **Setting*** | Outpatient = 4 | | |
| | University outpatient clinic = 6 | | |
| | Day clinic = 1 | | |
| | Inpatient = 9 | | |
| **Number treated pain patients** | 5 x 3-10 | | |
| | 1 x 11-20 | | |
| | 3 x 21-50 | | |
| | 6 x > 50 | | |
| **Professional association membership** | No = 7 + 1 (due to indication of compulsory memberships) | | |
| | Yes = 7 | | |
| **Ethics complaint** | No = 14 | | |
| | Yes = 1 | | |
| | ***Mean*** | ***SD*** | **Range** |
| **Professional experience in years** | 11.20 | 10.65 | 1-30 |
| **Empathic skills (1-7)** | 6.47 | 0.64 | 5-7 |
| **Flexibility (1-7)** | 5.80 | 0.78 | 4-7 |
| **Self reflection(1-7)** | 5.93 | 0.59 | 5-7 |
| **Pain treatment skills(1-7)** | 5.00 | 1.00 | 4-7 |
| **CBT knowledge (1-7)** | 5.60 | 0.63 | 5-7 |
| **Patient feedback (1-7)** | 6.20 | 0.41 | 6-7 |
| **Colleague feedback (1-7)** | 6.00 | 0.38 | 5-7 |

*Note.* N = 15; * multiple selections possible

**Appendix C6**

*Sociodemographic and Expertise results of researcher focus group*

**Appendix C6.1**

*Sociodemographic information of science experts in phase 3*

| Age | Gender | Country of birth | Nationality | Mother tongue* |
|---|---|---|---|---|
| *M* = 52,75 | Female = 3 | Netherlands = 2 | Dutch= 2 | Dutch = 2 |
| *SD* = 6,5 | Male = 1 | Poland = 1 | German = 1 | English = 1 |
| Range: 47-62 | Non-binary = 0 | US = 1 | US/UK = 1 | German = 1 |

*Note.* N = 4; * multiple selection possible

**Assessed variables:** All participating researchers in phase 3 were asked to describe their area of expertise in their own words as well as specialisations. The following variables were rated on a 7-point Likert scale: CBT knowledge (1 = no knowledge, 7 = in-depth knowledge), capacity for independent continuing education (1 = completely disagree, 7 = completely agree), participation in national and international collaborations (1 = completely disagree, 7 = completely agree), quality of feedback each from colleagues and students (1 = very negative, 7 = very positive), and communication skills (1 = very poor, 7 = very good).

**Appendix C6.2**

*Expertise information of science experts in phase 3*

| | |
|---|---|
| **Specialisations** | ACT 2 |
| | CBT 1 |
| | CBT license, Supervisor 1 |
| | Licensed psychologist 1 (Sweden) |
| **Area of Expertise** | Behavioural approaches to chronic pain and other chronic conditions, ACT 1 |
| | Exposure, ACT 1 |
| | Health Psychology, chronic pain 1 |
| | Psychotherapy for chronic pain 1 |
| | ***Mean* (SD)** |
| **Professional experience in years** | 26.75 (4.5) |
| **CBT Knowledge (1-7)** | 6.75 (.5) |
| **Self-initiated continuing education (1-7)** | 6.75 (.5) |
| **National collaborations (1-7)** | 6.5 (1.00) |
| **International collaborations (1-7)** | 6 (1.41) |
| **Colleague feedback (1-7)** | 5.5 (.58) |
| **Student Feedback (1-7)** | 6 (.82) |
| **Communication-skills (1-7)** | 5.25 (.5) |

