

CREATIVITY, INTELLIGENCE AND GIFTEDNESS: A STUDY WITH
PRIMARY SCHOOL CHILDREN

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Dedication

This dissertation is dedicated to those who are my refuge and my fortress:

my family.

Their unconditional love and support have always made me strong and free, so I could seek for the accomplishment of my dreams!

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At this moment I am ending a journey started a few years ago. It was an arduous but beautiful walk, along which I fortunately was not alone, and there is much to thank.

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Epigraph

Creativity is intelligence having fun.

Albert Einstein

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List of Abbreviations

Abbreviation	Meaning
ANCOVA	analysis of covariance
ANOVA	analysis of variance
CC	classical creativity
CI	classical intelligence
<i>d</i>	Cohen's measure of effect size
ET	<i>Entdeckertag</i> program
<i>F</i>	F-distribution variable
IQ	intelligence quotient
<i>M</i>	mean
<i>N</i>	sample size
ns	not statistically significant
<i>p</i>	p-value (attained level of significance)
<i>r</i>	estimate of the Pearson correlation coefficient
SD	standard deviation
<i>t</i>	Student's t distribution
<i>Z</i>	Z-score
α	Cronbach's alpha coefficient
β	probability of a Type II error or power of test
~	approximately equal to
η_p^2	partial eta-squared

Abstract

The present work investigated three important constructs in the field of psychology: creativity, intelligence and giftedness. The major objective was to clarify some aspects about each one of these three constructs, as well as some possible correlations between them. Of special interest were: (1) the relationship between creativity and intelligence - particularly the validity of the threshold theory; (2) the development of these constructs within average and above-average intelligent children and throughout grade levels; and (3) the comparison between the development of intelligence and creativity in above-average intelligent primary school children that participated in a special program for children classified as “gifted”, called *Entdeckertag (ET)*, against an age-class- and-IQ matched control group. The ET is a pilot program which was implemented in 2004 by the Ministry for Education, Science, Youth and Culture of the state of Rhineland-Palatinate, Germany. The central goals of this program are the early recognition of gifted children and intervention, based on the areas of German language, general science and mathematics, and also to foster the development of a child’s creativity, social ability, and more. Five hypotheses were proposed and analyzed, and reported separately within five chapters. It has been hypothesized that; (1) the threshold theory could be confirmed, (2) in a longitudinal design, creativity scores would increase from Time 1 to Time 2 if intelligence scores increase, but only when $IQ < 120$, (3) intelligence scores would increase continually throughout grade levels (one to four), whereas creativity scores would experience a slump in the fourth grade, (4) in a longitudinal design, intelligence scores would increase from Time 1 to Time 2 within all grades, whereas creativity scores would once more show a slump in the fourth grade, and (5) intelligence and creativity scores would increase for the ET participants only. To analyze these hypotheses, a sample of 217 children recruited from Pestalozzi *Grundschule*, from first to fourth grade, and between the ages of six and ten years, was tested for intelligence and creativity. Children performed three tests: Standard

Progressive Matrices (SPM) for the assessment of classical intelligence, Test of Creative Thinking – Drawing Production (TCT-DP) for the measurement of classical creativity, and Creative Reasoning Task (CRT) for the evaluation of convergent and divergent thinking, both in open problem spaces. Participants were divided according to two general cohorts: Intervention group ($N = 43$), composed of children participating in the *Entdeckertag* program, and a non-intervention group ($N = 174$), composed of children from the regular primary school. For the testing of the hypotheses, children were placed into more specific groups according to the particular hypothesis that was being tested. Data analyses were performed using the statistical package IBM® SPSS® Statistics version 21. It could be concluded that creativity and intelligence were not significantly related. The threshold theory was not confirmed; the correlation coefficient between intelligence and creativity for $IQ < 120$ was not significantly greater than the correlation coefficient for $IQ > 120$. However, with the addition of variables such as gender and grade level the pattern of the relationship changes (girls from fourth grade presented a nonlinear correlation, confirming the threshold theory). Additionally, intelligence accounted for less than 1% of the variance within creativity; moreover, scores on intelligence were unable to predict later creativity scores. The development of classical intelligence and classical creativity throughout grade levels also presented a different pattern; intelligence grew increasingly and continually, whereas creativity stagnated after the third grade. Performance on intelligence, measured as operating in closed problem spaces, was different from the performance measured as operating in open problem spaces. Finally, the ET program proved to be beneficial for classical intelligence after two years of attendance, but no effect was found for creativity. Overall, results indicate that organizations and institutions such as schools should not look solely to intelligence performance, especially when aiming to identify and foster gifted or creative individuals.

Keywords: intelligence, creativity, giftedness, childhood.

1. Introduction

The current society, which is characterized by sudden changes and problems that become increasingly more complex each day, is beginning to require people that are capable of adapting to these rapid transformations and that are able to solve these kinds of problems. The present work addresses to three interesting and complex constructs that researchers argue are the keys to overcoming difficulties and demands resulting from this situation.

These topics are very important in the field of psychology and have become essential in the current configuration of the world; they are: creativity, intelligence and giftedness. These three constructs were chosen for this study because of their importance in today's society. The contemporary society requires more progressive developments to be made in each one of the three domains. There is a long debate on these constructs and the existing relationship (or the lack of) between them. However, current research within these fields remains ambiguous. No consensus has been reached about important issues such as conceptualizations and consequent measurement methods.

Research in intelligence dominated academia for some time with creativity taking the back seat. It was only in 1950, with Guilford's address (Isaksen & Murdock, 1993; Plucker & Makel, 2010), that attention to the creativity field was attracted and the amount of research on this topic significantly increased (Lubart & Georgsdottir, 2004; Rhodes, 1961; Sternberg & Lubart, 1999). Reviewing the literature, one may discover that the question of whether creativity and intelligence are similar or different constructs, or about the existence of any kind of correlation between them, figure among the most frequent ones. Another issue often addressed is to what extent creativity can be predicted by intelligence or if it is possible for someone to be creative without a high level of intelligence and vice versa (Batey & Furnham, 2006). Surprising as it may seem, after a century of research, no consensus has been reached. The lack of a consensus among researchers about the definition of intelligence and creativity

may be one of the reasons for these contradictory findings. According to Batey and Furnham (2006), “a considerable obstacle in resolving this issue concerns how intelligence and creativity researchers refer to each others’ concepts” (p. 363).

Literature shows that as complex as the constructs of creativity and intelligence are, as well as the contradictory and inconclusive findings on both topics, the study of the relationship between the two is just as complex. Depending on the way that these constructs are conceptualized, they become more similar or more different and the correlation between them varies accordingly (Jaarsveld, Lachmann, & van Leeuwen, 2012).

However, according to Sternberg and O'Hara (1999) and Sternberg, Lubart, Kaufman, and Pretz (2005), there is a consensus on three basic results concerning the relationship between creativity and intelligence: (1) creative people have a tendency to present an above average IQ; (2) the two constructs seem to be more strongly correlated up to an IQ level of 120, and weakly or not correlated when IQ is above 120; (3) the correlation often varies from weak to moderate.

Additionally, Sternberg and O'Hara (1999) claim that the study of the relationship between intelligence and creativity can be divided into five approaches. Each approach considers intelligence and creativity from a different point of view. They are: (1) Creativity considered as a subset of intelligence, (2) Intelligence as a subset of creativity, (3) Creativity and intelligence as overlapping sets, (4) Creativity and intelligence considered as coincident sets, and (5) Creativity and intelligence as disjoint sets. To these authors, the most popular approach among researchers is the third one, where both concepts are assumed to be different constructs, but with some overlapping aspects.

The most known theory that considers creativity and intelligence as overlapping sets is the threshold theory. This theory affirms that a positive correlation is found to occur until an IQ threshold of 120. Beyond this threshold no correlation can be observed (Lubart, 2003; Runco, 2007). Studies about the threshold theory are inconsistent and contradictory. There is

no consensus about its validity. Researcher's opinions are divided. While some authors defend and have found results that prove the existence of this threshold (Cho, Nijenhuis, Van Vianen, Kim, & Lee, 2010; Fuchs-Beauchamp, Karnes, & Johnson, 1993; Weinstein & Bobko, 1980), others did not encounter any proof of it and are skeptical about the validity of the IQ-threshold of 120 (Jauk, Benedek, Dunst, & Neubauer, 2013; Kim, 2005; Preckel, Holling, & Wiese, 2006; Runco, Millar, Acar, & Cramond, 2010; Theurer, Kastens, Berner, & Lipowsky, 2011.) Research on this topic remains unclear.

Recently, another view that considers creativity and intelligence as overlapping sets has been developed. It is a new approach that measures the cooperative cognitive processes between creativity and intelligence and is termed "Creative Reasoning" (Jaarsveld, Lachmann, Hamel, & van Leeuwen, 2010). Intelligence cooperates with creativity in the creative thinking process (Jaarsveld et al., 2012). Additionally, a novel and innovative measurement method called The Creative Reasoning Task (CRT) is under development (Jaarsveld et al., 2010; Jaarsveld et al., 2012). The CRT is a test that measures this cooperative cognitive process, measuring intelligence and creativity in open problem spaces. This is the CRT differential; normally, classical intelligence is valued in closed problem spaces.

The task consists of conceiving a matrix similar to those found in the Standard Progressive Matrices (SPM) test. The matrix must be solvable and as difficult as possible. Since convergent and divergent thinking are to be measured by the CRT two sub-scores were developed (Jaarsveld et al., 2012). Therefore, the CRT presents two sub-scores, the CRT Relations and the CRT Components & Specifications, which are assumed to measure convergent and divergent thinking, respectively (Jaarsveld et al., 2012). Findings presented by Jaarsveld et al. (2012) revealed no correlation between both sub-scores. They suggested that "even though creative reasoning may require interplay of divergent and convergent operations, they are clearly distinguishable abilities in this task" (p. 185).

Clearly, the relationship between intelligence and creativity has yet to be completely understood. Researchers have not found a consensus about this topic until now. What they do agree on is that both play an essential role in the evolution of mankind. In the words of Sligh, Connors, and Roskos-Ewoldsen (2005), “certainly, intelligence and creativity are two of the most important and valued individual qualities in our rapidly changing world. They result in scientific discoveries and social solutions that affect quality of life for many people for many years” (p. 123).

Intelligence and creativity also play an important role on giftedness research and they are relevant for the definition of giftedness. Indeed, the study of giftedness began as synonymous with high intelligence. With the work of Lewis Terman began the research on giftedness and the notion that high IQ defines the gifted individual (Robinson, 2005; Sternberg, Jarvin, & Grigorenko, 2011). However, many researchers agree that giftedness is a complex and multifaceted phenomenon and the conventional intelligence tests are not adequate enough to define it; other abilities are also important and need to be considered (Brown et al., 2005; Reis & Renzulli, 2011; Sternberg et al., 2011).

Recent research has suggested that a high level of intelligence, coupled with high levels of creativity, together with other factors such as personality traits, motivation and environmental factors make up what is called giftedness. However, there is a lack of consensus concerning the concept of giftedness (Robinson, 2005), the characteristics of the gifted individual, about how it develops, etc. (Reis & Renzulli, 2011). Research on giftedness is diverse. There are many distinct definitions of giftedness, and as reported, so far only little consensus has been reached.

In contrast, there is an almost general consensus among researchers about the importance of gifted education. Gifted students require challenging educational experiences with others students who are equal to them (Feldhusen, 2005; Robinson, 2005) in order to learn and develop at their own level of aptitude (Feldhusen, 2005; Mönks & Heller, 1994).

Researchers have found that gifted education, which includes special curriculum and instruction, enhances performance of the gifted students (Gentry & Owen, 1999; Gentry, 1999; Kulik, 1992).

In 2004, the Ministry for Education, Science, Youth and Culture of the state of Rhineland-Palatinate, Germany, in an attempt to recognize and support gifted children from kindergarten through fourth grade, implemented a pilot program named *Entdeckertag*. The central concern of this program is the early intervention for children with extraordinary abilities, based on the areas of German language, general science and mathematics, as well as support children's creativity, their social ability, and more. Statistics from 2010/2011 showed that 424 children from 206 primary schools have already attended by the program (Ministry for Education, Science, Youth and Culture of the State Rhineland-Palatinate, 2009).

In light of all that has been aforementioned, given that (a) intelligence, creativity, and giftedness play relevant roles not only at the present moment, but all throughout human history, (b) there is no agreement on the respective topics researched, which means that many issues remain unclear. The purpose of this study was to elucidate some aspects about each one of these three topics, as well as possible correlations between them. Of special interest were: (1) the relationship between creativity and intelligence, particularly the validity of the threshold theory; (2) the development of these constructs within average and above-average intelligent children and throughout all grade levels; and (3) the comparison between the development of intelligence and creativity in above-average intelligent children that participated of the *Entdeckertag* program with an age-and-class matched control group.

According to the presented literature, it can be concluded that the importance of research on these topics is evident. It is believed that these aforementioned reasons justified very well the necessity of more studies. Nevertheless, more reinforcements may be necessary. Milgram (1990) highlighted that the study of creativity is important and that researchers must

be active and devoted in their work for the reason that, “creative solutions to the intransigent problems that continue to plague our world are urgently required” (p. 229).

Neisser et al. (1996) wrote about the importance of the study of intelligence with the following assertion, which can also be extended to the study of creativity and giftedness:

In a field where so many issues are unresolved and so many questions unanswered...

The study of intelligence... needs self-restraint, reflection, and a great deal more research. The questions that remain are socially as well as scientifically important.

There is no reason to think them unanswerable, but finding the answers will require a shared and sustained effort as well as the commitment of substantial scientific resources. Just such a commitment is what we strongly recommend (p. 97).

The present study is an attempt to respond to Neisser and his colleagues' recommendation. It is an effort in the search for a better understanding of these phenomena that are essential for the continuity of the development of the humankind and for improving the lives of others. This study focuses on these three areas, and particularly on children, who are the leaders and inventors of the future. Child research is supported by Tannenbaum (1983), who wrote “... there is no hesitation to focus on children, since precocity among the young is seen as a reliable forerunner of their future distinction” (p. 85). When writing about the general consensus that the study of giftedness should focus on children.

With the world depending on the cleverness and originality of gifted individuals, the increase in knowledge and understanding of creativity, intelligence, giftedness and the relationship established between them appears to be crucial in order to support the advancement of the identification, encouragement, and nurturing of these attributes while still in the early stages of a person's early life. Overall, the main purpose of this work is to contribute to the understanding of these topics, because as Hunt (2011) well highlighted in this sense, “much has been learned; much remains to be learned” (p. 882).

2. Literature Review

2.1 Creativity

Creativity is one of the most intriguing human abilities. It is recognized as a powerful and valuable resource, and has been challenging philosophers and scientists for a very long time. Creativity is very important in the collective society as well in individual situations for human evolution, modifications in society, arts and science, as well as in everyday life (Runco, 2008; Sternberg et al., 2011; Sternberg & Lubart, 1999). Several studies have been conducted; much has been discussed and inferred about what creativity is, where it comes from, how to measure it, and etc. Assumptions have been made, yet much remains unclear.

The accepted belief that research in creativity began with the address of the former president of the American Psychological Association, J.P. Guilford, is not entirely accurate (Isaksen & Murdock, 1993; Plucker & Makel, 2010); in fact, this information is not really precise. The beginning of creativity studies date back much earlier (Plucker & Makel, 2010; Plucker & Renzulli, 1999; Runco, 2010a). However, after Guilford's address, much attention to the field was attracted and, the amount of research aimed at this topic greatly increased (Lubart & Georgsdottir, 2004; Rhodes, 1961; Sternberg & Lubart, 1999).

Torrance (1988), in his publication about the difficulty of the conceptualization of creativity, reported, "creativity is almost infinite. It involves every sense - sight, smell, hearing, feeling, taste, and even perhaps the extrasensory. Much of it is unseen, nonverbal, and unconscious. Therefore, even if we had a precise conception of creativity, I am certain we would have difficulty putting it into words" (p. 43). For Runco and Albert (2010), creativity plays such diverse and fundamental roles that perhaps, because of this, it has been so hard to define it. Those authors also emphasized that several generations of writers, philosophers, and artists were needed to develop the concept of creativity.

The Study of Creativity

If creativity is going to be studied in some scientific method, a definition should be established, even if it was a rough conception (Torrance, 1988). One definition of creativity that has more or less been agreed upon by researchers is: creativity is the ability to produce something unique, original, something that has never been seen before; but also it must be useful, of necessity and fulfill a purpose (Lubart, 1994; Lubart & Georgsdottir, 2004; Runco, 2008; Sternberg & Kaufman, 2010; Sternberg & Lubart, 1999).

Creativity is a very broad phenomenon. It can be seen and studied in various ways and different forms. Each study addresses creativity from the point of view of which the researcher finds most important. Researchers have been focusing on what they view as the key to which will give them better understanding of creativity. As a consequence, the study of creativity as well as the construct is intricate and multifaceted. Now, it appears as though each research is a piece of a puzzle that needs to be sorted in order to understand the phenomenon as a whole.

Creativity research is generally divided into a framework defined as the *four P's*; this represents one form of division within the study of creativity. It was first employed by Rhodes (1961). This framework categorizes the study of creativity in: the person, the process, the product, and the place. According to Murdock and Puccio (1993), this structure has the flexibility required to address the multifaceted nature of creativity. In the following paragraphs, a summary of the study of creativity using Rhodes' framework is presented.

Creativity in the Person

The focus here is on the individual, his/her creative potential, and the characteristics required to be creative. Rhodes (1961) listed the following topics to this category: personality, intellect, temperament, habits, attitudes, self-concept, value systems, defense mechanisms, etc. In this category, an intricate interplay between abilities and personality aspects is

presented (Sternberg & Kaufman, 2010). Personality traits can either encourage or discourage creativity. Therefore, the assessment of the creative personality is an important factor when judging if these characteristics exist within an individual (Torrance from an interview reported in Shaughnessy, 1998).

According to Torrance (Shaughnessy, 1998), several researches agreed that willingness to take risks, curiosity, independence in thinking and judgment, persistence, courage, initiative, sense of humor, inquisitiveness, and the willingness to attempt difficult tasks/situations are characteristics that facilitate creativity. On the other hand, haughtiness, controlling, negativity, resistance, fearfulness, fault-finding, conformance, submissiveness to authority, and timidity are among the characteristics that impede creativity.

Runco (2008) calls attention to the role of motivation in creativity. Research validates the idea that creativity does not simple occur, that “people work at it, are interested in it, and intentionally nurture or utilize it” (p. 164). He highlights that several researchers accept that motivation is relevant and valuable to creativity, particularly intrinsic motivation. Indeed, intrinsic motivation appears as one of the main characteristics of creativity in studies that consider personality traits (Runco, 2008). It refers to the motivation to engage in an activity by an interest in the task itself, for the reason that it is perceived as attractive, challenging and enjoyable, and moreover, causes pleasure in doing it (Collins & Amabile, 1999).

To Runco and Pagnani (2011), when referring to a creative person, notable individuals, such as Leonardo Da Vinci or Albert Einstein, usually come to mind. Runco and Pagnani (2011) also pointed out that many people conceive of creativity as out-of-reach and only occurring among individuals with an enormous creative talent/ability, such as the Leonardo Da Vinci’s artwork; while, the fact that all people have the potential to be creative in their daily lives is forgotten. According to them, creativity can be expressed within many domains and levels. There is the eminent creativity and also the everyday creativity. The eminent creativity, also known as *Big C*, refers to those monumental and socially praised

achievements of prominent individuals; while the everyday creativity, also called *Small c*, refers to those daily creative endeavors, usually not acknowledged by others (Runco & Pagnani, 2011).

Creativity in the Process

Here the focus is on the creative process, to examine the steps involved.

Understanding the nature of mental mechanisms that arise when a person is involved in the creative process (Kozbelt, Beghetto, & Runco, 2010). According to Runco and Pagnani (2011), studies of the creative process are useful for the comprehension of the creative potential. Research on this topic complements research on creative persons, because there may be processes used by creative people which are not used as often by less creative persons. Torrance (Shaughnessy, 1998) explained his choice for focusing on the process, reporting that, studying the creative process, would enable him to discover what type of individual would successfully engage in the process, which environments factors would facilitate such engagements, and what types of products would result from them.

According to Lubart (1994), the creative process concerns the succession of thoughts and procedures that guide creative production. To him, there are many models aimed at explaining the creative process, but the most prominent is the four-stage creative process model. This model assumes that, for solving a creative problem, four stages are involved. It requires both conscious and unconscious mental activity. The stages are: preparation (conscious), incubation (unconscious), illumination (unconscious), and verification (conscious).

Creativity in the Product

In this topic the focus is on the creative production itself. According to Runco and Pagnani (2011), the creative products can be studied in a very objective manner. They have the advantage of being evaluated and judged with quantitative objectivity (Kozbelt et al.,

2010; Runco, 2005). For Plucker and Makel (2010), although the study of creative products is among the most important aspects of creativity measurement, they are not as widely studied as the other three (person, process, and place).

To Runco and Pagnani (2011), studies of creative production presume that the understanding of what creativity is can be reached by analyzing the end results, and they are usually correct; research on this topic is valuable and attractive, but does not bring a thorough comprehension of the creative process. These authors recall that not all creative endeavors will end in a product. Kozbelt et al. (2010) also highlight that when studying a product inferences become necessary, since little can be directly said about the process leading to it or to the creator's personality.

Creativity in the Place

Also known as *press*, this may be the broadest category in the study of creativity (Runco & Pagnani, 2011). Studies in this approach take into account the environment. More than that, it is associated with the interactions that happen between both people and place (Kozbelt et al., 2010). According to Rhodes (1961), the expression *press* applies to the relationship between human beings and the surrounding environment.

Lubart (1999) affirms that often creativity is studied out of context. Most of the time a person, product, or a creative process is examined without considering the environment; however, he recalls that, "creativity does not occur in a vacuum" (p. 339); the environment is always there and can affect the creative expression deeply, either encouraging or discouraging it.

According to Lubart (1999) and Runco and Pagnani (2011), some interconnected environmental contexts exert influence on creativity, such as the physical scenery, the family background, the school or work settings, the historical surroundings, and the cultural milieu.

Runco and Pagnani (2011) are of the opinion that both our past and present constantly influence our creative processes and production.

Studies conducted in different cultures show that creativity depends upon the context. The nature of creativity and the creative process is, to some extent, influenced by the cultural tradition in which it operates (Lubart, 1999). According to Runco and Pagnani (2011), the influence of culture over creativity is determined by three variables: (1) the extent of resources accessible, (2) the level of modernization and, (3) the particular zeitgeist of the moment.

Culture channels creativity to some domains of society or population subgroups, as well as affecting the general creativity activity level by motivating or impeding it (Lubart, 1999). Culture and creativity are interconnected. The definition of creativity itself may be a good example of the culture's influence on creativity. Even the meaning of the concept may change when applied to Western or Eastern culture. In the former culture the conception is a "product-oriented, originality-based phenomenon", while in the latter it is considered "as a phenomenon of expressing an inner truth in a new way or of self-growth" (Lubart, 1999, p. 347).

Further Theories of Creativity

In addition to the four P's framework, creativity has been commonly studied within sub-fields of psychology. To understand the construct of creativity, many approaches have been employed, such as: mystical, pragmatic, psychodynamic, psychometric, cognitive, social-personality and others (Lubart, 1994; Sternberg & Lubart, 1999). Ward and Kolomyts (2010) define creativity as a multifaceted phenomenon that require a substantial amount of approaches to comprehend it.

However, some creativity scholars are pointing to the importance of the confluence of approaches to understand the construct as a whole composition in a multidisciplinary view

(Lubart, 1994; Lubart & Georgsdottir, 2004; Murdock & Puccio, 1993; Sternberg & Lubart, 1999). It seems that in the last decades, a more integrated conception of creativity was sought, in which different approaches come together (Lubart & Georgsdottir, 2004).

One of these confluence theories is the investment theory of creativity, developed by Sternberg and Lubart. In this theory, “creative people are ones who are willing and able to ‘buy low and sell high’ in the realm of ideas” (Sternberg & Lubart, 1999, p. 10). Buying low implies that someone has an idea that is originally unknown or still not valued, but has potential to be appreciated. Selling high involves the persistence of the creative person in convincing others that the idea has value, generating a positive return, and then moving on to new ideas (Lubart, 1994; Sternberg & Lubart, 1999; Sternberg, 2009; Sternberg et al., 2011).