## Appendix C7

*Matching Matrix decision rationale*

| Item | I thought: "It will never get better!" | | I thought: "I can't stand it any longer!" | | I stopped activities becaues of my pain. | |
|---|---|---|---|---|---|---|
| | First Choice | Second Choice | First Choice | Second Choice | First Choice | Second Choice |
| | **Cognitive Module** | **Activating Resources** | **Selfcompassion** | **Cognitive Module** | **Exposure in vivo** | **Activity and Rest** |
| **Frequency Module selection Criterion: > 11 (n = 22)** | 16 | 9 | 13 | 3x First Choice, 3x Second Choice | 15 | 12 |
| **Agreement Clinicians Round 2 Criterion: > 5 (*n* = 15)** | 5.6 | 4.933 | 5.333 | 4.867 (agreement for module as first choice) | 5.333 | 5.333 |
| **Frequency agreement researcher Criterion: >2 (*n* = 4)** | 4 | 3 | 0 | not available | 3 | 1 |
| **Comments clinicians phase 2 (translated to English)** | Acceptance | | | NOTE: Most frequent choice was Activating Resources (*n* = 7), but it failed all three criteria (agreement Round 2 = 4.8, researcher agreement = 1) | | |
| **Comments researcher** | Everyone agreed; [with] patients who are very [therapy] experienced, change [to Activating Resources] Activating Resources bettern than fighting thoughts of patient | | Item functionally different from the other; both represent catastrophising thoughts; not clear why Selfcompassion instead of Cognitive (2x) | Attentional shift makes more sense, more welcoming; more accepting; depending on what "it" is, even exposure (test if you can stand it) | Type of pain important; Acceptance seems crucial, seems to be classic lack of acceptance | |
| **Reasoning for decision** | | Majority of Researchers | Majority of clinicians | Cognitive Module had more clinicians' votes than Attentional Control; Cognitive Module was suggested as first choice by researchers | | Majority of clincians |

| Item | Due to my pain I asked others to do strenuous activities for me. | | I avoided activities that cause pain. | | I felt irritable. | |
|---|---|---|---|---|---|---|
| | First Choice | Second Choice | First Choice | Second Choice | First Choice | Second Choice |
| | **Exposure in vivo** | **Values** | **Exposure in vivo** | **Activity and Rest** | **Selfcompassion** | **Acceptance** |
| **Frequency Module selection Criterion: > 11 (n = 22)** | 11 | 12 | 17 | 10 | 14 | 8 |
| **Agreement Clinicians Round 2 Criterion: > 5 (*n* = 15)** | 5.333 | 5.333 | 5.6 | 5.6 | 5.133 | 5.6 |
| **Frequency agreement researcher Criterion: >2 (*n* = 4)** | 3 | 4 | 4 | 2 | 3 | 4 |
| **Comments clinicians phase 2 (translated to English)** | | Selfcompassion would also fit | | | | |
| **Comments researcher** | Activity and Rest equal alternative, depending on [functionality] | Values as first choice, motivation, sets stage for adressing problem; Can be good [starting] point to get into exposure | Alternative: Acceptance, Values (3x); If clear avoidance: Exposure; Assuming activity is not highly relevant, Exposure not good choice; Depending on person and behaviour patterns: Which one better? | | Attentional Control; Relaxation can ease feeling or irritation; Overlap between Relaxation and Acceptance; If Acceptance means openness to discomfort, certainly apply; If irritable about pain, openness to pain would be remedy; If irritable with myself: Selfcompassion; If irritable towards others: Acceptance | |
| **Reasoning for decision** | Majority of reseachers | | | Clearly most frequent choice including first and second choice; Exposure includes values (therefore not Values Module) | | Majority of researchers |

| Item | I felt guilty. | | I felt sad. | | I felt listless. | | I was exhausted. | |
|---|---|---|---|---|---|---|---|---|
| | First Choice | Second Choice | First Choice | Second Choice | First Choice | Second Choice | First Choice | Second Choice |
| | **Cognitive Module** | **Selfcompassion** | **Activating Resources** | **Values** | **Activating Resources** | **Activity and Rest** | **Activity and Rest** | **Relaxation** |
| **Frequency Module selection Criterion: > 11 (n = 22)** | 15 | 13 | 13 | 9 | 11 | 8 | 19 | 14 |
| **Agreement Clinicians Round 2 Criterion: > 5 (*n* = 15)** | 5.8 | 5.533 | 5.133 | 5.4 | 5.667 | 5.467 | 5.8 | 4.733 |
| **Frequency agreement researcher Criterion: >2 (*n* = 4)** | 2 | 4 | 1 | 3 | 4 | 2 | 4 | 1 |
| **Comments clinicians phase 2 (translated to English)** | | | Acceptance first choice; Values first choice, Resources second | | First choice would be Values, then Activity and Rest, then Activating Resources; behind those is Behavioural Activation | | Relaxation only in combination with other things; rather behavioural activation, by that values-oriented | |
| **Comments researcher** | Alternative: Values; If specific situation: Cognitive; "A little cognitive module for dessert only" | Would be first choice (3x); If more about general idea of oneself, rather Self-compassion | Activating Resources seems beside the point, like running away; Acceptance more to embrace sadness; Alternative: Selfcompassion, Acceptance (3x); Sadness tells what you are missing, Values as way to move on; Careful with Values, not like sad shouldn't be there | | Alternative: attention/awareness; Where does it come from, what is the signal?; At least one of these modules should be used, both serve same function, making new reinforcing experiences | | Surprise that Activating Resources not selected; Context important: exhausted [from] things not really important, or after long day of doing things I liked?; Activity and Rest understandable; Exhausted because stress: Relaxation; Nothing clearly makes [Relaxation] first choice | |
| **Reasoning for decision** | Majority of clinicians | | Majority of clinicians | Majoritiy of researchers | Majority of reseachers | Overall most votes as second choice, content-wise values can be included | | Majority of clinicians |

| Item | I tried to befriend my pain. | | I was able to accept that the pain would accompany my life. | | I tried to prioritise those things really important to me. | |
|---|---|---|---|---|---|---|
| | First Choice | Second Choice | First Choice | Second Choice | First Choice | Second Choice |
| | **Acceptance** | **Values** | **Acceptance** | **Values** | **Values** | **Activating Resources** |
| **Frequency Module selection Criterion: > 11 (n = 22)** | 15 | 1x first choice 4x second choice | 17 | 13 | 21 | 14 |
| **Agreement Clinicians Round 2 Criterion: > 5 (*n* = 15)** | 5.867 | not available | 5.867 | 5.867 | 6 | 5.667 |
| **Frequency agreement researcher Criterion: >2 (*n* = 4)** | 4 | not available | 4 | 4 | 4 | 4 |
| **Comments clinicians phase 2 (translated to English)** | | NOTE: Selfcompassion with 7 votes most frequent second choice in Round 1 (agreement Round 2: 5.8; agreement researcher: 1) | Acceptance and Attention Control also doable | | | |
| **Comments researcher** | Everyone agreed | Alternative: Values | Everyone agreed; not really an Acceptance item | It's the experience that makes Acceptance; one cannot do one without the other | Everyone agreed; Interventions seem to overlap; Activating Resources more activating; If Values too abstract [or] dont't want to talk much: Activating Resources as first choice | |
| **Reasoning for decision** | | Theory-guided: Values = more active; if Acceptance contra-indicated, Selfcompassion probably contra-indicated as well because of large overlap; clinicians' rating Values also possible | | | | |

| Item | I assume that my pain will increase until the next survey. | | I thought: "Don't make such a fuss!"/ "Pull yourself together!" | | I tried not to think about my pain. | | I pulled through despite my pain. | |
|---|---|---|---|---|---|---|---|---|
| | First Choice | Second Choice | First Choice | Second Choice | First Choice | Second Choice | First Choice | Second Choice |
| | **Cognitive Module** | **Attention Control** | **Selfcompassion** | **Cognitive Module** | **Attention Control** | **Acceptance** | **Activity and Rest** | **Selfcompassion** |
| **Frequency Module selection Criterion: > 11 (n = 22)** | 15 | 10 | 8 | 5 | 11 | 8 | 16 | 10 |
| **Agreement Clinicians Round 2 Criterion: > 5 (*n* = 15)** | 5.6 | 5.667 | 5.333 | 5.267 | 5.2 | 5.267 | 5.8 | 5.133 |
| **Frequency agreement researcher Criterion: >2 (*n* = 4)** | 4 | 2 | 4 | 2 | 4 | 4 | 3 | 0 |
| **Comments clinicians phase 2 (translated to English)** | | | NOTE: There was a tie on second choice with Activity and Rest (Round 1: 5 votes on second choice, Round 2 agreement: 5, researcher agreement: 0)<br><br>COMMENT: Cognitive as first choice<br><br>Round 2 preference: Cognitive instead of Activity and Rest | | Values would be second choice; instead of Attention Control, Activity and Rest relevant to replace persistence behaviour with better Pacing | | | |
| **Comments researcher** | Makes sense, very classic; If Fear Avoidance close in network, also Exposure or Behavioural Experiments | If Exposure succeeds, it leads to attentional shift: rather Exposure | Everyone agreed; Selfcompassion would cover some of [Cognitive], too | Alternative [to Activity and Rest]: Values, overlaps with Self-compassion<br><br>Content not calling to Cognitive; Rather Cognitive than Activity and Rest (4x); If it's the way you speak with yourself: Cognitive Restructuring | Seem to overlap, one might lead to the other; Attentional Control has "shouldn't be there" in it, rather Acceptance; Acceptance first choice, pain is there anyway; Attention Control is stricter; If Attention Control includes attentional widening, it becomes more Acceptance | | | No understanding, rather Values or Acceptance; "despite" is problem here |
| **Reasoning for decision** | | Attention Control = clear second choice of clinicians and is also the target/goal according to researchers' comments | | Decision between Activity and Rest and Cognitive Module instead of discussing entirely new module; larger agreement for Cognitive Module in both groups | Majority of researchers | Majority of researchers | | Selfcompassion includes Acceptance; large gap in frequencies in Round 1 between Selfcompassion and Acceptance --> Selfcompassion stays |