This theory presumes that a cooperation of six components is necessary for the manifestation of creativity. These components are different and at the same time interconnected; they are: intellectual abilities, knowledge, styles of thinking, personality, motivation, and environment (Sternberg & Lubart, 1999; Lubart, 1994; Sternberg, 2009; Sternberg et al., 2011).

Lubart (1994) emphasized that the interaction among these components generates creativity, but creativity itself is not merely the outcome of the addition of the person’s scores on each component. There are some conditions that may interfere in this process, such as: (1) Regardless the intensity of all other components, creativity may not occur if for one component there is a threshold still needing to be reached. For instance, a minimum level of knowledge is necessary to be creative; below this threshold creativity is not possible. (2) A strong component can compensate for a weak one. For example, a high level of motivation can compensate for an environment which is not favorable to the development of creativity. (3) Two strong components may interact and increase creativity two-fold. For example, the confluence of high levels of motivation coupled with high levels of intelligence (Sternberg, 2009).

According to Sternberg (2009), the fact that a person has abilities is not sufficient; first, it is necessary that he or she decides to employ it, as creativity is a result of the decision-making process. To be considered creative, a person must first decide to produce many new ideas, analyze them, and finally, sell them to others. Together, these three steps represent the three intellectual abilities that a creative work requires: the production of innovative ideas, analytical assessment, and practical follow-through, respectively (Sternberg, 2005b).

Another confluence theory is the componential model of creativity developed by Amabile. Here, creativity is the result of the interaction of three main components: domain-relevant skills, creativity-relevant skills, and intrinsic task motivation (Amabile, 1990). The domain-relevant skills include, “memory for factual knowledge, technical proficiency, and special talents in the domain in question” (Amabile, 1990, p. 76). The creative-relevant skills embrace, “a cognitive style favorable to taking new perspectives on problems, an application of heuristics for the exploration of new cognitive pathways, and a working style conducive to persistent, energetic pursuit of one's work” (Amabile, 1990, p. 78). Finally, the intrinsic task motivation is composed of two elements, “the individual's baseline attitude toward the task and the individual's perceptions of his or her reasons for undertaking the task in a given instance” (Amabile, 1990, p. 79). All components are required for a certain level of creativity to be generated. The higher the level of each one of the three components, the greater the overall level of creativity (Amabile, 1990).

In summary, creativity research is vast (Runco & Sakamoto, 1999), presenting both consensus in some topics, and their absence in others (Mayer, 1999). This might be a consequence of the diverseness and complexity of creativity. In the words of Runco and Sakamoto (1999), “creativity is among the most complex of human behaviors. It seems to be influenced by a wide array of developmental, social, and educational experiences, and it manifests itself in different ways in a variety of domains” (p. 62).

Measurement of Creativity

Focusing the study of creativity on the processes themselves also promoted more quantitative approaches. For much time, researchers have been discussing the measurement of creative potential (Lubart, Pacteau, Jacquet, & Caroff, 2010). According to Plucker and Makel (2010), psychometric measurement of the creative process has been the dominant approach used in research on this topic. To date, the cognitive process most commonly linked with the creative process has been the divergent thinking process (Plucker & Renzulli, 1999), and it has been usually measured by divergent thinking tests (Lubart et al., 2010; Plucker & Renzulli, 1999).

Tests of divergent thinking refer to open-ended questions or tasks that encourage people to generate, in a limited time, as many answers as possible (Lubart et al., 2010; Plucker & Renzulli, 1999; Runco & Pagnani, 2011; Sternberg & Kaufman, 2010). The person's performance in a divergent thinking test is evaluated for: fluency (number of answers), originality (novelty of the answers), elaboration (the intensity of details), and flexibility (variety of categories or ideas) (Kaufman, 2009; Runco & Pagnani, 2011).

Divergent production is probably the most easily measured aspect of creativity, and presents a convincing and consistent estimation of the measurement of the creative potential (Runco & Pagnani, 2011; Sternberg & Kaufman, 2010); "but it probably does not encompass all of what laypeople and scientist alike mean by creative thinking" (Sternberg & Kaufman, 2010, p. 470).

Creativity in Childhood

Studies on creativity with children have shown ambiguous results. Some report a positive correlation between creativity and age, whereas others describe a decrease in creativity associated with age, particularly in certain stages of the development (Alfonso-Benlliure, Meléndez, & García-Ballesteros, 2013). In a review study, Maker, Jo, and

Muammar (2008), analyzed the results of the last fifty years of research on the development of creativity in elementary school children. They reported that many results concentrated on three life-stages of interest: the entrance into formal education (around ages 5 to 7), Grade 4, and Grade 6.

In a study with 4-, 5-, and 6-year olds, Chae (2003) found that as a child ages, his / her creativity scores increase. In a longitudinal study, Torrance (1968) found evidence of a decline in creativity in fourth grade children, which he called the *fourth grade slump*. This period of such a slump was contradicted by Kim (2011), whose findings in fact suggest a sixth grade slump, as the creativity scores either stayed the same or declined in sixth-grade participants. However, Claxton, Pannells, and Rhoads (2005) found an enhancement in divergent thinking scores over time when analyzing participants data from fourth through ninth grade.

According to Alfonso-Benlliure et al. (2013), the aforementioned inconsistencies can be elucidated by two explanations. The first explanation is that creativity is influenced by many issues that can inhibit or alter its growth, in spite of the fact that creative potential can be improved with age. The second explanation is that the creative process involves divergent and convergent thinking, where both change roles and alternate between each other (Alfonso-Benlliure et al., 2013). At some moments divergent thinking is required, while in others convergent thinking is necessary. Also important is the fact that both divergent and convergent thinking develop differently. According to these authors, convergent variables develop gradually and increasingly with age and intellect, whereas divergent variables proceed in a more inconsistent route full with instability, and fall considerably as childhood progresses.

According to Runco (1996), creativity is a multifaceted phenomenon that implies different and diverse abilities and qualities. Accordingly, some factors may stay unchanged while others mature; Runco believes that creativity involves a combination of abilities that

can be found in both childhood (immaturity) and adulthood (maturity, experience); thus explaining why continuity and discontinuity in the creative process may arise.

To Lubart and Georgsdottir (2004), the cognitive abilities that are relevant for creativity are diverse, and two important facts are related to them. First, it seems that cognitive abilities are interlaced with other abilities that are susceptible to developmental changes. Second, the relevant abilities develop with age. The authors note, however, that creativity is not only a cognitive process, that personality characteristics and motivation also play important roles in the development of creativity. Furthermore, as was discussed previously, the influence of the environment upon creativity through family and school etc. cannot be neglected, as they are able to enhance or diminish creativity.

Maker et al. (2008) assign such inconsistent findings of developmental research to the underestimation of the great impact that the educational environment has on creativity. Lubart and Georgsdottir (2004) also emphasize the importance of school setting in either the development of creativity or its absence, as it is in school that children undergo the process of socialization and knowledge acquisition. To Besançon and Lubart (2008), the development of children's creativity might be influenced not only by the school environment, but also by their preliminary level of creativity and the interaction between both conditions.

Summarizing, there is consensus about the processes and skills that are essential for the development of creativity (Russ & Fiorelli, 2010). However, full comprehension of all aspects and how they function in the creative process is still very complex; this is certainly the reason for research being so inconclusive in terms of the development of creativity and what exactly is essential to foster this development (Russ & Fiorelli, 2010).

Additionally, according to Russ and Fiorelli (2010), children have the potential to be creative. They are capable of generating original ideas, of course, within the range of their possibilities and limitations. Furthermore, it is important to nurture and encourage children's creativity in order to assure creative solutions to future problems. In the words of Russ and

Fiorelli (2010), “Helping children develop a variety of processes involved in creativity during childhood will increase the probability that they will make genuine creative contributions as adults” (p. 245).

2.2 Intelligence

There are not many constructs so hard to understand and at the same time serving so many functions as the one of human intelligence (Sternberg, 1994; Sternberg & Detterman, 1986). It is in fact considered a very controversial and puzzling topic studied in the field of psychology (Davidson & Kemp, 2011; Nickerson, 2011). Research on intelligence, like research on creativity, has generated much debate. Many inquiries have risen concerning the nature of this phenomenon, yet the answers seem unsatisfactory, and so the debate continues. As mentioned by Hunt (2011) much has already been learned, yet there is still much more to explore.

According to Davidson and Kemp (2011), one of the biggest mysteries around the study of intelligence refers to the lack of consensus on what intelligence precisely is meant to be or even what makes one person more intelligent than another. This construct has many definitions. The lack of a single and accepted concept contributes to disagreements and precludes a better understanding of the whole phenomenon; in this way, without consensus on what intelligence is, there is no general agreement on how to measure it (Willis, Dumont, & Kaufman, 2011). To Neisser et al. (1996), a person can be intelligent in many ways; as a result there are also many definitions.

According to Wallach and Kogan (1967), the concept of intelligence in psychology is characterized by a structure of abilities greatly correlated to one another. Abilities such as memory, problem solving, and being able to manipulate concepts, refer to the retention, transformation, and utilization of verbal and numerical symbols. Individuals who are talented

in one area have a propensity to be talented for all others. In the same way, people who are inept in one of these skills has a tendency to be inept for all others (Wallach & Kogan, 1967).

However, Neisser et al.(1996) emphasizes that individuals are not equal and the differences between them might be substantial. Individuals may differ from each other in their abilities to: understand complex ideas, adjust efficiently to the environment, gain knowledge from experience, engage in different reasoning tasks, and ponder over how to tackle an obstacle. According to these authors, it is possible that the intellectual performance of a person may vary in different domains or circumstances, and that it may also be evaluated by different societal norms; as a result, these differences between individuals are by no means reliable. Thereby, intelligence is a complex set of abilities, and its conceptualization is an effort to elucidate and systematize it. Even though much progress has been made, issues still remain (Neisser et al., 1996).

In 1921, editors of *The Journal of Educational Psychology* invited 17 famous intelligence investigators to contribute to a symposium responding, among others, the question of what they believe to be intelligence. 14 researchers responded positively to the task. The answers to this question were very diverse; numerous different explanations were offered. However, according to Sternberg (2000a; 2005a), the definitions in general can be encompassed into two premises: first, intelligence implies the ability to learn from experience, and second, it involves the capacity to adapt to the environment.

Sternberg and Detterman (1986) asked the same question to 24 intelligence scholars, 65 years later. The findings indicated the same two premises about intelligence presented in the aforementioned study. The exception was that a third was added to the definition, namely, the importance of metacognitive process and the importance of cultural context (Sternberg, 2000a; 2005a). According to (Sternberg, 2005a), “intelligence, then, is the capacity to learn from experience, using metacognitive processes to enhance learning, and the ability to adapt

to the surrounding environment, which may require different adaptations within different social and cultural contexts” (p. 751).

Aiming to bring enlightenment into this complex phenomenon, an overview of some relevant studies of intelligence will be presented next. This overview begins with the research of Galton and proceeds with discussing research of Binet and Simon, Spearman, Guilford, Cattell, and Sternberg. In view of the key role played in the present work, a topic on intelligence and IQ, and intelligence among children is included.

Francis Galton

Based on the work of Charles Darwin, Galton researched the degree of similarity in the intellectual accomplishments of individuals with familial ties (Urbina, 2011). He considered intelligence as a hereditary attribute which is entirely grounded in physiology. Therefore, he believed that the intellectual capacity of the population would be enhanced by the identification of highly intelligent young people and their offspring, encouraging them to produce as many children as soon as possible (Urbina, 2011).

In Galton’s own words:

“...civilization is the necessary fruit of high intelligence when found in a social animal, and there is no plainer lesson to be read off the face of Nature than that the result of the operation of her laws is to evoke intelligence in connection with sociability. Intelligence is as much an advantage to an animal as physical strength or any other natural gift, and therefore, out of two varieties of any race of animal who are equally endowed in other respects, the most intelligent variety is sure to prevail in the battle of life” (Galton, 1892, p. 336).

As mentioned above, Galton considered intelligence as a function of psychophysical abilities (Sternberg, 2005a; Sternberg et al., 2011). His argument was that, assuming that knowledge comes through the senses, a more intelligent individual is capable of making a

more accurate sensory discriminations, thus being able to store and act on a wider range of sensory information (Mackintosh, 2011).

Within his work on hereditary genius, Galton discovered that it was necessary to obtain several measurements of the psychophysical faculties of at least two generations. In an attempt to measure this in people using diverse tests, he established an anthropometric laboratory (Galton, 1908).

Alfred Binet and Theodore Simon

Binet and Simon worked on the identification of the intellectual retardation in children (Urbina, 2011). In 1905, they developed and published a method to test child intelligence (Urbina, 2011). Children were asked to perform a set of tests (Binet & Simon, 1912) that grew in complexity and they were able to discriminate between children of different levels of intellectual aptitude (Urbina, 2011). The fundamental assumption of Binet was that as children grow older they become more intellectually talented. As a result, good measurements of intelligence would be those coming from tests in which items were easier to the older children than to younger ones (Mackintosh, 2011).

By gathering data of several cognitive tests at different difficulty levels and arranging the items according to age groups in which children with normal intellectual performance were able to achieve, they realized they could generate a scale that classified levels of children's mental functioning based on the number of correct items at different levels (Urbina, 2011). When tasks were correctly solved by about 75% of the children within an age group, they were summarized within an age level; the higher series of tasks that a child could solve marked his / her intelligence *Mental Age* (Holling, Preckel, & Vock, 2004). According to Binet and Simon (1912), "much research has revealed which of these tests a normal child passes successfully at a given age" (p. 7), making possible to establish if a child is equivalent to what is considered the "norm" within their age group or whether this child is above or

below this norm. With this approach Binet and Simon were the first to revolutionize the measurement of intelligence (Holling et al., 2004).

However, research shows that this procedure is not so simply. Each child has their own particular individual characteristics (Binet & Simon, 1912). Binet and Simon noticed that children could solve an identical number of items in each task correctly, but also showed a reasonably different pattern of right and wrong answers (Mackintosh, 2011). When comparing a child's intelligence with the average performance of children of different ages, this child can be considered delayed in some tests of its age and superior in others (Binet & Simon, 1912). They concluded that children's intelligence should be measured by more than one test, i.e. a group of tests. Binet and Simon considered intelligence as a collection of abilities that are autonomous (Mackintosh, 2011) and extremely changeable (Sternberg, 2005a; Sternberg et al., 2011). Binet defined intelligence as a variety of different skills that depend on a multiplicity of cognitive factors such as attention, memory, imagination, judgment, ability to abstract and to judge (Mackintosh, 2011).

Spearman - Theory of General Intelligence

According to Willis et al. (2011), the Spearman general intelligence theory might be the most used and accepted theory by researchers on this topic. Several intelligence tests have their theoretical foundation grounded in this theory (Willis et al., 2011).

While analyzing results of studies using factor analysis, Spearman detected that when participants were either good or bad in a cognitive test they tended to perform the same way on other tests (Willis et al., 2011). He observed a correlation between the scores of the different intellectual abilities (Willis et al., 2011).

Spearman assumed that the positive correlations between the different tests occurred because each test not only measured one aspect, but also measured a general factor that appears in the performance of the whole test set, labeled *g* (Mackintosh, 2011; Sternberg,

2005a; Sternberg et al., 2011; Willis et al., 2011). This general factor provides the key to understanding intelligence (Sternberg, 2005a; Sternberg et al., 2011). According to Willis et al. (2011), Spearman believed that each person has a certain general level of intellectual ability, which could be manifested in many ways and expressed under diverse conditions.

Guilford – The Structure of Intellect Model

The structure of the intellect model is a multidimensional model developed by J.P. Guilford (1967). Initially, it embraced 120 different mental abilities, which could be found in the performance of a person during an intelligence test, for example. Guilford kept revising his theory and more factors were added to it. His theory now has a total of 180 intellectual factors (Willis et al., 2011). These factors are organized into three categories: operation, content, and product, which are arranged in a cube shape intersecting each other (Sternberg, 2005a).

It [the cube] represents three aspects of mental functioning, each by means of a dimension of the model. Each intellectual ability or function is distinguished from all others by having a unique combination of a certain kind of mental operation, a certain kind of informational content, and a certain kind of informational form or product. Intelligence itself is defined as a systematic collection of abilities or functions for processing different kinds of information in different ways, information differing both with respect to content (substance) and to product (mental construct) (Guilford, 1975, p. 109).

The operations category included initially five general mental processes (Guilford, 1967). After revision there were six (Guilford, 1988):

- *Cognition* – refers to the ability of comprehension and discovery of information.

- *Memory* – is defined as the capacity of retention of information. But to Guilford this was not adequate enough, so he decided to divide it into: *memory recording* (short-term memory), and *memory retention* (long-term memory) (Guilford, 1988).
- *Divergent production* – refers to the ability to generate as many solutions to a problem as possible.
- *Convergent production* – outlines the ability to find the specific solution to a problem.
- *Evaluation* – is the capacity to critically judge about the accuracy of information.

At the one set, the contents category included, four areas of information where the operations are applied (Guilford, 1967). They are:

- *Figural* – concrete information, images. After revision Guilford decided to split this aspect into *figural-auditory* and *figural-visual* (Guilford, 1975).
- *Symbolic*–signs or symbols (letters and number).
- *Semantic* –verbal meanings
- *Behavioral* – information perceived as persons acts, where perceptions, desires, emotions, among others, are all relevant.

The product category represents parallels that appear between the operations and contents categories. This dimension is comprised of six operations (Guilford, 1967):

- *Units* – items applied to nouns.
- *Classes*– set of units with common features.
- *Relations* – connection between units.
- *Systems* – structures of interconnected parts.
- *Transformations* – changes or modifications on knowledge.
- *Implications* – expectation, anticipation of knowledge.

Cattell - Gf-Gc Model of Intelligence

This model was developed by Raymond Cattell. He proposed that the general factor of intelligence (g) was divided into two distinctive and correlated sub-factors which he called: *fluid and crystallized general abilities*; g_f and g_c respectively (Cattell, 1963).

Fluid intelligence is the ability to solve problems and to identify patterns (Cattell, 1963; Horn & Cattell, 1967). It is also the rate and precision of abstract reasoning when solving novel tasks, and can be measured by such tasks as those presented by the Raven's Standard Progressive Matrices (Cattell, 1963; Horn & Cattell, 1967).

Crystallized intelligence refers to abilities learned by applying accumulated knowledge and vocabulary, and can be measured by tasks based on general information, use of language, and knowledge (Cattell, 1963; Horn & Cattell, 1967).

This subdivision of g corresponds to two different and independent influences in the development of intelligence (Horn & Cattell, 1967); they also differ in age in general (Cattell, 1963). Whereas g_f reaches its maximum at 14-15 years of age and decreases continuously from about 22 years of age; g_c increases until 18 to 28, or beyond (depending on the length of the learning process period); after this, g_c will show a slight descending tendency (Cattell, 1963).

Sternberg - The Triarchic Theory of Successful Intelligence

The triarchic theory of successful intelligence was developed by Robert Sternberg. It is classified as a system approach, for the reason that intelligence is viewed in a systemic way, as the interaction between cognition and environment (Sternberg, 1994). This theory assumes that intelligence is composed of three parts that connect themselves to the individual's internal world, to experience and to the external world (Sternberg, 1994; 2005a; Sternberg et al., 2011).

According to Sternberg (1994; 2005a) and Sternberg et al. (2011), the first part involves information-processing and is also divided into: metacomponents (planning, decision-making, and evaluation), performance components (implementation and execution), and knowledge-acquisition components (performance, solution finding). The second part refers to the level of experience and the interaction with information-processing. The familiarity with a task may vary from novelty up to automatization.

Finally, the third part affirms that intelligence has three functions in the external environment: adaptation to the environment (a person can change him / herself), shaping and creating a new environment (the environment is changed), and selection of a new one (when both of the two previous changes do not work) (Sternberg, 1994; 2005a; Sternberg et al., 2011).

According to this view, intelligence may vary from one person to another. While one person might perform better on abstract material, another might perform better when working with concrete tasks (Sternberg, 2005a). According to Sternberg (2005a), the intelligent person does not have to necessarily do extremely well in all of the facets of intelligence. Intelligent individuals are aware of their strengths and weaknesses, and know how to deal with them, i.e., how to take advantage of their strengths and to bypass their weaknesses.

Intelligence and the Intelligence Quotient (IQ)

Intelligence and IQ are often used as synonymous: IQ tests commonly refer to intelligence tests, but both terms are not fully analogous (Urbina, 2011). One reason for this misunderstanding is that IQ, developed by Wilhelm Stern, was devised to serve as a scoring method for the first intelligence test (Binet - Simon scale) and was used later for the development of other tests designed to evaluate intelligence (Urbina, 2011).

The Binet and Simon test used, at first, mental age (MA) as a measurement of intelligence (Sternberg et al., 2011). This MA represents the performance of an individual on

the test expressed in years and months (Urbina, 2011). However, this method had a problem: the growth of intelligence is not continuous; the difference between MA and chronologic age (CA) has namely different semantics within diversity of age (Holling et al., 2004; Stern, 1912; Sternberg et al., 2011).

With this in mind, Stern (1912) suggested the following solution: an *intelligence quotient* (IQ) should be obtained by dividing MA by CA and multiplying the result by 100 to avoid decimal numbers. The IQ can be represented by $IQ = 100 \cdot \frac{MA}{CA}$. The “normal” level (average intelligence level) of children’s performance on the test would be 100; i.e. the MA matched with the individuals’ CA (Stern, 1912; Urbina, 2011). Thereby, if the MA was bigger than the CA this would indicate that the child was above-average, he or she had exceeded the expected performance for his or her age (Urbina, 2011). Analogously, when the MA was lesser than the CA, the child was below average on intelligence level; he / she had failed relative to the expected test performance (Urbina, 2011).

However, Stern’s intelligence measurement method was still not ideal. It indicated well the performance of a child, but not of an adult (Robinson, 2005). The reason was that the test performance (MA) does not increase linearly with the CA (Holling et al., 2004; Urbina, 2011); the CA increases continuously whereas the MA may remain constant, consequently causing a progressive reduction in IQ score (Holling et al., 2004).

Therefore, David Wechsler devised a new measure to attain the IQ scores called deviation-IQ (Holling et al., 2004; Urbina, 2011). Now IQ scores are calculated by comparing the test performance (raw score) of an individual to the mean scores of a corresponding age-standardized sample (Urbina, 2011). Each age range has a normative IQ mean of 100 and a standard deviation of 15. This can be mathematically represented by $IQ = 100 + 15 \cdot \frac{x - \mu}{\sigma}$, where x is the individual’s raw score, μ is the mean value for the person’s age, and σ the corresponding standard deviation (Holling et al., 2004).

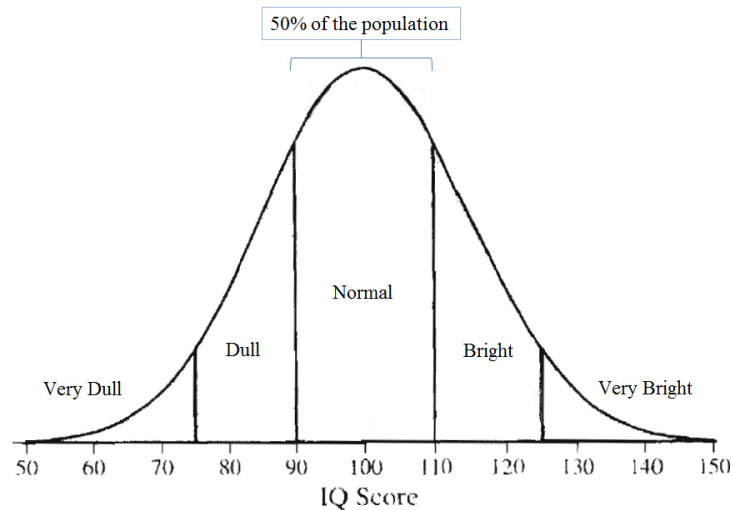


Figure 1. The IQ distribution. Adapted from “The bell curve – intelligence and class structure in American life.” By Herrnstein & Murray, op. 1994, p. 121. Copyright 1994 by Richard J. Herrnstein and Charles Murray.