| Item | I felt cheerful despite my pain. | | I trusted myself to be able to do something even though I was in pain. | | I was sure that I could live my life satisfactorily, even though I was in pain. | | I tried to be friendly to myself. | |
|---|---|---|---|---|---|---|---|---|
| | First Choice | Second Choice | First Choice | Second Choice | First Choice | Second Choice | First Choice | Second Choice |
| | **Activating Resources** | **Values** | **Exposure in vivo** | **Activating Resources** | **Values** | **Activating Resources** | **Selfcompassion** | **Cognitive Module** |
| **Frequency Module selection Criterion: > 11 (n = 22)** | 16 | 12 | 13 | 12 | 17 | 10 | 20 | 8 |
| **Agreement Clinicians Round 2 Criterion: > 5 (*n* = 15)** | 5.867 | 5.667 | 5.133 | 5.067 | 6 | 5.733 | 5.8 | 5.067 |
| **Frequency agreement researcher Criterion: >2 (*n* = 4)** | 4 | 4 | 3 | 3 | 4 | 3 | 4 | 2 |
| **Comments clinicians phase 2 (translated to English)** | | | Values and then Activity and Rest; Cognitive seems more fitting | | | | Second choice would be Acceptance; instead of Cognitive Module: Acceptance | |
| **Comments researcher** | Everyone agreed | Depends on patient, more practically oriented: Activating Resources, if capable: Values | Exposure builds trust in yourself | Activity and Rest would be more in line; Agreement with information that Activating Resources reminds patients of what they still can do | Everyone agreed | Acceptance would be relevant | Everyone agreed | Alternative: ACT approach (Acceptance or Values); Values could be nice to reinforce "be friendly" not just cognitively, more like an attitude (Values and Selfcompassion) |
| **Reasoning for decision** | | | | | | Majority of researchers | | Pro Acceptance: 2 clinicians and researchers suggested it, has only 1 vote less than Cognitive overall from Round 1<br><br>Pro Cognitive: seems better alternative to Selfcompassion, still has most votes, behavioural level included with behavioural experiments |

| Item | I have told myself that I am not alone with my problems. | | I felt ashamed. | |
|---|---|---|---|---|
| | First Choice | Second Choice | First Choice | Second Choice |
| | **Selfcompassion** | **Activating Resources** | **Cognitive Module** | **Selfcompassion** |
| **Frequency Module selection Criterion: > 11 (n = 22)** | 10 | 7 | 13 | 14 |
| **Agreement Clinicians Round 2 Criterion: > 5 (*n* = 15)** | 5.533 | 5.133 | 5.533 | 5.8 |
| **Frequency agreement researcher Criterion: >2 (*n* = 4)** | 4 | 3 | 1 | 4 |
| **Comments clinicians phase 2 (translated to English)** | Work cognitively here as well; Acceptance instead of Activating Resources | | Selfcompassion first choice | |
| **Comments researcher** | | Tendency to go away from it, Acceptance is more [like] "get in contact"; Alternative: Attention Control, attentional perspective | Values before Cognitive: What do you care about, what is the signal? | First choice (2x) |
| **Reasoning for decision** | Majority of researchers | Majority of researchers | Majority of clinicians | |

**Appendix D: Supplement Study Protocol**

**Appendix D1**

*Sampling Scheme of POINT Pain proof-of-principle study including all study phases*

| Study phase | Assessment mode | Duration | Assessment frequency | Questionnaire density | Incentives |
|---|---|---|---|---|---|
| Pre-test | Clinical screening interview (Mini-DIPS; Margraf & Cwik, 2020)<br>Conventional Questionnaires | 2 hours | Single-time assessment | 69 items (see outcome measures) | 50 € for general participation |
| Onboarding | Semi-structured qualitative interview | 1 hour | Single-time assessment | 29 regular items of EMA questionnaire | |
| A: Baseline 1 | EMA | 21 days | Six assessments per day | First questionnaire of the day: 29 items + 1 disctractor + 1 repeated single-item measure<br>Others: 26 items + 1 disctractor + 1 repeated single-item measure<br>Max. delay 30 minutes<br>Completion time max. 15 minutes total (2-3 minutes per questionnaire) | 50 € if at least 80 % assessments are completed |
| B: probatory phase | SCED | 3 weeks | Three assessments per week (two during the week, one at weekend) | 29 items + 1 distractor + 1 repeated single-item measure<br>Max. delay 3 hours | |

| Study phase | Assessment mode | Duration | Assessment frequency | Questionnaire density | Incentives |
|---|---|---|---|---|---|
| | | | | Completion time 2-3 minutes | |
| A': Baseline 2 | SCED | 1-3 weeks | Three assessments per week (two during the week, one at weekend) | 29 items + 1-2 individual items + 1 distractor + 1 repeated single-item measure<br>Max. delay 3 hours<br>Completion time 2-3 minutes | |
| C: Therapy | SCED | Up to 12 weeks | Three assessments per week (two during the week, one at weekend) | 29 items + 1-2 individual items + 1 distractor + 1 repeated single-item measure<br>Max. delay 3 hours<br>Completion time 2-3 minutes | |
| D: Post | Conventional questionnaires | 20 minutes | Single-time assessment | 70 items (see outcome measures) | |
| D: Post | SCED | 2 weeks | Three assessments per week (two during the week, one at weekend) | 29 items + 1-2 individual items + 1 distractor + 1 repeated single-item measure<br>Max. delay 3 hours<br>Completion time 2-3 minutes | |
| D: Post | EMA | 21 days | Six assessments per day | First questionnaire of the day: 29 items + 1-2 individual items + 1 disctractor + 1 repeated single-item measure | 50 € if at least 80 % assessments are completed |

| Study phase | Assessment mode | Duration | Assessment frequency | Questionnaire density | Incentives |
|---|---|---|---|---|---|
| | | | | Others: 26 items + 1 disctractor<br>Max. delay 30 minutes<br>Completion time max. 15 minutes<br>total (2-3 minutes per questionnaire) | |
| Three months | Conventional questionnaires | 1 hour | Single-time assessment | 70 items (see outcome measures) | |
| Follow-up | Semi-structured qualitative interview<br>Feasibility and acceptance scale | | | Feasibility scale | |