As seen in Figure 1, the IQ scores of the population, from low to high, can be represented by the so called bell curve or normal curve model (or Gaussian curve). Most people are close to the mean (IQ 100), while few are either one of the two extremes (Gottfredson, 1997). The IQ 130 is often considered the threshold for giftedness, while the IQ of 70 is the threshold for mental impediment and approximately 3% of the population is above the IQ 130 or below IQ 70 (Gottfredson, 1997).

Intelligence in Childhood

According to world-renowned developmental psychologist, Jean Piaget (1966b), in contrast to some special hereditary structural factors that are associated with the formation of the nervous system and of the sensory organs, cognitive structures develop after birth, when the individual begins the process of exchange with the world around him; these structures are built and modified over time. Such mental development is composed of two kinds of elements: variable and invariable. Therefore, it can be noted that “between the child and the adult a continuous creation of varied structures may be observed although the main functions of thought remain constant” (Piaget, 1966b, p. 4).

Piaget (1966b) affirms that the invariant operations are presented in the structure of two biological functions: *organization and adaptation*. These two functions play complementary roles in one single mechanism. Organization is the internal function while adaptation is the external one. According to Piaget, biologically speaking, organization cannot be disconnected from adaptation and is determined by the relationship between parts and whole. Adaptation in turn is the transformation of the organism induced by the surrounding environment, allowing for preservation (Piaget, 1966b).

In other words, adaptation is the equilibrium between two mental processes: *assimilation and accommodation* (Piaget, 1966a, 1966b). Assimilation occurs when the individual incorporates objects from the external world into the already-formed internal structure; it is the activity and the impact of the subject on the environment (Piaget, 1966a). Accommodation occurs when there is a change within the internal structures to allow for the embedding of external objects; it is the impact of the environment on the subject (Piaget, 1966a).

Based on these assumptions, Piaget (1966a; 1966b) defined intelligence as an adaptation. Intelligence is the capacity to adapt to novel situations and/or problems, and thus implies the continuous formation of new structures. Development occurs in successive stages, each increasing in complexity and chained to each other. Intelligence is the highest form of adaptation to the environment. It is an essential instrument of communication between the individual subject and the environment (Piaget, 1966a). Intelligence is on one hand assimilation, for the reason that it incorporates the experience data within its structure, and on the other hand it is also accommodation to the environment. Sometimes the one predominates over the other; it is a game of adjustments and compensations to reach consist and progressively more complex structures. The subject has an active role in the construction of schemes or structures which allow knowing, interpreting, and acting on reality. Individuals evolve with experience, and their modalities of perception are also altered by their

interactions with the environment, as these interactions in turn form new schemas within the subject who is him / herself acting on the environment.

The “accord of thought with things” and the “accord of thought with itself” express this dual functional invariant of adaptation and organization. These two aspects of thought are indissociable: It is by adapting to things that thought organizes itself and it is by organizing itself that it structures things” (Piaget, 1966b, p. 8).

Intelligence is related to the complexity of the individual's interaction with the environment; the more complex and extensive the interaction is, the more intelligent the individual (Piaget, 1966a). Thus, it can be assumed that individuals develop intellectually from stimulation offered through the surrounding environment, and so intelligence can be exercised. In other words, everyone is able to learn (except for some cases, for example, individuals with brain damage), and this ability is directly related to opportunities for exchanges.

Gottfredson (1997) shares the same view as Piaget. She highlights that although intelligence is in part heritable, it can also be affected by the environment; which means that intelligence levels are changeable. According to her, children’s IQs progressively stabilize within the course of development and do not alter much after that. To Bayley (1955) intelligence is, “a dynamic succession of developing functions, with the more advanced and complex functions in the hierarchy depending on the prior maturing of earlier simpler ones (given, of course, normal conditions of care)” (p. 807). Therefore, intelligence scores made in infancy cannot predict the level of intelligence later in life. Scores can be altered by environmental and emotional conditions, as well as changes in behavior (Bayley, 1955).

As discussed, the environment is important to the development of intelligence. According to some researchers (Ceci, 1991; Ceci & Williams, 1997; Neisser et al., 1996) school setting also has a significant impact on intelligence. To Neisser et al. (1996) and Ceci (1991), the development of intelligence is directly affected by attendance in school and the

attendance in school is also affected by intelligence. In other words, when taking into consideration the construct of intelligence, school attendance is at the same time a dependent and an independent variable (Neisser et al., 1996). Children with the highest test scores are generally least inclined to drop out of school and have more chances to succeed throughout grade levels and attend college. Nevertheless, mental abilities are modified by schooling, including those abilities measured by the tests (Neisser et al., 1996).

To Neisser et al. (1996), schooling influences intelligence in a number of different ways, the most evident is given by the transmission of information. But also, school supports and allows (at least the good schooling experiences) the development of important intellectual abilities and attitudes. According to these authors, such intellectual abilities and attitudes are: systematic problem-solving, abstract thinking, categorization, sustained attention to abstract thinking, categorization, sustained attention to material of little intrinsic interest, and repeated manipulation of basic symbols and operations. These abilities develop differently in each child; some students learn faster than others. The interesting fact is that intelligence tests usually measure many of these abilities and therefore, predict school achievement so well (Neisser et al., 1996). This view is also supported by Ceci (1991), “schooling fosters the development of cognitive processes that underpin performance on most IQ tests” (p. 703).

Neisser et al. (1996) reported that intelligence tests do predict school performance moderately well. IQ scores and grades presented a correlation coefficient of around .50. Studies show that there is a propensity to learn more of what was taught when the child had a high score on an intelligence test than when it had a low score. However, the learning success may rely on other individual characteristics, such as persistence and motivation; or it may depend on social factors, such as the support earned from family or teachers (Neisser et al., 1996). Furthermore, Neisser et al. (1996) emphasize that personal skills are not the only aspect that influence what children learn in school; what is taught and how it is taught are also important for the learning process.

Neisser et al. (1996) also highlight that the best predictor of a person's years of schooling is the intelligence test score. IQ scores have been showing significant correlations with the total years of education. The correlation coefficients found are around .55 (Neisser et al., 1996) and .80 (Ceci, 1991). There are several reasons why high scoring children tend to stay more years in school. One reason is: because they have good grades, they are more encouraged and rewarded by their peers, teachers and/or family and so the high IQ students are reinforced to go on with their studies, and so remain longer in school (Ceci & Williams, 1997; Neisser et al., 1996). Additionally, Neisser et al. (1996) emphasize that there are also children with high tests scores that drop out of school. Again individual and social aspects may influence a successful academic career.

Despite the traditional view that on the one hand IQ does have an influence on how many years a person remains in school, and on the other, that the opposite does not happened (Ceci, 1991; Ceci & Williams, 1997). Ceci (1991) argues that there is enough evidence to show that schooling has a powerful influence on intelligence as well.

Finally, children's scores on intelligence tests are useful in developmental and educational counseling and interventions (Baudson & Preckel, 2013). They display how a child performs in relation to one of their peers in the same age group (Neisser et al., 1996). Scores can decrease when education is interrupted or is of poor quality. Some interventions on the other hand, showed an increase in scores and mental skills, at least while the program was still running.

Additionally, according to Sternberg et al. (2011), intelligence can be enhanced.

...attempts to improve intelligence can help people at all level and with diverse kinds of intelligence. No matter how high one's intelligence, there is always room for improvement; and no matter how low, there are always measures that can be taken to help raise it (Sternberg et al., 2011, pp. 80–81).

2.3 Creativity and Intelligence

The correlation between intelligence and creativity has already been discussed for some years. Numerous studies have been done in this area (Barron & Harrington, 1981; Cho et al., 2010; Cline, Richards, & Needham, 1963; Edwards & Tyler, 1965; Fuchs-Beauchamp et al., 1993; Getzels & Jackson, 1962; Guilford, 1967; Jauk et al., 2013; Karwowski & Gralewski, 2013; Kim, 2005; Preckel et al., 2006; Preckel, Wermer, & Spinath, 2011; Runco & Albert, 1986; Runco et al., 2010; Silvia, Beaty, & Nusbaum, 2013; Sligh et al., 2005; Theurer et al., 2011; Wallach & Kogan, 1967; Weinstein & Bobko, 1980; Williams & Fleming, 1969). However, the relationship between these two constructs is still intriguing and arouses the curiosity of researchers in this field.

Scholars have been speculating greatly about this topic, but so far no consensus has been reached (Preckel et al., 2006). Findings are contradictory and/or inconclusive (Fuchs-Beauchamp et al., 1993; Kaufman & Plucker, 2011; Kim, Cramond, & Van Tassel-Baska, 2011; Preckel et al., 2011; Silvia et al., 2013; Theurer et al., 2011).

The reason why no conclusive results have been reached on this subject might be the fact that no unanimous definition of the two constructs has been attained to date (Jaarsveld et al., 2012; Jauk et al., 2013; Karwowski & Gralewski, 2013; Kaufman & Plucker, 2011; Preckel et al., 2006; Sligh et al., 2005). Depending on the definition of intelligence or creativity that is taken into consideration, the constructs may become more similar or more different. According to Jaarsveld et al. (2012), “concepts of creativity vary in the degree to which they take on board elements of what is generally considered to be intelligence” (p. 173), and vice-versa. To Karwowski and Gralewski (2013), for a better understanding of the relationship between creativity and intelligence, greater precision in the definition of the two constructs is required.

Different theoretical statements about the understanding of creativity and intelligence generate, in consequence, diverse evaluative measures of both constructs. The use of different

tests in each study are, as well, a reason of the contradictory findings in this field (Karwowski & Gralewski, 2013). The relationship between creativity and intelligence depends on how they are measured (Jaarsveld et al., 2012; Kim, 2005; Runco, 2010b; Runco & Albert, 1986).

In general, according to Sternberg and O'Hara (1999) and Sternberg, Lubart, Kaufman, and Pretz (2005), there is a consensus on three basic results concerning the relationship between creativity and intelligence. First, creative people have a tendency to present an above-average IQ, frequently greater than 120. However, this does not mean a cutoff, it only implies that highly creative individuals frequently have a high IQ (Sternberg et al., 2011). Second, the two constructs may be more strongly correlated when IQ is below 120, and weakly or not correlated when IQ is above 120 (threshold theory). Those with an extremely high IQ may have difficulties being creative because of their high analytical abilities (Sternberg et al., 2011). Finally, the third result affirms that the correlation often varies from weak to moderate. Sternberg et al. (2005a) and Sternberg et al. (2011) reported three factors affecting the correlation level between creativity and intelligence: which aspects of both constructs are being measured, how they are being measured, and in what area creativity is manifested.

According to Lubart (2003), due to the variation of sampling, correlation coefficients ranging from .0 to .50 can be found, but most generally coefficients around .20 are observed. Based on his own work and on those of others researchers, Barron (1963) reported a correlation coefficient of about .40.

As previously mentioned, there is no agreement on how these constructs are related to each other. However, Sternberg and O'Hara (1999) presented five different approaches that attempt to explain how this relationship could occur: (1) Creativity as a subset of intelligence, (2) Intelligence as a subset of creativity, (3) Creativity and intelligence as overlapping sets, (4) Creativity and intelligence as coincident sets, and (5) Creativity and intelligence as disjoint sets. These approaches are briefly explained below.

(1) Creativity as a subset of intelligence – this first approach considers creativity as a component of intelligence. Three intelligence models that relate to this approach are the one from Guilford, Cattell, and Gardner.

(2) Intelligence as a subset of creativity –intelligence here is understood as a dimension of creativity. Both Sternberg and Lubart’s investment theory of creativity and the Smith’s hierarchy model support this approach.

(3) Creativity and intelligence as overlapping sets – it means that despite their differences, some aspects intersect. Studies from Catherine Cox, Lewis Terman, Donald MacKinnon, Frank Barron, and others are found here.

(4) Creativity and intelligence as coincident sets - at this point creativity and intelligence are considered as unique constructs. Researchers such as Haensly, Reynolds, Weisberg and Langley support this concept.

(5) Creativity and intelligence as disjoint sets - this conception perceives creativity and intelligence as two completely different and distinctive constructs. Here the work of Getzels and Jackson, Wallach and Kogan, and Torrance can be found.

The most popular approach among researchers is the third one, creativity and intelligence as overlapping concepts. In the words of Sternberg and O'Hara (1999), “all of these relations have been proposed. The most conventional view is probably that of overlapping sets, that intelligence and creativity overlap in some respects, but not in others” (p. 251).

Therefore, two facets of this view will be now explained in detail. One refers to the well-known threshold theory. The second refers to a new approach that measures the cooperative cognitive process between creativity and intelligence which is termed *Creative Reasoning* (Jaarsveld et al., 2010; Jaarsveld et al., 2012).

Threshold Theory

This theory is commonly used to describe the relationship between creativity and intelligence. It affirms that a positive correlation is found to occur until an IQ threshold of 120, beyond which no correlation can be observed. A possible reason for this is discussed by Lubart (2003) and Runco (2007). To these authors, the threshold theory suggests the existence of a minimum level of intelligence necessary for a person to be creative. Hence, intelligence is only beneficial for creativity until a certain level of IQ (120). Above that threshold, no additional benefit can be found.

According to the authors mentioned above, a significant inference of this theory is that a high level of intelligence does not guarantee a high level of creativity. In other words, while a person who has a high IQ does not necessarily have a high creativity level, a person who has a low IQ will also have a low level of creativity. Therefore, as showed in Figure 2, the correlation cloud appears in a triangular shape.

Karwowski and Gralewski (2013) presented three categories of criteria for accepting the threshold theory: (1) correlations between creativity and intelligence are compared to zero. A statistically significant positive correlation coefficient different from zero is assumed to appear when $IQ < 120$, while a non-significant coefficient of about zero is presented for $IQ > 120$; (2) same criteria as category “1”, but now, correlations should differ significantly from each other; and (3) adaptation of category “2”, but here, correlation can also be statistically significant for $IQ > 120$. However, correlation for $IQ < 120$ must be positive and significantly greater than the correlation above the IQ of 120. This category alludes to a significant decrease in the slope of the relationship between intelligence and creativity, but not necessarily losses in the statistical significance (Karwowski & Gralewski, 2013).

Studies about the threshold theory are inconsistent and contradictory. Some of them confirm this theory (Cho et al., 2010; Fuchs-Beauchamp et al., 1993; Weinstein & Bobko, 1980), while others do not (Jauk et al., 2013; Kim, 2005; Preckel et al., 2006; Runco

& Albert, 1986; Runco et al., 2010; Sligh et al., 2005; Theurer et al., 2011). For example, Fuchs-Beauchamp et al. (1993) confirmed the threshold theory in their research with preschoolers: a significant correlation coefficient of .49 for children with an IQ below 120 and no significant correlation for the group with an IQ above 120. In contrast, Runco and Albert (1986) encountered results that do not support this theory in their study with 228 children.

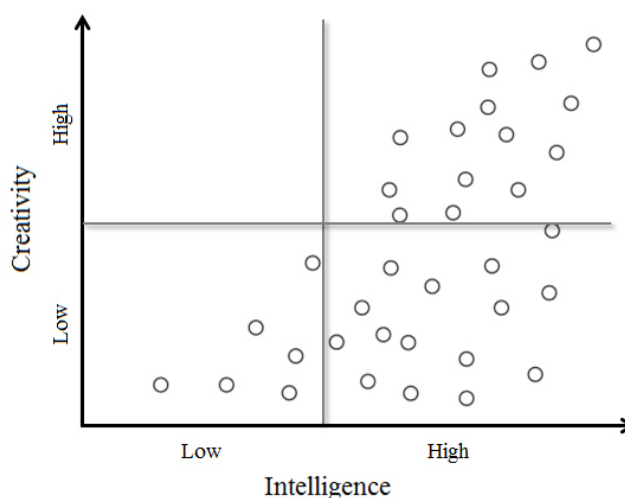


Figure 2. Correlation diagram demonstrating that highly intelligent individuals may have a low level of creativity, but that the contrary (low intelligence and high creativity level) is not possible. Adapted from “Creativity: Theories and themes: research, development, and practice,” by M. A. Runco, 2007, p. 7. Copyright 2007 by the Elsevier Academic Press.

Sligh et al. (2005) investigated the threshold theory taking into consideration both crystallized and fluid intelligence. They found that correlations between crystallized intelligence and creativity match modestly to the threshold theory (r 's = .34 for IQ < 120 and .19 for IQ > 120), whereas correlations between fluid intelligence and creativity did not match to the threshold theory. Actually, the inverse occurred of what the threshold theory suggests (r 's = .12 for IQ < 120 and .39 for IQ > 120). It is also interesting to note that when both groups are taken together, both crystallized and fluid intelligence presented a significant correlation coefficient (r = .43 and .42, respectively) with creativity.

Clearly, there is no consensus about the validity of the threshold theory. The opinions of researchers are divided. While some defend this theory, others are skeptical about the validity of the IQ-threshold of 120. According to Runco and Albert (1986) and Sligh et al. (2005), the threshold theory is to a certain degree a consequence of a statistical artifact, because the variation in the high IQ group is lower than in the average group. Knowing that the correlation coefficient is influenced by limited variance, it could be inferred that the lack of correlation in the group with higher IQ may be caused by this limited variation and not by the fact that the threshold truly exists (Sligh et al., 2005).

The question of why the IQ threshold is set at 120 and not at any other number continues to intrigue researchers. When referring to the relationship between intelligence and creativity, the threshold theory is one of the most widely known, yet the reason why 120 was particularly chosen to be that threshold is still unknown (Karwowski & Gralewski, 2013). Jauk et al. (2013) share the same view. These authors state that despite the lack of empirical evidence of an IQ threshold of 120, the threshold theory has not been questioned or carefully examined. For them, it appears as though none of the studies in this field are concerned about why the threshold is set at this particular point.

Therefore, Jauk et al. (2013) recently used segmented regression analysis in a study conducted with 297 participants. With this data analysis they were able to detect the breaking point leading to the best possible correlation coefficients between intelligence and creativity. They found a threshold for creative potential but not for creative achievement. Moreover, the threshold changes according to the criteria by which creativity is measured. A breaking point of about IQ = 86 for fluency was found, one of IQ = 104 for the Top 2 originality, and one of about IQ = 120 for the average originality.

According to Sternberg and Kaufman (2010), in addition to the lack of empirical support for the threshold theory, it is clear in the literature that at low levels of IQ, it is more difficult for creativity to manifest itself. One possible reason is that creativity is not only

about generating new ideas, but also requires an analytical evaluation to distinguish between good and bad ones (Sternberg & Kaufman, 2010). Further interactions between intelligence and creativity are presented in the next section.

Creative Reasoning

This concept considers the approach of creativity and intelligence as two partially overlapping sets. Intelligence (considered as mostly convergent production) cooperates with creativity (considered as mostly divergent production) in the creative thinking process. This cooperation between convergent thinking and divergent thinking is called *creative reasoning* (Jaarsveld et al., 2010; Jaarsveld et al., 2012), and it may be understood as the ability to generate appropriate solutions. In other words, both convergent and divergent thinking work together collaborating within a cognitive process emerging from a problem or a situation for which no solution was readily available. Therefore, these abilities mutually contribute to generating a solution (Jaarsveld & van Leeuwen, 2005).

The term creative reasoning emphasizes the mutual contributions and the cooperation between convergent and divergent thinking in open problem spaces requiring unique, accurate, and true solutions (Jaarsveld et al., 2012). Problem spaces are presented as a set of possible and logical steps that one must take in order to find the final solution. In closed or well-defined spaces, there is one correct solution, and in open or ill-defined spaces, there are numerous solutions.

The solution emerges after several alternating stages of convergent and divergent thinking. Divergent thinking creates new approaches and ideas, while convergent thinking ensures that the correct choices are taken and that the logical aspects of the solution are considered (Jaarsveld & van Leeuwen, 2005). This process is illustrated in Figure 3. Aiming to measure this cooperative cognitive process, a new and innovative measurement method

called The Creative Reasoning Task (CRT) is currently under development (Jaarsveld et al., 2010; Jaarsveld et al., 2012).

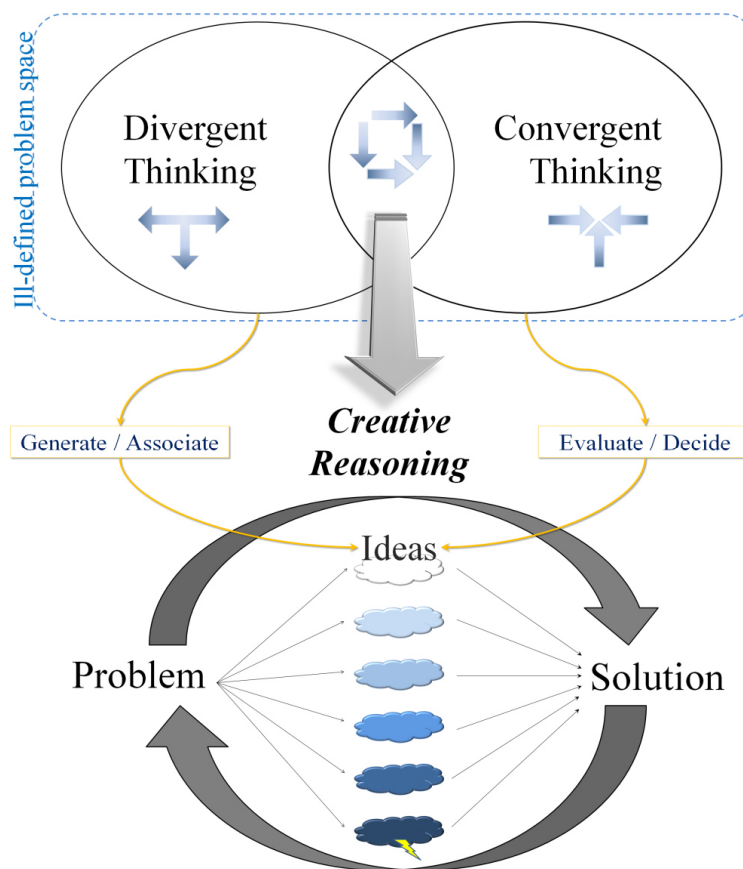


Figure 3. Representation of the creative reasoning process.

The CRT is a diagnostic device which measures intelligence and creativity within an ill-defined problem space and, this is what differentiates it from standard intelligence tests which measure intelligence in well-defined problem spaces. The task consists of conceiving a matrix similar to those found in the Standard Progressive Matrices (SPM) test, as exemplified in Figure 4. The matrix must be solvable and as difficult as possible. In a test form, there is the possibility of creating one of the three types of matrix formats presented in the SPM: 1x1 or the continuous pattern; 2x2 and 3x3. The correct solution must be drawn in a specific place – the outlined square in the lower right corner of the CRT answer sheet. In Figure 4, models of the SPM items and the worked-out CRT answer sheets are presented.