**Appendix D2**

*RoBiNT self-rating for POINT Pain proof-of-principle study*

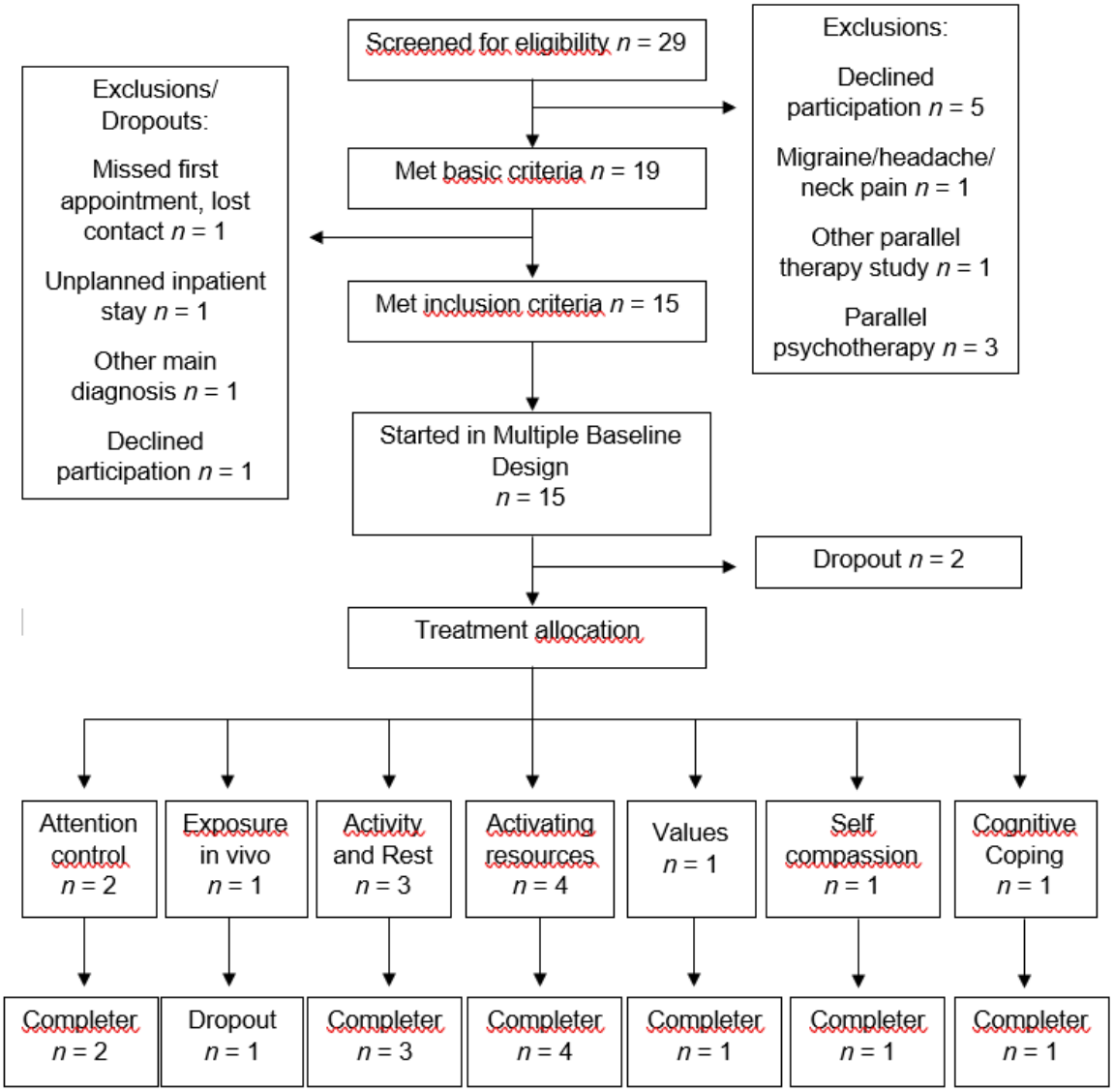
| Item | Expected points | Explanation |
|---|---|---|
| Design | 0 | Non-concurrent Multiple Baseline Design across 12 participants does not meet criterion for the award of any point for this item. |
| Randomisation | 1 | Restricted randomisation: The onset of phase C is randomised. |
| Sampling behaviour during all phases | 1 | Each phase contains at least 3 data points. |
| Blinding (masking) of the participant and the practitioner/entity delivering the intervention | 0 | In psychotherapy, blinding is very hard to achieve. The therapist knows the intervention he delivers and the participants know they are receiving psychotherapy as there is no control condition in this study. In order to receive the participants' consent to the intervention, they need to be informed. |
| Blinding (masking) of the assessor | 0 | The study management was also study therapist in at least four cases. Study management was aware of the phases and interventions of the other participants as well to ensure the necessary organisation of the study. |
| Inter-rater agreement | 2 | Data is collected via self-report in a repeated questionnaire. Visual analysis is for weekly monitoring purposes only and discussed by therapist and supervisor ($n$ = 2). The estimation regarding existence and magnitude of the treatment effect is statistical. We therefore expect 2 points on this item. |
| Treatment adherence | 1 | Self-reported adherence by the study therapists is analysed by the study management who treated at least four participants themselves. Adherence will later be analysed using video recordings of the session by independent raters, but the procedure is not yet specified. |
| Baseline characteristics of participants | 2 | The person-specific network is used as a functional analysis and accompanied by a micro analysis as is usual in CBT. Age and sex are assessed and will be |