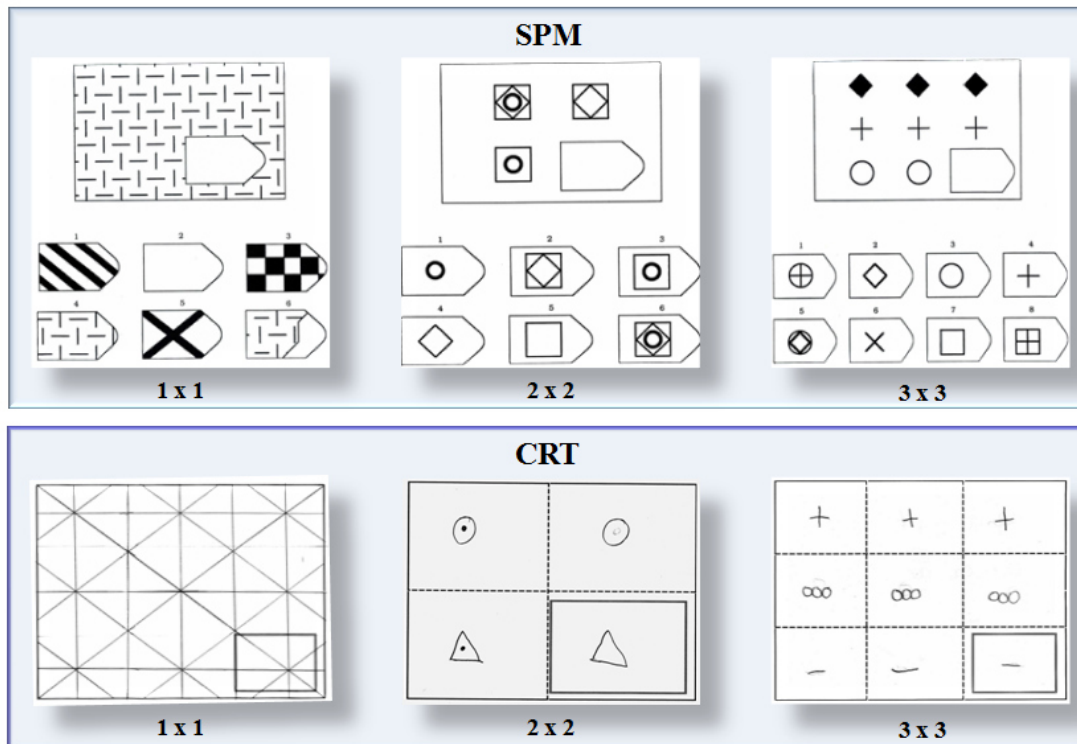


Figure 4. Three matrix formats of the Standard Progressive Matrices (SPM) with corresponding performances of the Creative Reasoning Task (CRT).

Since convergent and divergent thinking are to be measured by the CRT, and the major aim was to verify if both abilities are dependent or independent, two sub-scores were required and developed (Jaarsveld et al., 2012). According to Jaarsveld et al. (2012), the participant is faced with a task in which they are to create one or a sequence of primary components, such as squares, circles or trees. Each component can receive further specifications, such as shading or dashed lines, so that a virtually infinite number of created combinations is possible. The amount of components and specifications is used to quantify divergent thinking; this measurement is called *CRT Components & Specifications*. At the same time, one or more relations are expected to be found between the components and their specifications. The number and complexity of such relations is given in the *CRT Relations*, which quantifies convergent thinking.

According to Jaarsveld et al. (2012), the CRT Components & Specifications is composed of corresponding sub-scores. The sub-score of components is based on the number of components or subcomponents that are presented in the matrix. They can be *figurative*

(people, flowers, and etc.) and *non-figurative* (geometric forms). The sub-score of specifications is based on the transformations applied to the components.

Table 1- Fifteen evaluation criteria for CRT Relations (Jaarsveld et al., 2012, pp. 177–178)

Format	Evaluation criteria	Explanation	Score*	
			Min	Max
<i>Continuous Pattern</i>	<i>Idiosyncratic and Semantic Coherence</i>	Seemingly arbitrary collection of components	-	1
	<i>Jigsaw</i>	Drawings divided into jigsaw pieces	-	2
	<i>Pattern Completion</i>	Repetitive motive is continued in the completion	-	3
<i>String</i>	<i>Iteration of one component</i>	Single row / column of components as in the string AAA	2	9
	<i>Iteration of two or >2 component</i>	Single row / column of components as in the string C D E C D E	6	19
<i>Matrix 2 x 2</i>	<i>Symmetry</i>	Spatial mirror image transformation	3	8
	<i>Change & Increase**</i>	Components are same in a row but different in a column or vice versa Components increase or decrease in number or size in a row or column	6	19
	<i>Succession</i>	Identical cycle of components appears between rows or columns, but with a shift between components from one row or column to the next	7	10
<i>Matrix 3 x 3</i>	<i>Change</i>	Components are same in a row but different in a column or vice versa	8	27
	<i>Increase</i>	Components increase or decrease in number or size in a row or column	9	52
	<i>Succession</i>	Identical cycle of components appears between rows or columns, but with a shift between components from one row or column to the next	10	36
	<i>Combination & Indication of Mathematical Operation</i>	Components in the two cells of a row or column are combined to form a new component in a third cell Two items from a row or column are combined into a third component by an operation, in which a graphical representation of numerical operation can be recognized.	6	96
	<i>Two Values</i>	Three components each feature twice over three cells of a row or column	12	128
	<i>Contrast</i>	Subcomponent which is shared by two components features in the third while others that are not shared disappear. As a consequence, the shared subcomponent features in all three components and the ones that are not shared feature only once in a row or column	8	39
	<i>Group of Components</i>	The distribution of a component across the matrix has a 2-dimensional regularity.	3	13

Note. * The matrices can be corrected even if they are not as a whole correct, scores of rules per row or column is also possible.** Because in 2 x 2 matrices the Increase relation is indistinguishable from Change, they form a single category for these matrices and receive identical valuation.

They are divided into seven categories: *black-white*, *shaded*, *speckled*, *undulated*, *size*, *orientation* and *number*. However, the last three are scored in the CRT Components & Specifications only if they do not express an existing relation. Otherwise, the points are counted into CRT Relations, for instance, when in a matrix the number of components linearly increases in each successive frame of a given row, then the relation established is considered linear growth, and the CRT Relations evaluation criteria *increase* is applied. Thus, no point due to the specification *number* is given.

The CRT Relations is evaluated by means of 15 main criteria (see Table 1). On the other hand, the CRT deals with open space problems and it is therefore impossible to fix a set of evaluation criteria for all possible solutions (Jaarsveld et al., 2012).

To provide a better understanding of the CRT scoring method, the evaluation processes of two real examples investigated in this study is presented next. The first is a matrix created by a six year old boy from the first Grade (Figure 5a), called here Student 1, and the second is a matrix produced by a fourth Grade boy, named Student 2, aged 9 years (Figure 5b).

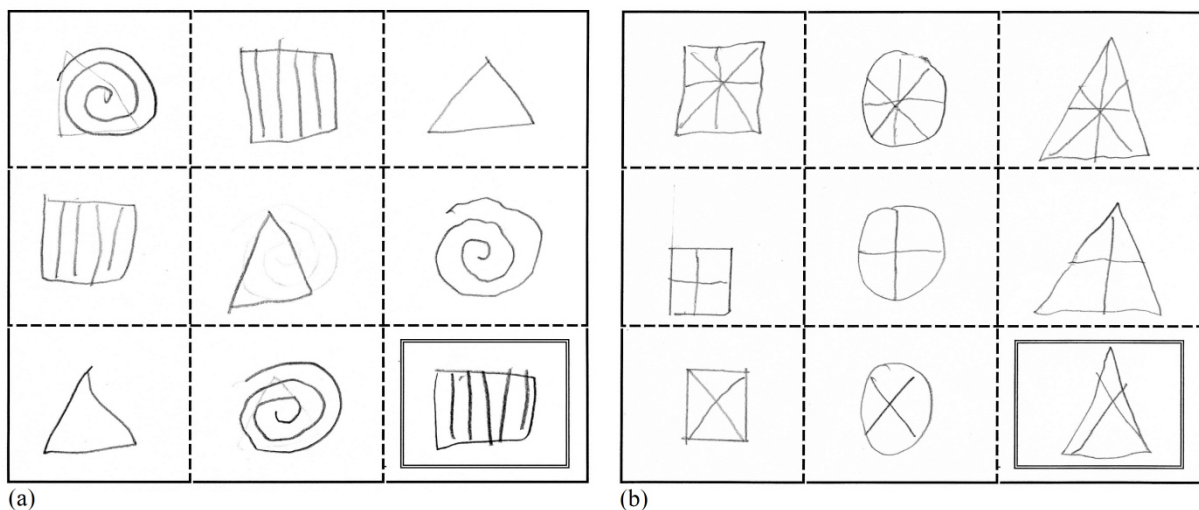


Figure 5. Examples of CRT matrices created by two boys, six- (a) and nine-year old (b).

In example one (Figure 5a), the rule utilized in the CRT Relations was *succession*. An equal set of components emerges between rows, but the components are simply shifted from

one column to another. Once the matrix has been correctly completed, the corresponding CRT Relations is 36 points (see Table 1). Regarding the CRT Components & Specifications score, three points were given for components (spiral, square, and triangle) and one for specification (shaded), resulting in a total of four points. This child received a total of 40 points upon the completion of his assignment, and the time spent on this task was 8 minutes.

Considering the matrix of Student 2, two relations are presented and must be taken into account for evaluating the CRT Relations score. There is a *combination* (33 points) and a *change* (27 points). The combination, beginning from the bottom and moving upward, is composed of the letter X (directly above previous one) and the cross (see Figure 5b, bottom left-hand corner); in the first row there is a new element generated by the combination of the two aforementioned components. When the matrix is viewed horizontally, there is a change in the geometric forms: a square is presented in the first column, in the second a circle and a triangle in the third. That is to say, the components are the same in the columns; however, the variations within the shapes differ among each row (see Figure 5b).

	R-Subtotal per Relation									N° of Relations	R-Subtotal Cumulative									
	1e	2e	3e	4e	5e	6e	7e	8e	9e		1. Sub score with one Relation	2. Sub score with two Relations	3. Sub score with three Relations	4. Sub score with four Relations	5. Sub score with five Relations	6. Sub score with six Relations	7. Sub score with seven Relations	8. Sub score with eight Relations	9. Sub score with nine Relations	
Student 1	36									1	36	36	36	36	36					
Student 2	33	27								2	33	60	60	60	60					

Score from the first relation Student's total score

Figure 6. CRT score template segment showing the CRT Relations sub-total score per relation, the number of relations used, and the cumulative score for CRT Relations subtotal. In this case, the total was the sub-score with two relations, because two relations had been used.

In this case, a total of 60 points was achieved for CRT Relations. The score is cumulative, meaning that is a summation of all previous sub-scores. Each sub-score is given separately which allows for detailed analysis (see Figure 6). The relation that has the higher score is entered first, followed by the second and so on. For example, in some cases only the score from the first relation may be of interest when studying convergent thinking scores in relation with standard intelligence scores, for example. Still considering Student 2, five points are given for the components category (square, circle, triangle, cross, and letter X) of the CRT Components & Specifications. Thus, this child achieves a final score of 65 points. The child needed 10 minutes for the completion of this task.

2.4 Giftedness

For decades, the study of giftedness and the factors that are or seem to be linked to this construct have fascinated people around the world (Reis & Renzulli, 2011). However, as in the study of intelligence and creativity, there are some difficulties in defining the concept of giftedness (Mönks & Katzko, 2005). There is much debate and little agreement about what comprises this concept (Robinson, 2005), who can be considered as gifted, how giftedness develops and, which are the characteristics of a gifted person (Reis & Renzulli, 2011). There is much to be clarified; there is an issue, for example, of why many students who exhibit characteristics that would identify them as gifted, fail to succeed both in school and in daily life (Reis & Renzulli, 2011). According to Reis and Renzulli (2011), a consensus may not be found and rightly so, due to the complexity of the topic.

Despite decades of attempts to study and identify a standard pattern of intellectual giftedness among high-potential children and individuals, no clear pathway has been identified and no specific formula exists regarding the “right” combination of genes, personality and environment needed to produce intellectual giftedness (Reis & Renzulli, 2011, p. 237).

The good news is that, according to Tannenbaum (1983), it seems that some central issues on the topic have a general consensus; they are: (1) the focus is on children; (2) gifted children do not have superpowers nor do they miraculous things that their peers do not, but rather, they show specific talents or abilities, such as the realization of things in a faster, more effective and imaginative way, when compared to other children of their age; (3) although schools tend to focus more on academic abilities, gifted children show heterogeneous talents.

Additionally, Frasier and Passow (1994) reported that researchers have identified some characteristics (traits, aptitudes, and behaviors) that seem to be common among all gifted individuals. The following characteristics are included: motivation, unusual interests, communication expertise, problem-solving aptitude, memory, inquiry, insight, reasoning, imagination/creativity and humor. This however, does not imply that a gifted child will show all of these characteristics, and that a non-gifted child will fail to manifest any of them (Frasier & Passow, 1994). Furthermore, when it comes to the identification of children from different backgrounds, it should be taken into consideration the fact that the behavioral manifestations of these characteristics may differ with circumstances, and so children may manifest these characteristics in different ways (Frasier & Passow, 1994).

Nevertheless, research on giftedness is diverse. There are several different definitions of giftedness, and as reported before, only little consensus has been reached. Sternberg et al. (2011), argued that, generally, the nature of giftedness can be seen through the lenses of three different approaches: (1) no conception of giftedness at all, (2) giftedness as measured by traditional assessments (IQ and related constructs), and (3) giftedness as IQ plus other qualities (conventional tests are not enough to define giftedness, other abilities are also important and must be considered).

Aiming to bring enlightenment about this complex phenomenon, an overview of some relevant studies about the topic, on these three approaches, are presented next. Thus, for the first approach, no conception of giftedness, a brief summary about the view of James Borland

is presented. It continues with the work accomplished by Lewis Terman and the view of giftedness related to IQ scores. Then, the third view is described. According to Sternberg et al. (2011), this approach might be the most studied; many authors have contributed by developing theories and models. Following, some of them are reviewed (Renzulli's Three-Ring Conception of Giftedness, Sternberg's WICS Model of Giftedness and, The Munich Model of Giftedness). This review is followed by a succinct description of the idea defended by some authors that diverse types of giftedness exist. Finally, some issues about special education for gifted children are commented.

No Conception of Giftedness

Borland (2003; 2005) believes that the concept of giftedness is inconsistent and unsustainable. He bases his argumentation on four grounds: (1) it is a construct that is socially determined and, therefore, presents a dubious validity; (2) gifted education has been ineffective; (3) the gifted education, in the U.S., has aggravated the unequal distribution of educational resources; and (4) the concept of giftedness is dispensable; gifted education can and should happen without gifted children. In short, he proposes that the concept of giftedness should be eliminated, and that the education given before just to gifted children should be used for the education in general so that all students could benefit from it and not only some chosen ones (Borland, 2003; 2005).

According to Sternberg et al. (2011), "it is odd and might even seem oxymoronic to think of no conception of giftedness as a conception of giftedness" (p. 14). They do not agree with this statement. Sternberg and colleagues agree that the concept of giftedness based on a single measure of intelligence (IQ tests, for example) is obsolete. But in recent years, giftedness has become a more complex and sophisticated concept. Therefore, there is no need to dismiss the conception of giftedness, but rather one should dismiss the absolutist notion that people can be classified as gifted or not gifted (Sternberg et al., 2011).

Giftedness as IQ scores

The research on giftedness began with Lewis Terman, and it was with him that IQ became an index defining giftedness (Robinson, 2005). He developed the Stanford-Binet Intelligence Scale based on the work of Binet and Simon. Using this scale he tested and studied the life of approximately 1,500 children, most of them with IQ above 140 (Feldhusen, 2005; Reis & Renzulli, 2011). Terman found that these high intelligent children were healthy and not different from the average children, except for their academic superiority (Feldhusen, 2005; Reis & Renzulli, 2011).

IQ had an active and important role in two aspects, in identifying supposedly gifted children and in developing the concept of giftedness (Sternberg et al., 2011). To Brown et al. (2005), this approach promoted an absolutist view of giftedness; the term gifted was then used to refer to a child that presented high IQ (Feldhusen, 2005; Frasier & Passow, 1994), and non-gifted to a child with low IQ (Brown et al., 2005). Today, IQ tests continue to be used in the selection process of many gifted programs (Sternberg et al., 2011).

However, in light of recent evidence, Brown et al. (2005) suggest a change in view when deciding whether or not a child is gifted, as view does not match with recent research. Findings of the last decades support giftedness as a multifaceted phenomenon (Reis & Renzulli, 2011). Researchers have agreed that giftedness must be viewed at with multifaceted approaches, rather than with a single focus, assessed by only one measurement such as an IQ test (Reis & Renzulli, 2011). The argument is not that IQ tests should be abolished, but should be complemented with other methods of assessment (Sternberg et al., 2011).

Joseph Renzulli's Three-Ring Conception of Giftedness

Renzulli (1978) developed a multi-component conception of giftedness named the Three-Ring Conception. He suggested that giftedness is comprised of a set of three interacting

clusters of human traits: *above-average ability, high level of task commitment, and high level of creativity*. To Renzulli (1978), they are equal in importance for the composition of giftedness and it is the interaction between these points (not one isolated) that characterizes giftedness. Thereby, giftedness is characterized by the piece where the three rings overlap (see Figure 7).

The first cluster of traits, above-average ability, can be defined as general *ability and specific abilities* (Renzulli, 2005). The former refers to the ability to process information, to think abstractly, and to incorporate experiences, which will, in novel conditions, result in suitable and adaptive responses (Renzulli, 2005). Specific abilities, on the other hand, outline the aptitude to attain knowledge, abilities, or even the capacity to execute activities of a particular category (Renzulli, 2005).

The second cluster of traits, task commitment, is a focused form of motivation; it is the energy exerted on a particular issue or situation (Renzulli, 1978; 2005). Characteristics such as perseverance, resistance, self-confidence, and others, are commonly employed to describe task commitment. Meanwhile, the third cluster of traits is based on factors frequently grouped beneath the general title of creativity (for more information about this topic see Section 2.1).

The overlap of the clusters traits, in turn, interact with general and specific fields of human performance (Renzulli, 1978; 2005). According to Renzulli (1978), giftedness is the result of interface or overlap between the clusters. However, giftedness does not happen in a vacuum (Renzulli, 1978); the set of cluster traits is also surrounded by a background called *Houndstooth* (Renzulli, 1978, 2005).

This Houndstooth background is the interface between personality and environmental aspects which give birth to the three rings of giftedness (Renzulli, 2002; 2005). It is formed by six co-cognitive factors that contribute to giftedness (Reis & Renzulli, 2011; Renzulli, 2002; 2005). These co-cognitive factors are: *optimism* (hope, positive position in front of difficult task), *courage* (psychological/intellectual autonomy, moral belief), *focused passion*

(interest, enthusiasm), *compassion to human apprehensions* (insight, empathy), *physical/mental vigor* (charisma, curiosity), and *sense of destiny* (sense of power to change things, search for objectives) (Reis & Renzulli, 2011; Renzulli, 2002; 2005).

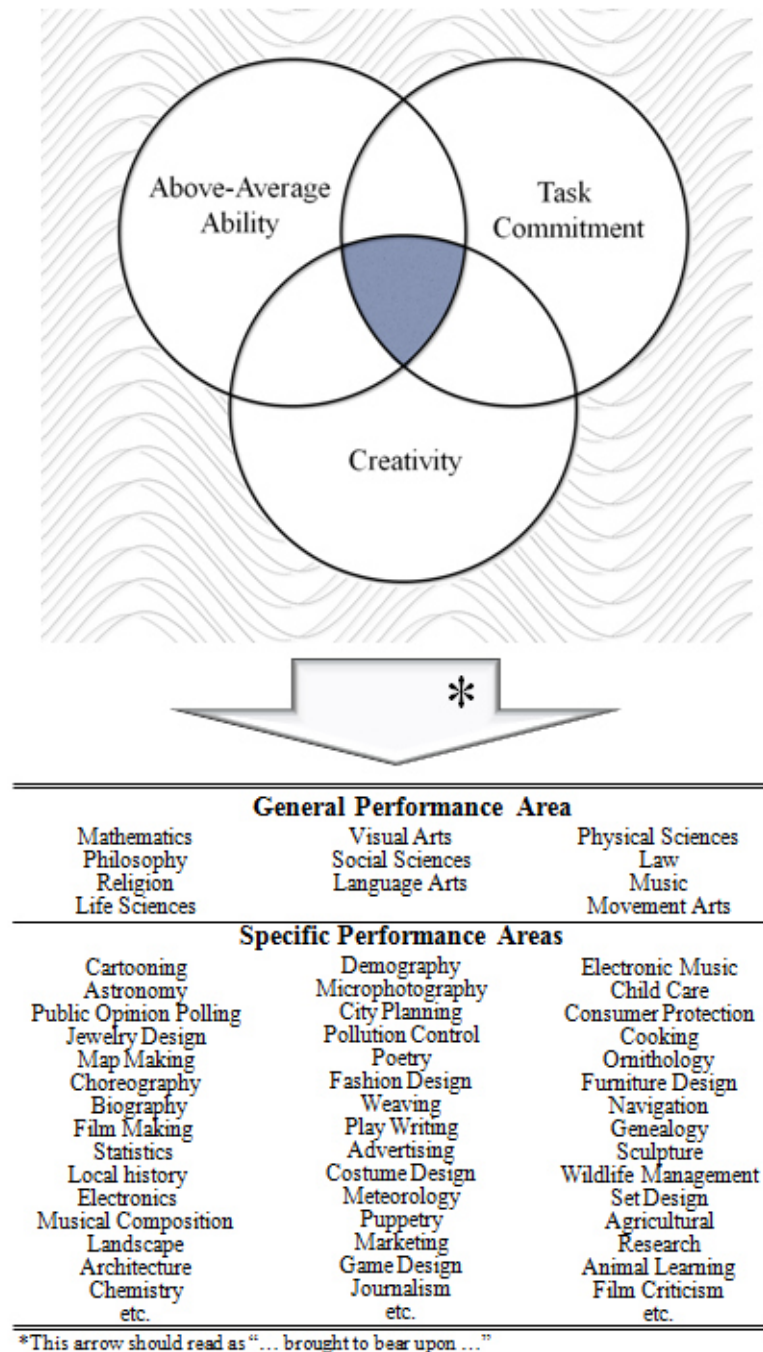


Figure 7. Graphic Representation of the Renzulli's Three-Ring Conceptions of Giftedness. Adapted from "The Three-Ring Conception of Giftedness" by J. S. Renzulli, 2005, *Conceptions of Giftedness*, p. 257. Copyright 2005 by the Cambridge University Press.

Thereby, Renzulli (1978) claims, “gifted and talented children are those possessing or capable of developing this composite set of traits and applying them to any potentially valuable area of human performance” (p.185). Renzulli (2002) argued that with this definition, and by expanding the concept of giftedness, something really significant happens: students with high potential who are not selected for programs that use traditional identifying methods, will be found.

Robert Sternberg’s WICS Model of Giftedness

WICS is an acronym for three attributes that are considered prerequisites to giftedness, which are: Wisdom, Intelligence, and Creativity Synthesized (Sternberg, 2005b; 2005c; 2010; Sternberg et al., 2011).

An elementary idea behind this model is that giftedness is, in large part, a function of creativity in generating ideas, analytical intelligence in evaluating the quality of these ideas, practical intelligence in implementing the ideas and convincing others to value and follow the ideas, and wisdom to ensure that the decision and their implementation are for the common good of all stakeholders (Sternberg et al., 2011).

The first attribute, wisdom, is based on the balance theory of wisdom (Sternberg et al., 2011). According to Sternberg (2001) this theory states that wisdom is, to a large extent, the choice of the individual to use their abilities for the common good, rather than for their own interests, within an equilibrium between interpersonal, intrapersonal and extrapersonal interests. Wisdom is probably the most remarkable of the attributes (Sternberg, 2005b). High intelligence and high creativity are no guarantee for wisdom (Sternberg et al., 2011). “People who use their cognitive skills for evil or even selfish purposes, or who ignore the well-being of others, may be smart, but they are also foolish” (Sternberg, 2005b).

The second attribute, intelligence, is based on the successful intelligence theory¹ (Sternberg, 2005b). The successful intelligence theory refers to the abilities and attitudes that one must reach in order to succeed (each individual may have his or her own definition of success) in life within a certain environment (Sternberg et al., 2011). Gifted individuals may not exhibit all abilities, but can recognize their strengths and weaknesses and how to deal with them (Sternberg et al., 2011). Within this scenario, intelligence may vary; two kinds of intelligence are highlighted by Sternberg et al. (2011), the academic and the practical intelligence.

The third attribute, creativity, is based on the investment theory of creativity² (Sternberg, 2005b). Within the scope of this theory, creativity is a decision (Sternberg, 2009), and a creative person is the one who buys low and sells high (Sternberg & Lubart, 1999). This attribute is important to giftedness because it is from here that novel and suitable thoughts and products are generated.

Sternberg et al. (2011) highlights that the WISC is a model for children and adults, which infers that the concept of giftedness in childhood should to be extended for the common good of the world.

The state of the world makes clear that what the nations of the world need most is gifted leaders – people who make a positive, meaningful, and enduring difference to the world – not just individuals who get good grades or good test scores, or who have the skills that will get them into elite colleges, which in turn will prepare them to make a lot of money (Sternberg et al., 2011, p. 53).

According to Sternberg et al. (2011), the WISC offers the key to this situation; it can be helpful in developing gifted abilities who will become tomorrow's leaders.

¹ For more information about the theory of successful intelligence, see Sternberg – The triarchic theory of successful intelligence on this manuscript on page 25.

² For more information about the investment theory of creativity, see further theories of creativity within this manuscript on page 13.

Munich Model of Giftedness (MMG)

The Munich Model of Giftedness is a model that considers giftedness as a multidimensional construct (Heller, Perleth, & Lim, 2005). It is based on a psychometric categorization approach (Heller et al., 2005), and corresponds to a typological model (Heller, 2004). According to the MMG, giftedness is “a multifactorized ability construct within a network of non-cognitive (e.g., motivation, interests, self-concept, control expectations) and social moderators which are related to the giftedness factors (predictors) and the exceptional performance areas (criterion variables)” (Heller, 2004, p. 306).

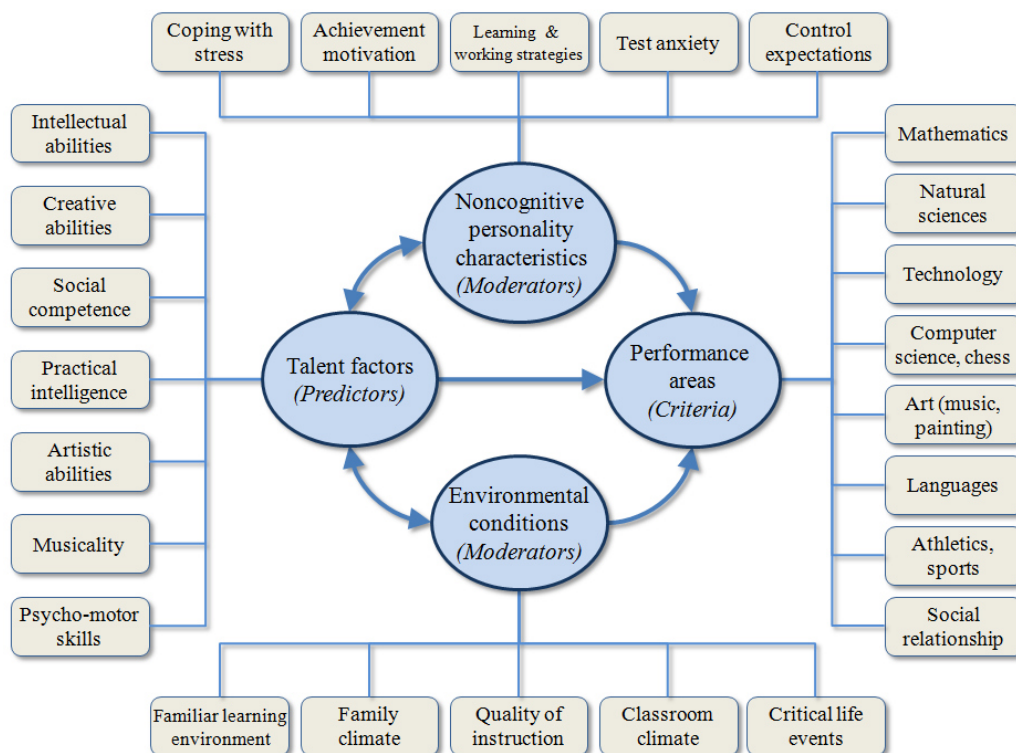
This model contains (see Figure 8): (1) *Predictors* which consist of seven moderately autonomous abilities groups; (2) *Criteria variables* which refer to various performance domains and; (3) *Moderators* which consist of personality elements and environmental aspects (Heller et al., 2005). The moderators are responsible for the conversions of personal potentials into exceptional achievement in a variety of domains (Heller et al., 2005).

The Diverse types of Giftedness

Some authors support the idea of the existence of different categories or types of giftedness. Sternberg (1990) suggests that it is necessary to go beyond the view of giftedness as a composition of multiple components, to the view where there are multiple types of giftedness with multiple components.

When reviewing literature, Renzulli (1982) concluded that there are two types of giftedness: *the schoolhouse giftedness* and *the creative-productive giftedness*. Both are equally important, there is an interaction between, and special programs should provide support for both types of giftedness (Renzulli, 1982; 2005). The former, schoolhouse giftedness, could also be called test-taking or lesson-learning giftedness, as they represent the outcome of good grades and tests scores (Renzulli, 1982; 2005). Not surprisingly, special programs for the gifted are full of this type of giftedness; this is the most noticeable type of

giftedness for teachers. The abilities required on an IQ and/or aptitude test are the same as the ones which are most highly appreciated in traditional school education (Renzulli, 2005).



Legend:

Talent factors (predictors)

- intelligence (language, mathematical, technical abilities, etc.)
- creativity (language, mathematical, technical, artistic, etc.)
- social competence
- musicality
- artistic abilities
- psycho-motor skills
- practical intelligence

(Noncognitive) personality characteristics (moderators)

- achievement motivation
- hope for success vs. fear of failure
- control expectations
- thirst for knowledge
- ability to deal well with stress (coping with stress)
- self-concept (general, scholastic, of talent, etc)

Environmental conditions (moderators)

- home environmental stimulation ("creative" environment)
- educational style
- parental educational level
- demands on performance made at home
- social reactions to success and failure
- number of siblings and sibling position
- family climate
- quality of instruction
- school climate
- critical life events
- differentiated learning and instruction

Performance areas (criteria variables)

- mathematics, computer science, etc.
- natural sciences
- technology, handicraft, trade, etc.
- languages
- music (musical-artistic area)
- social activities, leadership, etc.
- athletics/sports

Figure 8. Graphic Representation of the Munich Model of Giftedness. Adapted from "Munich Model of Giftedness Designed to Identify and Promote Gifted students" by Heller et al., 2005, *Conceptions of Giftedness*, p. 149. Copyright 2005 by the Cambridge University Press.

The latter kind of giftedness described by Renzulli, the creative-productive, goes beyond the achievement and storage of knowledge. It "describes those aspects of human

activity and involvement in which a premium is placed on the development of original thought, solutions, material, and products that are purposefully designed to have an impact on one or more target audiences” (Renzulli, 2005, p. 255).

Milgram (1990) also supports the notion that various types of giftedness exists. According to her, there are four different categories of giftedness: (1) *General intellectual ability or overall general intelligence*, which refers to the ability to solve problems and to think rationally and abstractly. (2) *Specific intellectual ability*, as the name says, it outlines a skill in a particular area such as painting. (3) *General original/creative thinking*, which relates to the generation of high qualitative and original ideas. (4) *Specific creative talent*, this refers to a specific creative ability within a domain. She also defends the view that gifted behavior may be exhibited in different levels (mild, moderate, and profound).

Interventions and Programs for Gifted Students

Generally, there is a consensus among researchers about the importance of gifted education (identification and interventions). The process of nurturing the abilities and talents gifted students initiate when they receive guidance in understanding their abilities, and also when they can benefit from a distinguished curriculum and learning practices, so that they are able to learn and develop at their own pace (Feldhusen, 2005, Mönks & Heller, 1994). Gifted students require and earn accurate and challenging education experiences with other students who are equal to them (Robinson, 2005). According to Feldhusen (2005),

Gifted and talented youth should be very much concerned about their futures. They need better and better recognition and understanding of their talents and of how they must guide their own talent development. Schools, teachers, counselors, and parents play major roles in talent development processes and in advancing gifted youth toward expertise and high-level creative achievement (pp. 74–75).

The reasons why gifted students deserve special learning opportunities are addressed for both the individual and the social level: (1) All individuals have the right to receive the

opportunity to fully develop their abilities and potentialities (Mönks & Katzko, 2005; Heller et al., 2005). (2) Every child needs moments of exchange where she/he has the opportunity to share feelings or thoughts with other children who are similar to her/him (Mönks & Heller, 1994). (3) It might assist a healthy and fortunate growth of the gifted child (Mönks & Heller, 1994). (4) It may bring multiple benefits for society as a whole, in that the gifted student can reach socially important and indispensable accomplishments (Heller et al., 2005).

Interventions with gifted students can be made by offering programs of acceleration and enrichment within homogeneous or heterogeneous grouping (Mönks & Heller, 1994). There is a wide range of teaching and learning activities that can be used in the acceleration and / or enrichment programs (Mönks & Heller, 1994). The acceleration program usually offers learning activities that take into consideration the child's abilities and speed of processing level, which probably will differ from his or her classmates, whereas the enrichment program commonly comprises activities that are or at least should be challenging and that go wider and deeper on the matters; it can engage subjects that typically are not addressed in regular school curriculum (Mönks & Heller, 1994).

To attract and challenge gifted students, Reis and Renzulli (2011) advised that a combination of both acceleration and enrichment programs is the best option. And so did Heller (2009), he reinforces that a "...combination of enrichment and acceleration is the quickest way to promote general thinking skills and learning abilities as well as domain specific knowledge" (p. 64).

Reviewing literature on the topic, Reis and Renzulli (2011), reported that some essential issues need to be taken into consideration, when it refers to the need for special intervention for the gifted students and the kind of programs offered. Two main aspects are highlighted by these authors: (1) studies showed that the needs of the gifted students have not been met in regular classrooms (at least not in the American ones); (2) gifted students

demonstrably benefit from programs that group them together with the educational purpose to meet their needs (Reis & Renzulli, 2011).

Regarding the first point cited above, results of studies realized in American schools demonstrated that in the regular classroom settings only modest differential teaching was granted for the gifted students, and that teachers were not didactically prepared to offer these students the required support (Archambault et al., 1993; Reis et al., 2004; Westberg, Archambault, Dobyms, & Salvin, 1993).

Concerning the second aspect, research has found that cluster grouping with acceleration and enrichment practices are effective on the instruction of gifted students (Gentry & Owen, 1999; Gentry, 1999; Kulik, 1992). Additionally, most benefit was found when teaching and curriculum was properly adjusted, hence, contributing to a potentiality enhancement (Gentry & Owen, 1999; Gentry, 1999; Kulik, 1992).

Renzulli and Renzulli (2010) argue that programs destined for gifted education has been a fertile room for experimentation, because these programs are not overwhelmed with prescribed curriculum guides or traditional educational methods. However, according to Sternberg et al. (2011), every day the number of children failing to fully develop their potential increases, and this number also includes gifted children. To him, one reason for this may be linked to the quality of the learning practices; the way that they are being taught in school does not permit them to learn properly. Thereby, he completes: “The time has come to expand gifted education to recognize all the gifts that students can bring to their schoolwork and to their work throughout their lives” (Sternberg, 2000b, p. 15).

3. Main Questions and Hypotheses

The major objective of this study is to clarify some aspects about the topics of creativity, intelligence, and giftedness, answering some specific questions. Each one of these questions is represented as a hypothesis to be tested within specific studies. However, before presenting such hypotheses some considerations need to be made.

The present study investigates classical intelligence (CI) and classical creativity (CC) with standard measurements of intelligence and creativity. The standard tests for intelligence and creativity used in this study were Raven's Standard Progressive Matrices (SPM) and The Test of Divergent Thinking – Drawing Production (TCT-DP), respectively.

Additionally, a new approach was tested in which intelligence was measured in terms of convergent thinking (CT) in open problem spaces by the CRT Relations and creativity was also measured in terms of divergent thinking (DT) also in open problem spaces by the CRT Components & Specifications. Therefore, four scores are presented: 2 for intelligence (CI and CT) and two for creativity (CC and DT). The first two studies, which address the threshold theory, consequently required group separation using IQ scores. It was therefore, it was decided to use only the standard tests for this investigation. More explanations about each test can be found in the Method section (4.2).

Main Question 1:

Can the threshold theory be confirmed within a sample of primary school children?

The threshold theory asserts that a positive correlation is found to occur until an IQ threshold of 120, beyond which no correlation can be observed (Lubart, 2003; Runco, 2007).

Expectation: A correlation between classical intelligence (CI) and classical creativity (CC) is expected when the IQ level is below 120; above this value no correlation should be expected, and thus threshold theory is expected to be confirmed. Mathematically:

Hypothesis 1:

$$r_{(CI,CC)} = r_0 \quad \text{If IQ} < 120 \quad (1)$$

$$r_{(CI,CC)} \sim 0 \quad \text{If IQ} > 120 \quad (2)$$

Where $r_{(CI,CC)}$ is the correlation coefficient between CI and CC, and r_0 is a constant greater than zero.

Relevance: The threshold theory is a well-known theory about the relationship between intelligence and creativity. Several studies on validity have been conducted yet no conclusive results have been reached. Furthermore, as addressed by Theurer et al. (2011), only few studies have been conducted on primary school children. Aside from trekking on new territory by exploring this age range, this study also has some distinctive attributes. One attribute is that the same number of children was placed in both groups, above and below the IQ of 120. This assures a more uniform comparison.

Another attribute is that both groups were formed with matched pairs for gender and grade, meaning that every subject in the IQ > 120 group has an equivalent in the IQ < 120 group; thus minimizing the possible differences between individuals, as well as minimizing the risk factor for confounding variables. This study is one of the unique, if not the first, to use a matched subjects design on the testing of the threshold theory.

Main Question 2:

How do the theoretical constructs of classical intelligence and classical creativity develop in average and above-average intelligent primary school children within a year, given the threshold theory?

The following study complements of Study 1; its results should corroborate the ones of the first study. The threshold theory implies a nonlinear trend because the magnitude of the association between intelligence and creativity actually depends upon the IQ level; creativity increases as a function of intelligence, but then once it comes to an IQ of 120, the pattern

changes, the slope decreases at the upper end of the intelligence distribution (Karwowski & Gralewski, 2013; Sligh et al., 2005).

Expectation: Taking this into consideration, if there is an increase in the classical intelligence (CI) score from Time 1 to Time 2, then an increase in classical creativity (CC) score should also be expected, but only when IQ is below 120. Mathematically:

Hypothesis 2:

$$\text{If } (\overline{CI}_{Time\ 2} - \overline{CI}_{Time\ 1}) > 0 \quad \rightarrow \quad (\overline{CC}_{Time\ 2} - \overline{CC}_{Time\ 1}) > 0 \quad \text{When IQ} < 120$$

Where \overline{CC} and \overline{CI} are the mean of CC and CI, respectively, in a two-test administration time design.

Relevance: Studies that have investigated the threshold theory in a longitudinal design are very rare (Theurer et al., 2011). This study can foster important clarifications to the inconclusive findings in the field, since the manifestation of the phenomenon is observed over time within the same subjects. As in the previous study, another relevant factor of this study is the matched groups for gender and grade.

Main Question 3:

How does creativity and intelligence develop from first through fourth grade? Does it increase?

According to Alfonso-Benlliure et al. (2013), intelligence develops gradually and increasingly with age and creativity progresses in a more inconsistent course, full of instability, presenting a noticeable decrease as childhood progresses. Therefore, different development through grades is expected:

(a) *Intelligence* –According to some researchers (Ceci, 1991; Ceci & Williams, 1997; Neisser et al., 1996), the school setting has a significant impact on a child's intelligence. Intelligence

test scores have been showing correlations with the total years of education of around .55 to .80 (Ceci, 1991; Neisser et al., 1996).

Expectation (a): Intelligence is expected to grow continually through grades 1 to 4.

Mathematically:

Hypothesis 3(a):

$(\overline{CI}_{Grade\ 1} < \overline{CI}_{Grade\ 2} < \overline{CI}_{Grade\ 3} < \overline{CI}_{Grade\ 4})$ so $(\overline{CI}_{Grade\ 1} < \overline{CI}_{Grade\ 4})$ with p -value $< .05$

$(\overline{CT}_{Grade\ 1} < \overline{CT}_{Grade\ 2} < \overline{CT}_{Grade\ 3} < \overline{CT}_{Grade\ 4})$ so $(\overline{CT}_{Grade\ 1} < \overline{CT}_{Grade\ 4})$ with p -value $< .05$

Where \overline{CI} and \overline{CT} are the mean of CI and CT, respectively.

Relevance (a): This study is important because it compares two measurements of intelligence that differ on problem spaces. It would be useful to see if intelligence measured in open problem spaces develops differently from classical intelligence measured in closed problem spaces. According to Jaarsveld et al. (2010) and Jaarsveld et al. (2012), intelligence functions differently in ill-defined and well-defined problem spaces.

(b) *Creativity* –In a longitudinal study, Torrance (1968) found evidence of a decline in creativity in fourth grade children, which he called the fourth grade slump. He suggested that children from Grade 3 are more creative than children from Grade 4 (Torrance, 1968; 1995). “Quite likely a fourth grade slump in creative abilities in the general population is partially the result of increasing peer group pressures for conforming behavior around age nine or ten” (Nash, 1974, p. 170).

Expectation (b): Taking into consideration Torrance’s statement, a discontinuity in the growth of creativity is expected; a decrease of children’s creativity score from Grade 3 to Grade 4 should be observed. Mathematically:

Hypothesis 3(b):

$$(\overline{CC}_{Grade\ 3} > \overline{CC}_{Grade\ 4}) \quad \text{and} \quad (\overline{DT}_{Grade\ 3} > \overline{DT}_{Grade\ 4}) \quad \text{with } p\text{-value} < .05$$

Where \overline{CC} and \overline{DT} are the mean of CC and DT, respectively.

Relevance (b): Studies on the development of child creativity have shown ambiguous results.

This study can provide advances in the study on this topic, helping to clarify this important issue. According to Maker et al. (2008), “Clearly, more research is needed to clarify the inconsistent finding of research on development of children’s creativity” (p. 405).

Main Question 4:

How does intelligence and creativity develop within a school year from the first to the fourth grade?

This question is complementary to the previous one (Question 3). The difference is that now increases or decreases are observed in a longitudinal design, within a school year.

(a) Intelligence – the development of intelligence is directly affected by attendance at school Neisser et al. (1996) and Ceci (1991). According to Ceci (1991), there is enough evidence proving that schooling has a powerful influence on intelligence.

Expectation (a): Intelligence is expected to increase from Time 1 to Time 2 throughout all grade levels. Mathematically:

Hypothesis 4(a):

$$(\overline{CI}_{Time\ 1} < \overline{CI}_{Time\ 2}) \quad \text{and} \quad (\overline{CT}_{Time\ 1} < \overline{CT}_{Time\ 2}) \quad \text{with } p\text{-value} < .05$$

Where \overline{CI} and \overline{CT} are the mean of CI and CT, respectively, in a two tests administration design.

Relevance (a): As in the previous question, it is important to observe intelligence measured in both ill- and well-defined problem spaces. Differences in the development may be presented, and thereby, a new pattern for intelligence assessed in open problem spaces may be found.

(b) *Creativity* – According to Torrance (1968), many children end fifth grade with lower scores in creativity than those obtained in third grade.

Expectation (b): A decrease of the creativity scores is expected from Time 1 to Time 2 for Grade 4. It may be possible that this decrease may also be observed in Grade 3, taking into consideration the finding of Torrance (above). Therefore, it is also expected that the mean score for classical creativity (Time 1 and Time 2) from Grade 3 children will be higher than the mean score for classical creativity (Time 1 and Time 2) from Grade 4. Mathematically:

Hypothesis 4(b₁):

$(\overline{CC}_{Time\ 1} > \overline{CC}_{Time\ 2})$ and $(\overline{DT}_{Time\ 1} > \overline{DT}_{Time\ 2})$ with p -value $< .05$ When Grade 4

Hypothesis 4(b₂):

Grade 3 $(\overline{CC}_{Time\ 1+Time\ 2}) >$ Grade 4 $(\overline{CC}_{Time\ 1+Time\ 2})$ and

Grade 3 $(\overline{DT}_{Time\ 1+Time\ 2}) >$ Grade 4 $(\overline{DT}_{Time\ 1+Time\ 2})$, with p -value $< .05$

Where \overline{CC} and \overline{DT} are the mean of CC and DT, respectively, in a two tests administration time design.

Relevance (b): As mentioned in the previous question, more studies are necessary to clarify inconsistent findings on this topic.

Main Question 5:

Can a special program for promoting gifted students, such as Entdeckertag, increase the intelligence and/or creativity level of above-average intelligent primary school children?

Intelligence can be enhanced (Sternberg et al., 2011), as well as creativity (Lubart & Georgsdottir, 2004). Additionally, research has found that cluster grouping with acceleration and enrichment practices are effective in the instruction of gifted students, especially when teaching and curriculum are properly adjusted (Gentry & Owen, 1999; Gentry, 1999; Kulik, 1992).

Expectation: Since both intelligence and creativity can be improved, they are expected to increase. Mathematically:

Hypothesis 5:

$$(\overline{CI}_{Time\ 2} - \overline{CI}_{Time\ 1}) > 0 \quad \text{and} \quad (\overline{CT}_{Time\ 2} - \overline{CT}_{Time\ 1}) > 0 \quad \text{with } p\text{-value} < .05$$

$$(\overline{CC}_{Time\ 2} - \overline{CC}_{Time\ 1}) > 0 \quad \text{and} \quad (\overline{DT}_{Time\ 2} - \overline{DT}_{Time\ 1}) > 0 \quad \text{with } p\text{-value} < .05$$

Where \overline{CI} , \overline{CT} , \overline{CC} , and \overline{DT} are the mean of CI, CT, CC, and DT, respectively, in a two tests administration time design.

Relevance: Working with gifted children is of vital importance at the current global conjuncture, and also important is the quality of the training that is offered to these children. This study may provide improvements to both the program and to the participants involved that will receive better care, and consequently, benefits the society as a whole.

The results of the study can lead to improvements in the program, not only showing the effectiveness or the absence of it, but also assisting in the detection of its strengths and weaknesses, and so can change or improve deficiencies. In consequence of this, participants receive better quality care, which brings benefits not only to themselves but to the society as well.

Furthermore, according to Heller (2009), only some of the major programs offered to gifted children have been appropriately evaluated in Germany.

4. Method

This chapter describes the general terms, procedures, and topics common to all five studies carried out in this work. Specific details about each study are given in the corresponding chapters 5, 6, 7, 8, and 9.

4.1 Participants

In this study, 217 children from Grade 1 to Grade 4, between the ages of 6 and 10 years old were tested for intelligence and creativity. The children were recruited from a primary school in Kaiserslautern, Germany (Pestalozzi *Grundschule*). The state authorities approved this study and parents consented to their child's participation. Participants were divided according to two general cohorts: Intervention group and non-intervention group. Later, children were placed into more specific groups based on the hypothesis being tested.

4.1.2 Intervention Group

The intervention group (IG) was comprised of children ($N = 43$) classified as gifted and who participated in a special intervention program called *Entdeckertag* (Discovery day).

Entdeckertag (ET)

This is a pilot program which was implemented in 2004 in the state of Rhineland-Palatinate, Germany. It was developed by the Ministry for Education, Science, Youth and Culture of the referred federal state, in an attempt to recognize and support gifted children from kindergarten through the fourth grade. The definition of giftedness adopted in this program takes into consideration individuals whom are meant to have exceptional, diverse and very high potential in a variety of areas (Ministry for Education, Science, Youth and Culture of the State Rhineland-Palatinate, 2009).

The main focus of this program is the early intervention for children with exceptional skills, based on the areas of German language, general science and mathematics.

Nevertheless, the program's objective is not only to promote cognitive skills, but also to support a holistic personality development, to strengthen social ability, their capacity for team work, etc. At the ET, children are supported and challenged specifically in mathematics, language and science. However, the content and tasks do not focus exclusively on these fields, it is an interdisciplinary and holistic learning which involves musical and motor activities as well (Ministry for Education, Science, Youth and Culture of the State Rhineland-Palatinate, 2009).