| Item | Expected points | Explanation |
|---|---|---|
| | | reported for each participant, aetiology and symptom severity are assessed at the pre-test for each participant. |
| Setting | 2 | There will be detailed information on the general (i. e. outpatient clinic) as well as the specific setting of the intervention (i. e. single or double sessions, rooms of outpatient clinic or outside, used materials) |
| Dependent variable – target behaviour | 2 | To identify the treatment target, we rely on self-report data using an EMA questionnaire with an 11-point scale. The target itself is selected based on the mean ratings during phase A and averaged centrality of the contemporaneous and temporal networks. The target is assessed throughout all SCED phases. Details on the assessment and selection of the treatment target will be reported in the Methods section, changes in the target scores will be reported in the Results section. |
| Independent variable – intervention | 2 | All interventions and their respective materials can and will be described in detail, along with the number of sessions, session duration, and frequency. |
| Raw data record | 2 | We will provide the graphed raw data of each participant. Data is collected during all phases and all data points will be depicted. |
| Data analysis | 2 | We conduct statistical analysis with a specified rationale regarding existence of an effect and its size. Results on the statistical analysis will be adequately reported. Visual analysis is mainly used for the monitoring of the treatment target regarding trend and level. |
| Replication | 0 | The study does not contain any replication in the sense of another independent Multiple Baseline Design. A replication with a larger sample size will be |

| Item | Expected points | Explanation |
|---|---|---|
| | | planned after analysing the results of this feasibility study. |
| Generalisation | 1 | A test battery is administered pre- and post-intervention and will be used to assess transfer and/or generalisation effects. Furthermore, all participants answer the whole EMA questionnaire throughout all phases regardless of their individual target, enabling the analysis of transfer effects on the other variables as well. However, it was not determined a priori which variables will be analysed exactly to discuss transfer effects. |
| Total | 18/30 | |

**Appendix D3**

*Participant Flow Chart after study completion*



## Appendix E: Curriculum Vitae

**Work Address**
Rheinland-Pfälzische Technische Universität

Kaiserslautern-Landau

Klinische Psychologie und Psychotherapie des

Erwachsenenalters

Ostbahnstr. 10

76829 Landau

### Education

| | |
|---|---|
| 12/2023 - present | PhD student under supervision of Dr. Saskia Scholten and Prof. Dr. Julia Glombiewski, RPTU Kaiserslautern-Landau |
| 04/2021 – 09/2024 | Post-graduate training in cognitive-behavioural therapy, WiPP Landau e.V. (RPTU-Kaiserslautern-Landau) |
| 10/2018 – 12/2020 | Master of Science Psychology, University of Koblenz-Landau |
| 10/2015 – 09/2018 | Bachelor of Science Psychology, University Ulm |
| 06/2015 | Secondary School Leaving Examination (Abitur), Liebfrauenschule Bensheim |

### Professional Experience

| | |
|---|---|
| 10/2022 - present | Research Fellow/Research Assistant, RPTU Kaiserslautern-Landau, Department of Clinical Psychology and Psychotherapy (Prof. Dr. Julia Glombiewski) |
| 05/2021 – 08/2022 | Psychotherapist in training, Pfalzklinikum for Psychiatry and Neurology |
| 05/2019 – 04/2021 | Student Research Assistant, University of Koblenz-Landau, Department of Clinical Psychology and Psychotherapy (Dr. Saskia Scholten) |

Landau, June 3rd 2026 Verena E. Hofmann

**Appendix F: Statutory Declaration**

I hereby declare that I have developed and written the enclosed dissertation entirely by myself. I have listed all resources I have used in the dissertation. Generative AI-applications (namely ChatGPT versions 5.2 and 4o; https://www.chatgpt.com/) were used to revise text passages both in the publication manuscripts as well as the synopsis and to generate, shorten, and correct R analysis code. Text revisions did not go beyond grammatical corrections and stylistic improvements and are therefore not marked in text passages. After using ChatGPT, I reviewed and edited the content as needed and take full responsibility for the content of this dissertation.

The contributions of my co-authors to the manuscript are detailed in the preface. References to the work and theories of others have been fully and correctly cited and indicated. The dissertation has not been submitted in the same or similar form to this or any other university in Germany or abroad for the award of a doctoral degree. The above statement was made as a solemn declaration. I believe and state it to be true to the best of my knowledge and declare that it has the same legal significance and value as if it were made under oath.

Landau, June 3rd 2026, Verena E. Hofmann