The program is conducted in select primary schools around the state. Each school has a team of experts responsible for the implementation and organization of the ET. They are presented with qualified teachers trained to meet the purpose of the program; a teacher that recognizes and fosters an active, creative, and inquisitive thinking attitude among the gifted children. Each school receives children within its city and region. Statistics of 2010/2011 showed that 424 children (276 males and 148 females) from 206 primary schools participated in the program within 13 ET schools (Ministry for Education, Science, Youth and Culture of the State Rhineland-Palatinate, 2011). Since then, the program has been implemented into two additional schools. Currently, the state has 15 ET schools (Ministry for Education, Science, Youth and Culture of the State Rhineland-Palatinate, 2013).

Steps involved in the ET selection process are as follows:

1. Parents or teachers suspect that their child is gifted. They contact the *Entdeckertag* school and request the questionnaire necessary for the approval process;
2. Upon receipt of the completed questionnaires, the school conducts interviews with the child, parents and teachers;
3. The project group makes their decision based on the information gathered in the selection process (questionnaires and interviews) (see Figure 9).

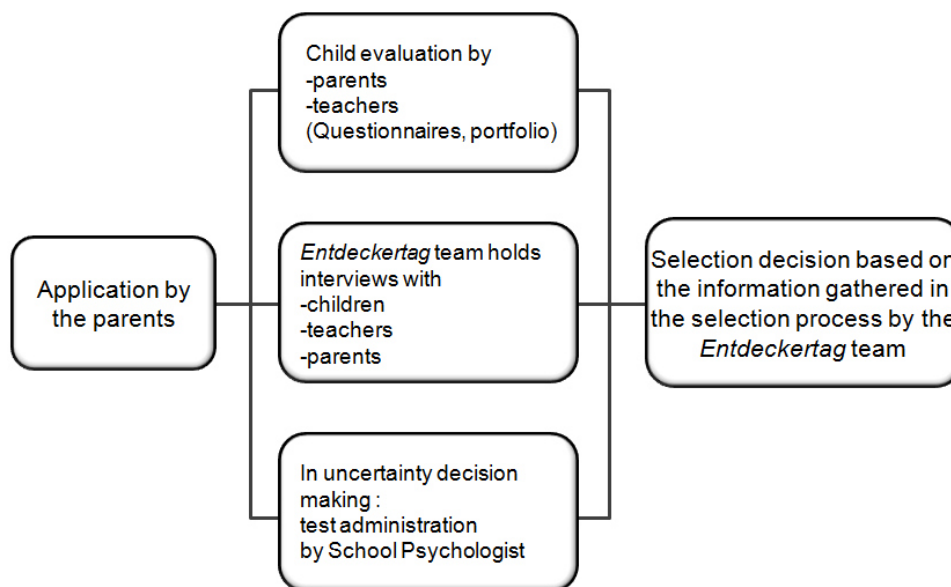


Figure 9. Procedures of the *Entdeckertag* program selection process. Adapted from “Erkennen und Fördern hochbegabter Kinder in der Grundschule: Entdeckertag - Modellprojekt des Landes Rheinland-Pfalz” by Ministry for Education, Science, Youth and Culture of the State Rhineland-Palatinate, www.grundschule.bildung-rp.de.

The ET takes place once a week. On this day all children who participate in the program go to the ET school. On the other days of the week, they attend their regular classes. When teaching gifted primary school children, it is necessary to consider that these children usually bring rich knowledge and that at their regular classes, they encounter minimal challenge in learning situations; therefore, “work packages” were planned. These consist of a task package that the children take to their regular classes to work on. This is necessary for the creation of an educational connection between the two learning systems in which these children are involved (Ministry for Education, Science, Youth and Culture of the State Rhineland-Palatinate, 2009).

There is a daily structure that the participating schools must follow (see Table 2), but all of them develop their own proposal within the program’s scope. The daily details of the ET are the responsibility of each school involved.

In 2009, the *Entdeckertag* program started in the Pestalozzi School serving gifted children from the city of Kaiserslautern and neighboring communities. As previously explained, the children meet once a week (on Wednesdays). They remain in school for a

duration of eight hours, from 07:55 until 16:00. Children are divided into two groups. Group 1 is composed of children from kindergarten, first and second grades, and Group 2 of children from the third and fourth grades.

Table 2 - Daily structure of the Entdeckertag Program

Time		Daily Structure*
From	To	
8:00	09:30	Work on topic 1 (mathematics, natural sciences or German language)
09:30	10:30	Work on topic 2 (language learning or task packages)
10:30	12:00	Research-based learning to self-selected projects
12:00	13:00	Sports, games, planned leisure activities, reading or computer work
13:00	13:30	Lunch and free time
13:30	13:45	Physical activity outdoors
13:45	16:00	Afternoon projects possibly with extracurricular experts

Note. *Time interval can be interpreted as a flexible framework for the *Entdeckertag*. This also applies to the intermediate pause times that are not listed separately. Adapted from “Erkennen und Fördern hochbegabter Kinder in der Grundschule: Entdeckertag - Modellprojekt des Landes Rheinland-Pfalz” by Ministry for Education, Science, Youth and Culture of the State Rhineland-Palatinate, 2009, www.grundschule.bildung-rp.de.

All meetings follow the same scheduling structure (see Table 3). Aside from the weekly activities, once a year, some special activities are held, such as hiking/climbing day and/or visits to museums, such as the Technic Museum Speyer, in Speyer and to the TECHNOSEUM (State Museum of Technology and Work) in Mannheim, both in Germany.

At the commencement of this study, from 2010-2011, the program had already begun the year before at the Pestalozzi School. From the 43 children that participated in the program by this time, 14 started their first year, 24 began their second year, and 5 children began their third year in the program (see Figure 10).

4.1.3 Non-intervention Group

The non-intervention group (NIG) was composed of children ($N = 174$) from the regular primary school (Pestalozzi *Grundschule*). After a first test administration, participants

were allocated according to their scores on the non-verbal intelligence test, Standard Progressive Matrices, into two groups: IQ > 120 and IQ < 120.

Table 3 - Pestalozzi School Entdeckertag program schedule

Time		Daily Schedule
From	To	
8:00 a.m.	10:00 a.m.	Debate on a topic selected by the teachers and task packages*
10:00 a.m.	11:00 a.m.	Russian lessons
11:00 a.m.	12:00 a.m.	"Own topic"***
12:00 a.m.	13:00 p.m.	Reading and playing time
13:00 p.m.	14:00 p.m.	Lunch and exercise (gymnastics)
14:00 p.m.	16:00 p.m.	chemicals / experiments

Note. *The package tasks are composed of five fields (reading, writing, puzzling, counting and star), and the children have to work it over the week in their regular classes (See Appendix C). **Each child chooses a topic of interest to research and present to the class. They use internet to perform their research. The presentation is made in poster (Group 1) or power point (Group 2). Each child sets the time limit for their research.

The IQ was calculated using the following procedure: first each child's test was scored, then the SPM raw score was taken and converted into percentile rank using Table A 6: Age norm for children in the primary school – transformation of raw scores to percentile ranks (Heller, Kratzmeier, & Lengfelder, 1998)^{3 4}. Finally, percentile ranks were converted into IQ using Table A: standard values scales – transformation of percentile ranks to IQ (Gutjahr, 1974). Both tables are presented in Appendix A and Appendix B, respectively.

From 174 tested children, a total of 8 were excluded from data analysis. Their tests presented problems concerning validity and could not be utilized; seven of them showed problems in the SPM and one in the CRT. These children (four male and four female) attended the first grade. Of the remaining 166 participants, 52 had an IQ > 120 and 114 an IQ < 120 (see Figure 10).

³ This table is from 1998, it was used because no recent German normalization for children aged less than 10 years-old could be found.

⁴ The normalization for children of 6 years-old was not available; they were classified as the seventh years-old children

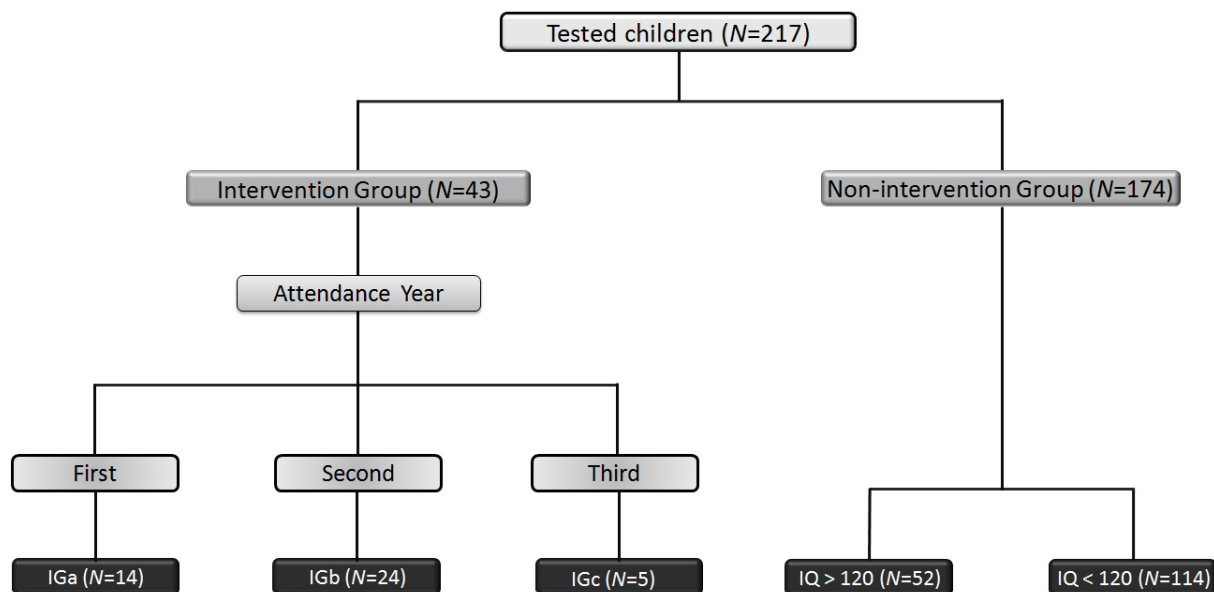


Figure 10. Main group formation of all tested children. Eight participants from the non-intervention group were excluded from data analysis because of invalid test results. Therefore they are not presented in this diagram.

4.2 Material

Three tests were applied to each participant: Standard Progressive Matrices (SPM), Creative Reasoning Task (CRT), and Test for Creative Thinking – Drawing Production (TCT-DP, Form A and B). The pen-and-pencil version of the three tests was applied. Following detailed description.

4.2.1 Standard Progressive Matrices (SPM)

The SPM was developed in 1938 by John C. Raven and is a frequently used to test “general intelligence” (g). Raven wanted to measure directly the two main components of g : *eductive* and *reproductive* ability. The first term refers to the ability to think clearly and to infer meaning from confusion. The second concerns the ability to store and reproduce acquired information (Raven, 2000).

The test consists of 60 graphical multiple-choice items divided into five sets (set A to E) of twelve items. Each item in the SPM comprises a pattern presented in the form of a 1x1, 2x2 or 3x3 matrix of puzzles with one piece missing. The candidate’s task is to choose the correct missing piece that completes a pattern from six or eight possible given answers. The

items are, at first, easy and simple and become increasingly more difficult within and across sets, requiring higher levels of cognitive abilities to encode and analyze information. The individual test processing time and the difficulty progression of the SPM items are meant to check the extent of clear thinking as the degree of task complexity increases (Heller et al., 1998).

The objective of the test was to create a set of items whose difficulty would increase in such a way that everyone would complete all the items up to the most difficult they could solve, then fail to solve the rest of the more difficult items (Raven, 2009). The SPM was intended to capture the different degrees of cognitive abilities - not only in one, but in as many age groups as possible, regardless of education, nationality, or health condition. Raven had the intent to develop a test theoretically relevant, easy to administer, and clear to interpret for the population of different ages and socio-economic backgrounds (Raven, 2009). Normally, the SPM is used from six years old onward. All candidates have the same set of tasks in the same order (Heller et al., 1998). The maximum score achieved is 60 points, since each item is fixed as pass or fail.

For this study, German norms were used. The first German standardization of the SPM occurred in 1996/97. The main data base was collected in the Bavarian primary, secondary, high school, and University. This data set was supplemented by data from other states (Heller et al., 1998).

4.2.2 Creative Reasoning Task (CRT)

The CRT is a test that measures reasoning in terms of convergent thinking and creativity in terms of divergent thinking both in open problem spaces. Children are asked to generate a matrix such as the SPM pattern diagrammatic puzzles. Their matrix should be as difficult as possible, and, in theory, solvable. Complete information about this test is presented in the literature Review section (2.3).

4.2.3 Test for Creative Thinking – Drawing Production (TCP-DP)

The TCP-DP is meant to be a screening instrument developed in 1985 by Jellen and Urban for measuring the creative thinking potentials of individuals. It can be used to identify very high creative potential as well as to recognize individuals with underdeveloped creative abilities who are in need of stimulation and support. “This assessment device may be seen as an attempt to apply a more holistic and gestalt- oriented approach to diagnostics of creativity” (Urban, 2005, p. 388).

This test consists of an answering sheet that provides six special fragments of figures stimulating further drawing in a very free and open way. Based on these fragments, the respondent is required to complete the drawing. These fragments are: semi-circle, point, large right angle, curved line, broken line, and a small open square outside the large square frame.

The drawing product is evaluated and scored by means of 14 evaluation criteria that can deliver up to six raw points each, except for the four criteria of unconventionality which are valued at a maximum of 3 points (see Table 4). The maximum achievable score is 72 points which can be transformed into percentiles and T-scores. The test is available in two forms, A and B, applicable in a single or group testing set with individuals aged between 5 and 95 years. The administration requires 15 minutes per form. Forms A and B were used in the present study.

The TCT-DP standardization studies were held between the years of 1988 and 1993. The main data base was collected basically in the north and central part of Germany. The student samples ($N = 2519$) were gathered from kindergarten, primary, secondary, high school, University (Pedagogy students), and other educational institutions (Urban & Jellen, 1995).

4.3 Procedure

The test sessions occurred at the beginning of the school year and for some, also at the end. Children were tested in groups of four to seventeen participants in a room provided by the school, during the class period. Each testing session was conducted and supervised by the researcher herself and a senior researcher to ensure accuracy of the test application.

Table 4 - The fourteen evaluation criteria of the TCT-DP (Urban, 2004, pp. 389-390)

Evaluation criteria	Explanation
<i>Continuations (Cn)</i>	Any use, continuation or extension of the six given figural fragments.
<i>Completion (Cm)</i>	Any additions, completions, complements, supplements made to the used, continued or extended figural fragments.
<i>New elements (Ne)</i>	Any new figure, symbol or element.
<i>Connections made with a line (Cl)</i>	between one figural fragment or figure and another.
<i>Connections made to produce a theme (Cth)</i>	Any figure contributing to a compositional theme or "gestalt".
<i>Boundary breaking that is fragment dependent (Bfd)</i>	Any use, continuation or extension of the "small open square" located outside the square frame.
<i>Boundary breaking that is fragment independent (Bfi)</i>	from the "small open square" located outside the square frame.
<i>Perspective (Pe)</i>	Any breaking away from two-dimensionality.
<i>Humor and affectivity (Hu)</i>	Any drawing which elicits a humorous response shows affection, emotion, or strong expressive power.
<i>Unconventionality a (Uc a)</i>	Any manipulation of the material;
<i>Unconventionality b (Uc b)</i>	Any surrealistic, fictional and/or abstract elements or drawings;
<i>Unconventionality c (Uc c)</i>	Any usage of symbols or signs;
<i>Unconventionality d (Uc d)</i>	Unconventional use of given fragments.
<i>Speed (Sp)</i>	A breakdown of points, <i>beyond a certain score-limit</i> , according to the time spent on the drawing production.

All sessions followed a systematic procedure: the researchers introduced themselves, discussed the purpose of the study, and explained the complete procedure. Children were asked to work alone and quietly, trying not to disturb the others. This was made possible by ensuring large spaces between tables.

After the introduction, researchers handed out the forms and explained each test according to the manual. The tests were applied one after the other. The children were first asked to perform the SPM. Next, they were asked to generate a SPM-style item themselves in the CRT. Third, they were requested to accomplish the TCT-DP. Participants that had completed a test form could engage in another quiet activity, such as: homework, reading, drawing, etc., until the time allowed for the test was over or all children had finished it. The total test session lasted about 80 minutes (SPM = ca 45 min, CRT = 20 min and TCT-DP = ca 15min). The test instructions and answer sheets are presented in the appendix section.

4.4 Data Analysis

Tests were scored according to their manuals. The raw score of each test was used to perform the data analyses. Data analyses were performed using the statistical package IBM® SPSS® Statistics version 21. Generally, the following statistical methods were used applied: bi-variant Pearson's correlation, repeated measures analysis of variance (ANOVA), Student *t*-test. It is important to note that *t*-tests were only performed when a statistically significant effect was detected by the ANOVA. When more than one *t*-test was conducted for each dependent variable, multiple testing corrections were used. The *p*-value was adjusted by the Bonferroni correction, which sets the significance cut-off at α/n . That means that alpha of .05, established for this study, was divided by the number of *t*-tests performed.

5. Study 1

This chapter presents the procedures applied to verify Hypothesis 1, which as previously mentioned in the introduction, is about the relationship between intelligence and creativity and the testing of the threshold theory.

5.1 Experimental Procedure - Study 1

5.1.1 Participants

This sample was composed of children from the non-intervention group ($N = 98$); 52 were females and 46 males (Table 5) with an IQ ranging from 90 – 139. Participants with an IQ above 120 (IQ > 120 group) were compared to a grade and gender matching group of children with an IQ below 120 (IQ < 120 group) (see Figure 11). The IQ > 120 group was composed of 52 children, but, unfortunately, for three of them, no match could be found in the IQ < 120 group. Thus, both groups had a total of 49 participants.

Table 5 - Study 1 participants sample by grade

Grade	<i>N</i>	Gender		Age	IQ
		Male	Female	<i>M (SD)</i>	<i>M (SD)</i>
1	4	2	2	6.5 (0.57)	113.5 (12.15)
2	20	12	8	6.9 (0.31)	120.2 (15.14)
3	36	16	20	8.06 (0.33)	117.81 (15.94)
4	38	16	22	9.11 (0.31)	121 (16.98)
Total	98	46	52	8.16 (0.95)	119.36 (15.98)

Note. *M* = mean, *SD* = standard deviation

5.1.2 Material

The following tests were used in this study (detailed information is presented in the Method section (4.2)): Standard Progressive Matrices (SPM) and Test for Creative Thinking – Drawing Production (TCT-DP, Form A).

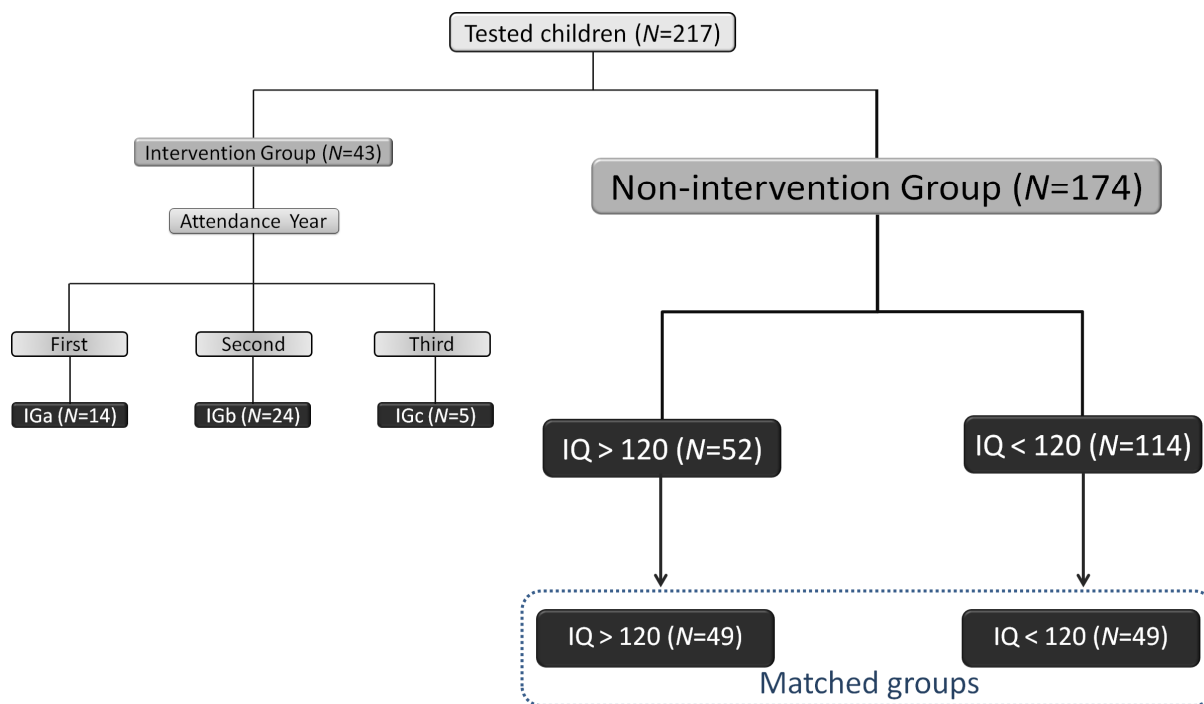


Figure 11. Group formation for the test of Hypotheses 1, which is about the correlation between intelligence and creativity and the testing of threshold theory. Eight participants from the non-intervention group were excluded from data analysis because of invalid test results. Therefore, they are not presented in this diagram.

5.1.3 Data Analysis Overview

Different statistical methods were applied in order to check the relationship between intelligence and creativity and the tenability of the threshold theory. The Kolmogorov-Smirnov test was applied to verify the normality of the sample distribution. Since the normality of the distribution was confirmed, a bi-variant Pearson's correlation (two tailed) was performed considering the whole sample and both separate IQ groups (IQ < 120 and IQ > 120).

Furthermore, in order to explore data more fully, correlations were carried out in sub-groups in order to verify if any difference would be shown for children in different grade and gender groups for both requisites. The Fisher Z-Test (Bortz, 2005) was calculated for the investigation of the comparison between the correlation coefficients to see if any significant difference could be found between them. Additionally, a nonlinear regression analysis with a

quadratic function was conducted to ascertain whether or not a nonlinear correlation could be found. According to Runco (2007), this method enabled the testing of the threshold theory.

5.2 Results and Discussion

Pearson's Correlation (two tailed) cutoff IQ120

Bi-variant Pearson correlations considering the data from all participants revealed that intelligence and creativity were not significantly related ($r = .115, p = .261$). This result is not totally in agreement with the literature. In general, according to Sternberg and O'Hara (1999) and Sternberg et al. (2005a), there is a consensus that the correlation often varies from weak to moderate. Lubart (2003) affirms that the correlation coefficients found in research on this topic are frequently around .20, ranging from .0 to .50. Also, Barron (1963) reported a correlation coefficient around .40. Yamamoto (1964) found, in his study with 272 high school students, a correlation coefficient of .30 ($p = .01$). Sligh et al. (2005) observed for both crystallized and fluid intelligence a significant correlation coefficient (1-tailed) of .43 ($p < .05$) and .42 ($p = .05$), respectively. The divergent findings can be explained by two factors: the use of different tests and the different age levels.

According with Sternberg et al. (2005a) and Sternberg et al. (2011), three factors affect the correlation level between creativity and intelligence. They are: which aspects of both constructs are being measured, how they are being measured, and in what area creativity is manifested. Therefore, the usage of different measurements may be the source for conflicting results. As previously stated, in section 2.3, the relationship between creativity and intelligence depends on how both constructs are measured (Jaarsveld et al., 2012; Kim, 2005; Runco, 2010b; Runco & Albert, 1986). According to Karwowski & Gralewski (2013), the use of different tests in each study is one of the reasons for the contradictory findings in the field.

For instance, Theurer et al. (2011), using the same creativity test (TCT-DP), but a different intelligence test (CFT, *Grundintelligenztest – Skala 1*), observed a weak, but

statistically significant correlation coefficient between creativity and intelligence of $r = .152$, $p < .001$. The use of a different measurement for the evaluation of intelligence may be the reason for the discrepancy between the correlation coefficients in both studies.

Despite the use of different tests to measure both constructs, age also appeared to have an influence on the correlation coefficient, and could be the reason for the divergent findings. Kim (2005) observed in her meta-analysis that, “the variance in the magnitude of the correlation coefficients was also significantly explained by the variance among age groups” (p. 65). She found that the correlation coefficients were significantly higher for older groups (middle and high school, and adult), in comparison with the younger group (kindergarten to fifth grade).

Karwowski and Gralewski (2013), for instance, in a study carried out in Poland with 921 middle and high school students, observed a weak, but statistically significant, correlation coefficient between creativity and intelligence of $r = .24$, $p < .001$. They also used, as in the present research, the SPM and the TCT-DP for the measurement of intelligence and creativity, respectively. In this case, the difference between the correlation coefficients could be then explained by the different age levels. Accordingly to the findings from Kim (2005), correlation coefficients were higher for older groups than for younger ones.

The correlations of the separated groups showed a weakly positive correlation coefficient of $.282$ ($p = .049$), when $IQ < 120$, and a weakly positive non-significant correlation coefficient of $.101$ ($p = .490$), when $IQ > 120$. Comparing the two correlations, no statistically significant difference could be detected ($Z = -0.904$, $p = .182$). That is, they did not differ from each other. This result contradicts the statement that there is an IQ threshold below which a correlation between intelligence and creativity appears and above which no correlation can be found anymore. Thereby, Hypothesis 1 could not be confirmed. The threshold theory received no support within this sample, which means that the threshold theory may be a statistical artifact as inferred by Runco and Albert (1986) and Sligh et al.

(2005). This finding is consistent with results obtained in previous studies (Jauk et al., 2013; Kim, 2005; Preckel et al., 2006; Runco & Albert, 1986; Runco et al., 2010; Sligh et al., 2005; Theurer et al., 2011).

The result of the present study diverged from those found by Sligh et al. (2005). Using different tests for the measurement of creativity and intelligence, but also computing fluid intelligence, their investigation showed an inverse threshold for fluid intelligence (r 's = .12, $p = ns$ for $IQ < 120$ and .39, $p = .05$ for $IQ > 120$). Sligh et al. (2005) used the Kaufman Adolescent and Adult Intelligence Scale (KAIT) and the Finke Creative Invention Task (FCIT) for measuring fluid intelligence and creativity, respectively. The authors emphasized, "...no other researchers have identified an aspect of IQ that correlates [with creativity] only among high-IQ individuals and not among average-IQ individuals" (p. 133). They also reported that, "to some degree, the results of the present study could be due to the specific creativity test we used. To our knowledge, no previous studies of the relation between creativity and intelligence have used the FCIT" (p. 133).

Pearson's Correlation (two tailed) cutoff IQ120, Grade and Gender

When the sample was divided within grade levels only a marginal significant correlation coefficient appeared for the fourth grade participants ($r = .315$, $p = .054$). No significant difference between genders appears when the variable gender is added (see Table 6). Also, within grade levels, no differences between genders could be inferred. Kim (2005) also did not observed any evidence of gender differences. Similarly, Yamamoto (1964) and Yamamoto, Yamamoto and Chimbidis (1966) did not find any significant difference between gender.

Correlations between children in different grade, gender, and IQ groups ($IQ > 120$ and $IQ < 120$) demonstrated that the correlation between intelligence and creativity was statistically significant for female participants, particularly for young girls in Grade 1-2 when

IQ > 120 and for Grade 1-2 and Grade 4 with an IQ < 120. Significant correlations were observed for male participants only when IQ >120 and only for Grade 1-2. Additionally, the male participants as well as the fourth grade children presented a marginally significant correlation (see Table 6). No significant correlations were observed for the third grade participants, neither females nor males, considering both groups together or separately.

Taking into consideration the threshold theory, when the sample was divided into IQ > 120 and IQ < 120, some differences between grade and gender could be observed. While the males (Grade 1-2) presented significant correlations only above the threshold (IQ > 120), females showed significant correlations in both IQ groups. The correlation presented by the males may indicate the inverse threshold suggested by Sligh et al. (2005)(see Table 6). However, the difference between the two correlation coefficients was only marginally significant ($Z = -1.374, p = .085$). It is important to note that the sample size is very small in this case; meaning that the test may not be sensible enough to detect the effect precisely, and/or the result may have been obtained by chance.

Table 6 - Correlations between intelligence and creativity by grade, gender, and groups

Grade	Gender	Whole Sample			IQ > 120			IQ < 120		
		<i>r</i>	<i>p</i>	<i>N</i>	<i>r</i>	<i>p</i>	<i>N</i>	<i>r</i>	<i>p</i>	<i>N</i>
1 to 2	M & F	.044	.838	24	.598	.040	12	.497	.100	12
1 to 2	M	.083	.777	14	.829	.021	7	.210	.651	7
1 to 2	F	.034	.927	10	.944	.016	5	.886	.046	5
3	M & F	.1	.561	36	-.183	.466	18	.070	.781	18
3	M	.190	.482	16	.448	.265	8	.183	.664	8
3	F	-.004	.988	20	-.364	.301	10	-.114	.754	10
4	M & F	.315	.054	38	-.004	.986	19	.664	.002	19
4	M	.397	.128	16	-.063	.883	8	.101	.812	8
4	F	.208	.353	22	.111	.745	11	.785	.004	11

Note. The SPM - raw score and the TCT-DP - raw score were used for the correlation analysis. Grade 1 and Grade 2 were taken together because of the small number of participants. M = Male, F = Female

Furthermore, for Grade 4, the threshold theory could be confirmed ($r = .664, p = .002$ for $IQ < 120$ and $r = .004, p = .986$ for $IQ > 120$; $Z = -2.274, p = .011$). Females appear to be responsible for this result (see Figure 12). While males showed no significant correlation neither for $IQ > 120$ nor for $IQ < 120$, females presented a positively moderate significant correlation when $IQ < 120$, but showed no significant correlation when $IQ > 120$.

Moreover, a curious similarity between males and females was exhibited: only the youngest participants showed correlations above the IQ of 120. It appears as though the correlation above an IQ of 120 might be assigned to the younger children (Grade 1-2). The correlation coefficient presented by first and second graders was significantly higher than the correlations presented by Grade 3 ($Z = -2.076, p = .019$) and Grade 4 ($Z = -1.860, p = .048$) participants. This result was confirmed by the females (Grade 1-2 and Grade 3, $Z = -2.688, p = .004$; Grade 1-2 and Grade 4, $Z = -2.102, p = .018$), and only partially confirmed by the males (Grade 1-2 and Grade 4, $Z = -1.860, p = .031$). It is important to note that care should be taken when generalizing these results, due to the small sample size.

The correlation coefficients for females from Grade 1-2 and Grade 4 did not differ from each other; they did, however, differ from the correlations shown by females of Grade 3 ($Z = -1.893, p = .029$ and $Z = -2.266, p = .012$, respectively). Age may have an influence on the correlation coefficient, as inferred by Kim (2005), correlation coefficients were higher for older groups than for younger one.

From this point of view, it may be possible that such differences can be found within groups containing a smaller age range as within primary school children; considering a developmental view, there is an enormous difference between six-year olds children and ten-years old. According to Piaget (1966a), around seven or eight years of age begins the transition between the *pre-operational stage* (symbolic thinking) and the *concrete operational stage*, where children begin thinking logically about concrete events.

Grade	Gender	Whole Sample			IQ > 120			IQ < 120			
		<i>r</i>	<i>p</i>	<i>N</i>	<i>r</i>	<i>p</i>	<i>N</i>	<i>r</i>	<i>p</i>	<i>N</i>	
1 to 2	M & F	.044	.838	24	.598	.040	12	.497	.100	12	$Z = -0.307, p = .379$
1 to 2	M	.083	.777	14	.829	.021	7	.210	.651	7	$Z = -1.374, p = .085$
1 to 2	F	.034	.927	10	.944	.016	5	.886	.046	5	
3	M & F	.1	.561	36	-.183	.466	18	.070	.781	18	$Z = -1.374, p = .085$
3	M	.190	.482	16	.448	.265	8	.183	.664	8	
3	F	-.004	.988	20	-.364	.301	10	-.114	.754	10	
4	M & F	.315	.054	38	-.004	.986	19	.664	.002	19	$Z = -2.274, p = .011$
4	M	.397	.128	16	-.063	.883	8	.101	.812	8	
4	F	.208	.353	22	.111	.745	11	.785	.004	11	$Z = -1.894, p = .029$

Note. The SPM - raw score and the TCT-DP - raw score were used for the correlation analysis. Grade 1 and Grade 2 were taken together because of the small number of participants. M = Male, F = Female

$Z = -1.679, p = .047$

Figure 12. Comparison of correlation coefficients with Fisher Z-Test.

A significant gender difference was observed when the variable “grade” was added, but only for Grade 4. For Grades 1 and 2, both male and female participants showed a positive moderate correlation coefficient when $IQ > 120$, but only the female participants presented a significant correlation coefficient when $IQ < 120$ (Table 6). According to the Fisher Z-Test, this difference was only marginally significant ($Z = -1.374, p = .085$).

Nevertheless, for Grade 4, a significant gender difference occurred ($Z = -1.679, p = .047$); while the female participants showed a significant positive moderate correlation when $IQ < 120$, the males presented a non-significant correlation (see Figure 12). An independent *t*-test demonstrated that females ($M = 20.09, SD = 7.16$) had statistically significant higher scores on classical creativity (TCT-DP raw score) than males ($M = 12.63, SD = 5.66$), $t(17) = 2.441, p = .026$. No significant differences were found between the sexes for SPM – raw score, but a marginally significant difference does appear for IQ ($M = 109.64, SD = 9.65$ and $M = 101.38, SD = 8.05$ respectively), $t(17) = 1.970, p = .065$.

As reported by Runco and Albert (1986), there is a clear difference between the correlation coefficients at the various IQ levels. The significant difference between creativity scores and the marginal significant difference between IQ levels may explain gender differences presented within this sample.

Quadratic Regression Analysis

The threshold theory implies a nonlinear effect. Therefore, a hierarchical regression analysis with the linear and the quadratic component was performed. According to Sligh et al. (2005), to confirm the threshold theory, a significant positive linear trend as well as a significant quadratic trend should be expected.

The linear and quadratic regression yielded the parameters presented in Figure 13. The quadratic function did not exhibit better enlightenment than the linear model. The observed variability found within the linear regression change only about 0.2% based on the addition of the nonlinear effect. Both the linear trend and the quadratic trend were non-significant. The quadratic regression analysis confirmed the previous results of the Pearson's correlation. The threshold theory could not be supported within the studied sample. The findings of the present study are consistent with those presented by Runco et al. (2010), which also did not observe any traits of a threshold, when using quadratic regressions.

Model Summary									
Model	R	R Square	Adjusted R Square	Std Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,115 ^a	,013	,003	11,352	,013	1,276	1	96	,261
2	,121 ^b	,015	-,006	11,403	,002	,149	1	95	,700

a. Predictors : (Constant), SPM_IQ

b. Predictors : (Constant), SPM_IQ, SPM_IQ_Square

Figure 13. SPSS output of the quadratic regression analyses.

Linear regression demonstrated that less than 1% of the variability within creativity can be attributed to intelligence; showing that that creativity is not very dependent upon intelligence. This result is in accordance with early investigations. According to Batey and Furnham (2006), prior research on the field suggested that the two constructs are not unique:

The most intelligent individuals were not found to be the most creative, and correlations between creativity and IQ were fairly low, never exceeding $r = .30$, but

they were more often about $r = .10$. That finding indicates that less than 10% of the variance in creativity scores can be explained by IQ (p. 364).

Overall, the presented results suggested that, besides intelligence, there are other important variables that may influence creativity and therefore must be taken into consideration. According to prior literature, these variables could be: personality traits (Houtz, Rosenfield, & Tetenbaum, 1978; Shaughnessy, 1998), motivation (Collins & Amabile, 1999; Runco, 2008), environmental factors (Lubart, 1999; Runco & Pagnani, 2011), and others. This finding is consistent with results encountered over time. According to Batey and Furnham (2006):

The work of early pioneers, many of whom, like Terman, had assumed that IQ would correlate strongly with creativity indicated the opposite to be true. IQ could explain a little of the variance of the creativity complex, but other factors appeared to be important (p. 364).

5.3 Conclusion

In this study, the correlation between classical intelligence and classical creativity was investigated. The expectation was that the threshold theory would be confirmed. This expectation was not fulfilled. No proof of the threshold theory could be found within the studied sample. Results revealed that classical intelligence did not correlate with classical creativity stronger for the $IQ < 120$ group than for the $IQ > 120$ group. Comparing the two correlations, no statistically significant difference could be detected, failing to support the threshold theory. Furthermore, the non-linearity of the relationship between both constructs, suggested by the threshold theory, also failed to be supported by the regression analyses. The quadratic component did not give better explanation than the linear model.

Additionally, creativity and intelligence were not significantly correlated considering the whole sample. Results demonstrated that intelligence was able to account for less than 1% of the variance in creativity. Other important variables aside from intelligence may affect creativity, since creativity appears to be very independent from intelligence.

Moreover, this study revealed a change in the pattern of the relationship when the variables gender and grade/age were added to the analysis. For example, if only fourth grade children had been chosen to participate in this study, results would have been different. It would have been reported that Hypothesis 1 could be confirmed – that there is indeed a cutoff on intelligence level, above which no correlation can be found; hence, the relationship between intelligence and creativity proves to be very complex, as well as the constructs themselves. It would be ideal to perform further investigations using primary school children in larger sample sizes in order to corroborate the findings presented here. The standard deviation found here may aid in replication this study, or in the design of futures experiments.

6. Study 2

This chapter presents the procedures applied to verify Hypothesis 2, which, as previously mentioned, is about the development of intelligence and creativity within the threshold theory in primary school children.

6.1 Experimental Procedures - Study 2

6.1.1 Participants

A total of 70 children from first to fourth grade participated in this longitudinal study. There were 44 males and 26 females with an IQ ranging from 90 to 139 (Table 7). This sample was composed exclusively of children who participated in Study 1 (see Figure 14). These children were previously tested at Time 1 and Time 2, at the end of the school year. The terms Time 1 and Time 2 were chosen instead the terms pre- and post-test because no treatment was applied between the two test administrations. Children were placed into two groups according to their IQs: $IQ > 120$ ($N = 35$) and $IQ < 120$ ($N = 35$).

Table 7- Study 2 participants sample by grade

Grade	<i>N</i>	Gender		Age	IQ
		Male	Female	<i>M (SD)</i>	<i>M (SD)</i>
1	2	2	0	7 (0.00)	114 (1.56)
2	12	12	0	6.83 (0.39)	120.6 (16.89)
3	32	16	16	8.03 (0.31)	117.56 (16.29)
4	24	14	10	9.17 (0.38)	118.54 (17.64)
Total	70	44	26	8.19 (0.91)	118.33 (16.55)

Note. *M* = mean, *SD* = standard deviation

6.1.2 Material

The tests used in this study were: the Standard Progressive Matrices (SPM) and the Test for Creative Thinking – Drawing Production (TCT-DP, Form A and B). Detailed information about the tests can be found in the Method section (4.2).

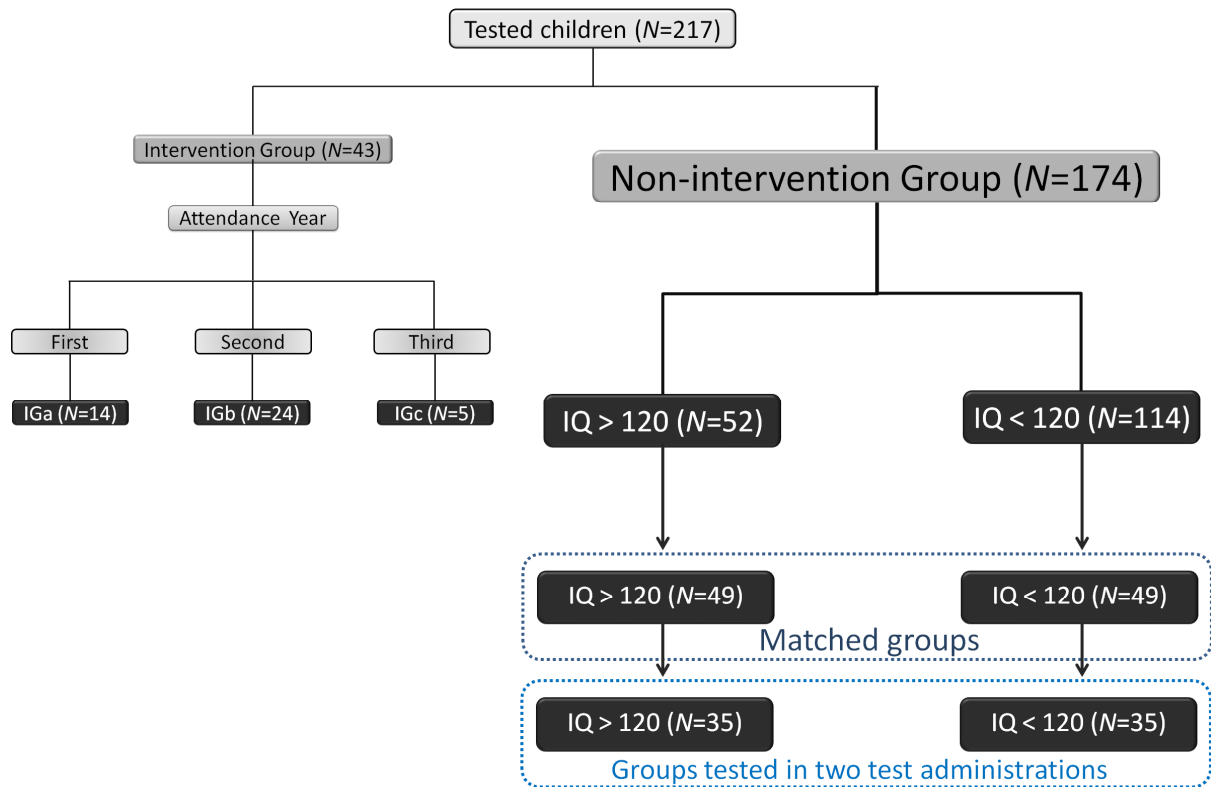


Figure 14. Group formation for Hypotheses 2 test, which refers to the development of intelligence and creativity within the threshold theory in primary school children. Eight participants from the non-intervention group were excluded from data analysis because of invalid test results. Therefore, they are not presented in this diagram.

6.1.3 Data Analysis Overview

Repeated measures ANOVA as well as independent and related *t*-tests were used.

6.2 Results and Discussion

Means and standard deviations are presented in Table 8. The ANOVA with repeated measures revealed a significant main effect of time in classical intelligence (SPM – raw score), $F(1, 68) = 14.790, p < .001, \eta_p^2 = .179$. Additionally, the ANOVA indicated a significant interaction effect, $F(1, 68) = 20.570, p < .001, \eta_p^2 = .232$. Children had higher

scores in Time 2 than in Time 1, but just one group improved significantly (Figure 15). A related t -test revealed the improving group to be of the IQ < 120 ($t(34) = 5.661, p < .001, d = 0.83$). No significant development in classical intelligence level was found for the IQ > 120 ($t(34) = 0.513, p = .611$). In contrast, the IQ > 120 participants demonstrated a slightly non-significant decrease (Table 8). Furthermore, a significant effect of group occurred, $F(1, 68) = 66.409, p < .001, \eta_p^2 = .494$. In an independent t -test, IQ > 120 participants showed higher intelligence scores than the IQ < 120 in both Time 1 ($t(68) = 10.353, p < .001, d = 2.48$) and Time 2 ($t(68) = 4.722, p < .001, d = 1.13$).

Table 8 - Means and standard deviations of the two groups and the two tests administrations for all the dependents variables

Test		IQ > 120 (N = 35)		IQ < 120 (N = 35)	
		Time 1	Time 2	Time 1	Time 2
SPM	<i>M</i>	46.26	45.89	35.34	39.86
	<i>SD</i>	3.62	4.66	5.08	5.69
TCT-DP	<i>M</i>	16.14	17.06	14.40	13.43
	<i>SD</i>	9.17	7.60	6.62	5.00

Note. *M* = mean, *SD* = standard deviation

For classical creativity (TCT-DP – raw score), IQ > 120 showed a narrow increase, whereas IQ < 120 showed a slight decrease (Figure 15). However, ANOVA with repeated measures did not reveal any significant effects. The IQ < 120 group had a statistically significant increase in the scores of intelligence, while the creativity scores did not show improvement. Thereby, Hypothesis 2 could not be confirmed. The threshold theory assumption that intelligence and creativity correlate positively for individuals with an IQ under the threshold of 120 also improves failed to be supported.

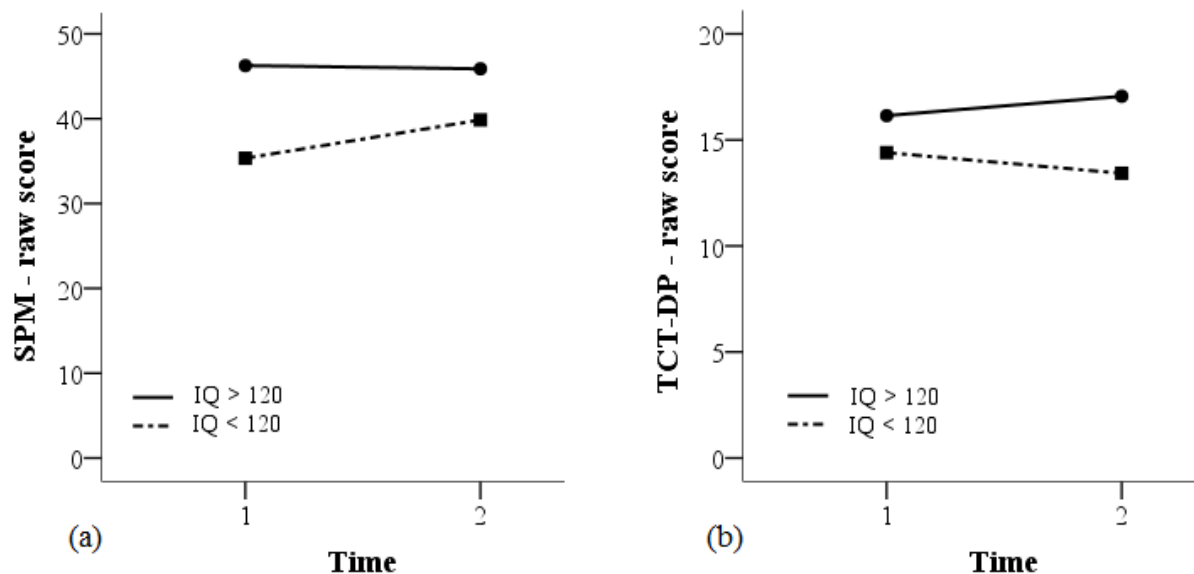


Figure 15. Classical intelligence (a) and classical creativity (b) measured by SPM and TCT-DP, respectively, of the two groups and the two tests administrations

It was observed that 18 participants showed instability in their scores. 7 participants that, in Time 1, were placed on the IQ > 120 group presented scores below the IQ of 120 in Time 2. Additionally, 11 children that, in Time 1, were placed on IQ < 120 group scored above IQ of 120 in Time 2. Therefore, the former presented a negative unstable performance (NU), whereas the latter revealed a positive unstable (PU) performance. It is possible that the failure to confirm Hypothesis 2 could be a reflection of the results of these 11 children who scored higher than an IQ of 120 on Time 2.

In order to explore the data more carefully and to be more precise about the rejection of Hypothesis 2, another repeated measure ANOVA was done, taking into consideration four groups; two groups formed by children that presented a stable performance over time: IQ > 120 ($N = 28$), IQ < 120 ($N = 24$), and two groups formed by children that presented an unstable performance over time: NU ($N = 7$), and PU ($N = 11$).

For classical intelligence (SPM – raw score), analysis revealed a significant main effect of time in $F(1, 66) = 5.385, p = .023, \eta_p^2 = .075$, a significant interaction effect, $F(1, 66) = 12.277, p < .001, \eta_p^2 = .358$, and a significant effect of group, $F(1, 66) = 39.905, p < .001, \eta_p^2 = .645$. Means and standard deviations are presented in Table 9.

Table 9 – Means and standard deviations of the four groups and the two tests administrations for all the dependents variables

Test		IQ > 120 (N = 28)		IQ < 120 (N = 24)		NU (N = 7)		PU (N = 11)	
		Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
		SPM	<i>M</i>	46.71	47.54	33.92	37.83	44.43	39.29	38.45	44.27
	<i>SD</i>	3.73	3.64	5.18	5.69	2.64	4.07	3.21	2.15
TCT-DP	<i>M</i>	14.89	17.57	13.83	13.38	21.14	15.00	15.64	13.55
	<i>SD</i>	7.58	7.47	6.16	5.77	13.50	8.37	7.69	2.91

Note. NU (Negative Unstable) group refers to participants that presented, in Time 1, scores above IQ of 120, and in Time 2, showed scores below IQ of 120, while the PU (Positive Unstable) group refers to children that were, in Time 1, placed on the IQ < 120 group, and in Time 2, showed IQ above 120. *M* = mean, *SD* = standard deviation

Post hoc of a univariate ANOVA (Figure 16) demonstrated:

- IQ > 120 participants had statistically significant higher scores than: (a) IQ < 120 group in both Time 1 ($p < .001$) and Time 2 ($p < .001$); (b) PU group only in Time 1 ($p < .001$); and (c) NU group only in Time 2 ($p < .001$).
- NU participants had statistically significant higher scores than: (a) IQ < 120 ($p < .001$); and (b) PU ($p = .024$) only in Time 1.
- PU group, surprisingly, showed higher scores than IQ < 120 in Time 1 ($p = .023$) and Time 2 ($p = .001$).

Related *t*-test showed that the groups IQ < 120 and PU had a significant increase on classical intelligence scores ($t(23) = -3.519$, $p = .002$ and $t(10) = -9.033$, $p < .001$, respectively). Furthermore, NU presented a significant decrease, $t(6) = 3.753$, $p = .009$.

For classical creativity (TCT-DP – raw score), analysis showed a significant interaction effect, $F(1, 66) = 3.048$, $p = .035$, $\eta_p^2 = .122$. Means and standard deviations are presented in Table 9. Post hoc of a univariate ANOVA did not show any significant difference between groups in Time 1 and in Time 2. A related *t*-test revealed that the IQ > 120

presented a marginally significant increase on classical creativity scores $t(27) = -1.214, p = .073$, whereas NU had a marginally significant decrease $t(6) = 2.410, p = .053$.

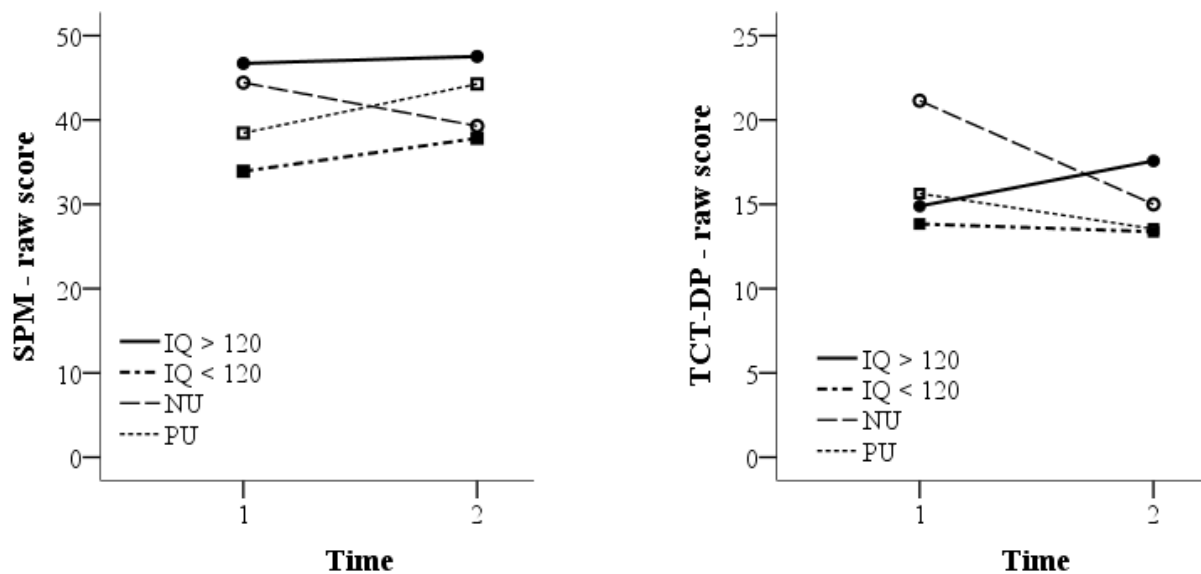


Figure 16. Classical intelligence (a) and classical creativity (b) measured by SPM and TCT-DP, respectively, of the four groups and the two tests administrations. NU (Negative Unstable) group refers to participants that presented, in Time 1, scores above IQ of 120, and in Time 2, showed scores below IQ of 120, while the PU (Positive Unstable) group refers to children that were, in Time 1, placed on the IQ < 120 group, and in Time 2, showed IQ above 120.

The fact that the IQ > 120 participants presented a marginal significant increase on classical creativity scores may be related to the first basic consensus concerning the relationship between creativity and intelligence reported by Sternberg and O'Hara (1999) and Sternberg et al. (2005a). They reported that creative people have a tendency to present an above-average IQ, frequently greater than 120.

Theurer et al. (2011) tested 797 primary school children at Time 1 (begin of the first school year) and Time 2 (end of the second school year). They found that the more creative the child, the higher his / her intelligence scores is. However, Russo (2004) found no indication that above-average intelligent participants were more creative than the average students; indicating that "IQ may be limited in its importance as a predictor of creativity" (p. 187). She investigated the relationship between intelligence and creativity within 37 fifth and

sixth grade participants in an after-school Future Problem Solving program. Based on the results of this research, Russo concluded that, “an intelligent person who has not learned the skills of creative thinking might well be less creative than a less intelligent person” (p. 188).

Considering the results, Hypothesis 2 could not be confirmed. According to the nonlinear effect of the threshold theory, creativity increases as a function of intelligence up to an IQ threshold of 120 (Karwowski & Gralewski, 2013; Sligh et al., 2005). Therefore, it was anticipated that if intelligence scores would increase, creativity scores would be expected to increase as well. However, this did not occur. Within this sample, children with an IQ below 120 showed a significant increase in scores on classical intelligence from Time 1 to Time 2, but did not show any enhancement on classical creativity. This result may be explained by the findings in Study 1, which failed to prove the existence of the threshold theory. Thus, if the threshold does not actually exist, this result should not be surprising.

Theurer et al. (2011) as well concluded that the threshold theory had no validity. This theory was not supported by the results of their longitudinal design analyses. According to them, based on the threshold theory, it would be assumed that the previous score on intelligence should predict, at least to some extent, future levels of creativity; however it was not true. Theurer et al. (2011) found that intelligence was no better an explanation for the varying levels of creativity than the vice versa situation of creativity’s effect on intelligence. They concluded that there is a high degree of independence between the two constructs.

Theurer et al. (2011) suggested that the fluid intelligence measured by the CFT (*Grundintelligenztest – Skala I*) could not explain the development of creativity within primary school children (which was detected by the TCT-DP). From the results obtained in their study, they concluded that it could not be assumed that intelligence is a necessary condition for creative performance, as stated by the threshold theory.

Overall, these results demonstrated that development in creativity could not be explained by intelligence. This indicated that creativity is a very complex construct and that

others factors may influence its development. Theurer et al. (2011) also came to the same conclusion, in addition, they found a low stability for creativity scores, indicating that creativity was influenced by other external factors.

The fact that creativity is influenced by other aspects than intelligence is a common issue in the literature. According to Alfonso-Benlliure et al. (2013), creativity is influenced by many issues that can inhibit or alter its growth. To Lubart and Georgsdottir (2004), personality characteristics and motivation play important roles for the development of creativity. Furthermore, they highlighted the influence of the environment upon creativity. According to them, family, school and other environmental factors can either enhance or diminish creativity.

Theurer et al. (2011) emphasized that it is necessary to examine aspects related to school, teaching, and social environment and investigate the relationship between these aspects and the development of creativity. Thereby, more studies on this topic analyzing the above cited factors with a larger sample size are highly recommended.

6.3 Conclusion

This study was carried out in tandem with Study 1 and its results are expected to corroborate the ones of Study 1. Here, the development between classical intelligence and classical creativity within the threshold theory was investigated. Taking into consideration the nonlinear effect of the threshold theory, which states that creativity increases as a function of intelligence up to an IQ threshold of 120, the expectation was that if an increase in classical intelligence scores from Time 1 to Time 2 would occur, then an increase on classical creativity score should also exist if the IQ score would be under 120.

The aforementioned expectation was not fulfilled and Hypothesis 2 could not be confirmed. There was no support for the expectation that intelligence scores would predict creative performance when $IQ < 120$. Intelligence itself was not a good explanation for the

variations within creativity scores. This result is in agreement with the findings from Study 1. Here again, the threshold theory was denied.

Results indicate that there are future issues to explore. Other factors that may influence the development of creativity demands further investigation for a better understanding of the construct of creativity and its relationship with intelligence.

7. Study 3

This chapter presents the procedures applied to verify Hypothesis 3. Hypothesis 3 is about the development of intelligence and creativity across grade levels within primary school children (Grade 1 to Grade 4).

7.1 Experimental Procedure - Study 3

7.1.1 Participants

This sample was composed of children of the non-intervention group ($N = 166$) (Figure 17). Groups are formed according to grade (Grade 1 through Grade 4). The mean age of the sample was 7.67 (0.85). From the 166 children, 89 were male and 77 were female (Table 10).

Table 10 – Study 3 participant's sample by grade

Grade	<i>N</i>	Gender		Age
		Male	Female	<i>M (SD)</i>
1	25	9	16	6.28 (0.92)
2	61	31	30	7.00 (0.52)
3	39	19	20	8.05 (0.51)
4	41	18	23	9.17 (0.59)
Total	166	77	89	7.67 (0.85)

Note. *M* = mean, *SD* = standard deviation

7.1.2 Material

The tests used in this study were: Standard Progressive Matrices (SPM), Creative Reasoning Task (CRT), and Test for Creative Thinking – Drawing Production (TCT-DP, Form A). More information about the tests can be found in the Method section (4.2.)

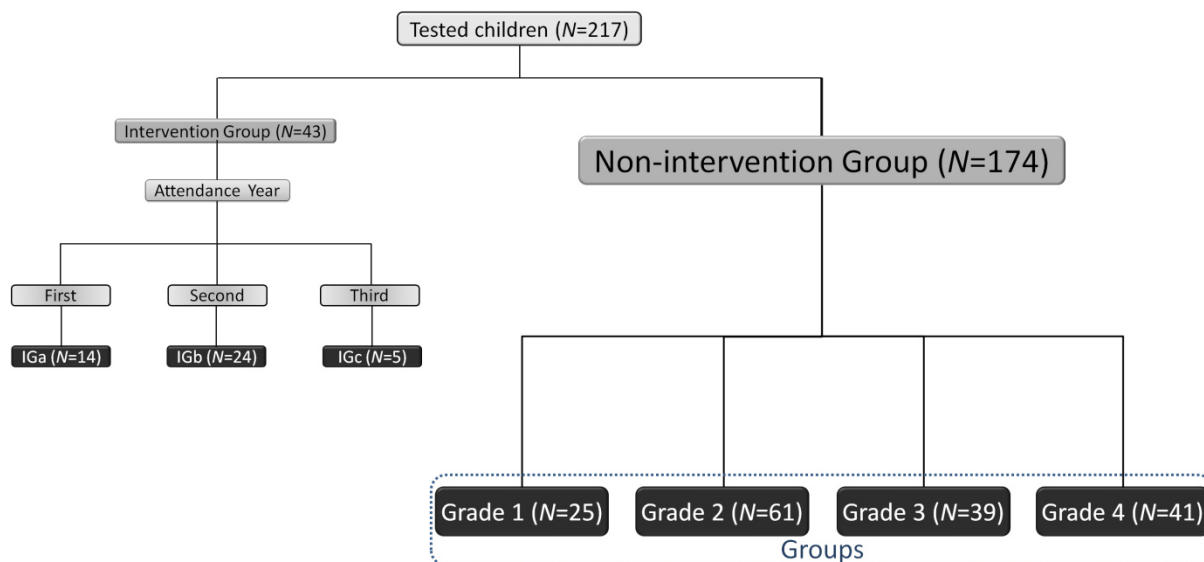


Figure 17. Group formation for the test of the Hypotheses 3, which refers to the development of intelligence and creativity across grade levels. Eight participants from the non-intervention group were excluded from data analysis because of invalid test results. Therefore, they are not presented in this diagram.

7.1.3 Data Analysis Overview

ANOVA and *t*-tests were performed. Levene's test for equality of variances was performed. When it showed that the assumption of homogeneity of variance was violated, the non-parametric statistic Kruskal-Wallis-Test was performed.

7.2 Results and Discussion

Analysis of variance tested the effect of grade level on intelligence and creativity. Means and standard deviations are presented in Table 11. Results indicated a main effect of grade on intelligence on both test measures: classical intelligence (SPM raw score, $F(3, 162) = 43.870, p < .001, \eta_p^2 = .448$) and convergent thinking (CRT Relations, $F(3, 162) = 10.094, p < .001, \eta_p^2 = .157$). The Levene's test showed that the groups were not homogeneous for both cases. However, the same result was found with the Kruskal-Wallis-Test: $H(3) = 79.059, p < .001$ for classical intelligence and $H(3) = 28.002, p < .001$ for convergent thinking.

Table 11 – Means and standard deviations of the four grade levels for all the dependents variables

Test		Grade 1	Grade 2	Grade 3	Grade 4
SPM	<i>M</i>	24,80	30,48	40,67	43,54
	<i>SD</i>	8,78	9,57	6,43	5,07
CRT Relations	<i>M</i>	7,32	6,59	20,77	22,41
	<i>SD</i>	12,49	11,40	18,62	24,63
CRT Components & Specifications	<i>M</i>	5,84	4,49	4,36	4,51
	<i>SD</i>	2,90	2,74	2,11	2,48
TCT-DP	<i>M</i>	9,52	11,56	16,59	18,27
	<i>SD</i>	4,74	6,02	6,34	8,80

Note. *M* = mean, *SD* = standard deviation

As presented in Table 11, the main score SPM (raw score) increased significantly through grades. Since the increase on the scores between children of Grade 3 and Grade 4 was not so large, an independent *t*-test was performed to confirm if the difference between them was statistically significant. The *t*-test demonstrated that the increase was significant, $t(78) = -2.223$, $p = .029$, $d = 0.50$. This corresponds to what is usually found in the literature; performances on intelligence tests are correlated with chronological and educational age (Brouwers, Van de Vijver, & Van Hemert, 2009; Ceci, 1991; Ceci & Williams, 1997; McArdle, Ferrer-Caja, Hamagami, & Woodcock, 2002; Neisser et al., 1996).

Results were in accordance with the findings reported by Brouwers et al. (2009). In a cross-cultural and historical meta-analysis of Raven's Progressive Matrices, they found that the performance of children increased sharply across childhood. Additionally, findings showed a positive correlation between educational age and test scores; educational age was found to be the best predictor of test performance (Brouwers et al., 2009).

For the CRT Relations scores, only the difference between Grades 2 and 3 was statistically significant, $t(98) = -4.728$, $p < .001$, $d = 0.98$. Non-significant differences were presented between Grade 1 and Grade 2 ($t(84) = 0.262$, $p = .794$) as well as between Grade 3

and Grade 4 ($t(78) = -0.336, p = .738$). This result disagreed with previous research. Jaarsveld et al. (2012) did not find any significant effect of grade level for the CRT Relations scores.

This large difference presented by children from Grade 2 and Grade 3 may be explained by differences in childhood development, in general. Again, in this case, according to Piaget (1966a) around seven/eight years of age marks the beginning of the transition between the symbolic thinking to the logical thinking about concrete events. It is possible then, that children change their way of thinking when doing the CRT task, changing the pattern of the relations applied.

Older children may use more complex relations such as succession, and / or combination, and so, in turn, receive more points than younger children who use more simple rules such as pattern completion. Older children may also exhibit more capability in dealing with more than one relation, which would increase significantly their scores. According to Jaarsveld et al. (2012), the more complex and correct the relation employed, the higher the received score.

Findings may suggest that classical intelligence (SPM raw score) and the intelligence measured in an open problem space (CRT Relations) developed somewhat differently across grades levels in primary school children (Figure 18). While classical intelligence seemed to increase continuously across grade levels, convergent thinking remained the same in the first two grade levels, and then showed a big change in the third grade. Children from Grade 3 presented a significant increase in scores in comparison with Grade 2. No further changes occurred from Grade 3 to Grade 4.

These results confirm what was highlighted by Jaarsveld et al. (2010) and Jaarsveld et al. (2012), intelligence functions differently in ill-defined and well-defined problem spaces. According to Jaarsveld et al. (2012), this difference may occur because the performance on SPM requires abilities that are more likely to be trained in school than the abilities required to solve the CRT task. However, some similarities were also found. For both cases, older

children presented higher scores than the younger ones and the most prominent increases occurred between Grade 2 and Grade 3.

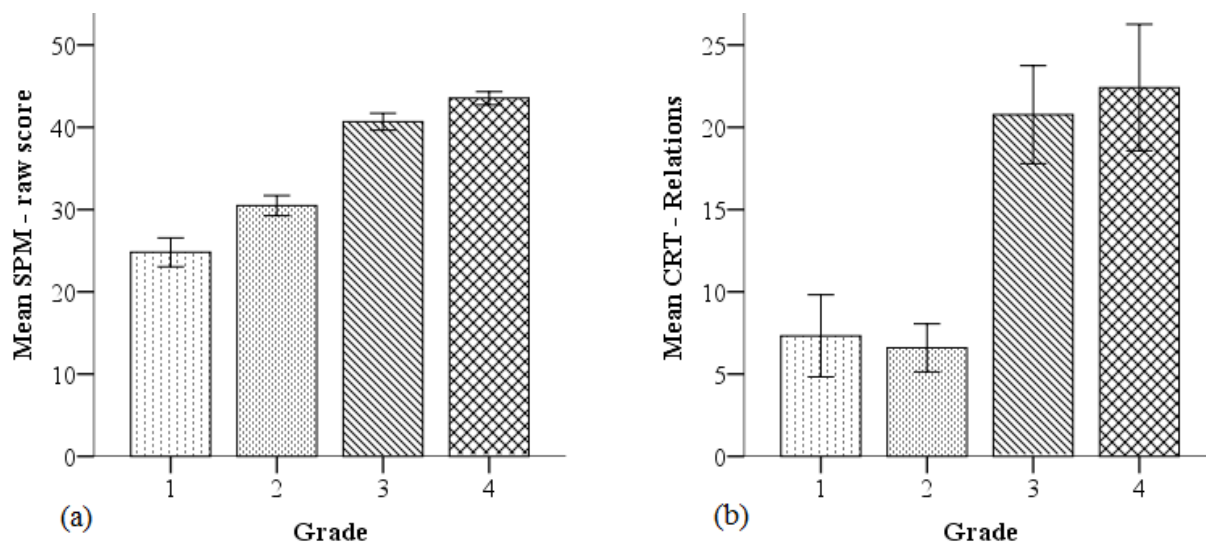


Figure 18. Means and standard errors of the classical intelligence (a) and the convergent thinking (b), measured by the SPM and the CRT Relations, respectively.

It was anticipated in Hypothesis 3a that intelligence would present a continual growth throughout grade levels. This was confirmed for classical intelligence, in that the scores increased continuously and significantly throughout grades. Additionally, it was partially confirmed for convergent thinking, in that scores increased from Grade 1 to Grade 4, but the growth throughout the grades was inconstant. Overall, the findings for classical intelligence were consistent with literature reporting that convergent variables develop regularly and increasingly with age (Alfonso-Benlliure et al., 2013).

Regarding creativity, results showed a main effect of grade for classical creativity, $F(3, 162) = 13.781, p < .001, \eta_p^2 = .203$, but not for divergent thinking, $F(3, 162) = 2.075, p = .106, \eta_p^2 = .037$. The Levene's test displayed that the group's variance was significantly different for classical creativity, but homogeneous for divergent thinking. Therefore, the Kruskal-Wallis-Test was performed for classical creativity only. An identically result from ANOVA was found ($H(3) = 35.825, p < .001$).

Independent *t*-tests were performed for classical creativity ($\alpha = .017$) between Grades 1 and 2 ($t(84) = -1.510, p = .135$), Grades 2 and 3 ($t(98) = -3.994, p < .001, d = 0.83$), and Grades 3 and 4 ($t(78) = -0.975, p = .333$). A significant difference was found only between Grades 2 and 3. Both creativity scores presented quite a different development across grade levels (Figure 19). While classical creativity improves significantly from Grade 1 to Grade 4, divergent thinking scores did not change significantly.

Results concerning divergent thinking were consistent with previous findings from Jaarsveld et al. (2012). They also did not find any significant effect of grade level for the CRT Components & Specifications. According to the results seen in Table 11, either children did not experience any significant development concerning divergent thinking, or the test performance could not perceive such differences.

An explanation for the divergent thinking scores presented by the studied sample may be attributed to the fact that the CRT Components & Specifications sub-score is related to the CRT Relations sub-score. It may be possible that first grade children made more use of the relation named *idiosyncratic and semantic coherence*, which consists of an apparently arbitrary collection of components that is scored with one point. Divergent thinking scores are usually higher in these instances because children generally draw figurative components (tree, persons, cars and etc.). These elements are richer detail, i.e., in specifications. According to Jaarsveld et al. (2012), the more details and the variety of components, the higher the score.

Then, in the second grade, children may have increased their logical thinking, and therefore, did not draw an arbitrary collection of components anymore. However, they may still use simple relations to create their matrices such as *pattern completion*. This relation consists of a repetitive motive that is carried out to completion and has a low evaluation score (3 point). Therefore, the scores on CRT Relations did not change, instead, the divergent thinking score decreased as this relation did not require the use of a high volume of

components and/or specifications. Moreover, the components applied in this relation are typically non-figurative.

From the third grade on, children may have applied more complex relations, which increased their scores on convergent thinking, but did not necessarily increase their scores in divergent thinking. Thus, it may be inferred that the use of more complex relations should more-or-less stabilize scores in divergent thinking.

The aforementioned explanation is consistent with Jaarsveld et al. (2012) findings. In a study with 205 German primary school children, they found that the scores on CRT Relations were higher on participants who used non-figurative components. While, for the CRT Components & Specifications, scores were higher for participants who used figurative components. As a result, they inferred:

...participants who tend to apply Non-figurative components in an ill defined problem situation, have a better developed ability to reason about relations between components. By contrast, participants who tend to apply Figurative components would have a more pronounced ability to pay attention to form, detail and design (p. 183).

Jaarsveld et al. (2012) also observed that older participants used predominantly non-figurative components, whereas young participants used primarily non-figurative components. They concluded that the use of non-figurative components enhances with age.

It was anticipated that the third grade children's scores on creativity would be higher than the scores of children from Grade 4. However, Hypothesis 3b could not be confirmed; there was no support for the fourth grade slump suggested by Torrance (1968). The result presented for classical creativity may suggest a possible stagnation on the development, since there was only a small non-significant increase on the scores from Grade 3 to Grade 4.

A similar result was found by Houtz et al. (1978). In a study with 233 elementary school students (second through sixth grade), they found that, among the gifted children,

creative thinking performance presented a plateau from Grade 4 onwards. It was also not characterized as “slump” (declines in score), but rather, a “slow down” (Houtz et al., 1978).

Analyzing the normative data from the Torrance Tests of Creative Thinking (TTCT), Kim (2011), also did not find evidence of the fourth grade slump. Results, in fact, suggest a sixth grade slump in which scores in creativity remained constant or declined. One reason for this may be the development of logical and reasoning aptitudes (Kim, 2011). However, Maker et al. (2008) investigated 1,986 students from kindergarten to sixth grade. They observed that the creativity scores measured by the TCT-DP increased across grade levels, growing year after year without any significant peaks or slumps.

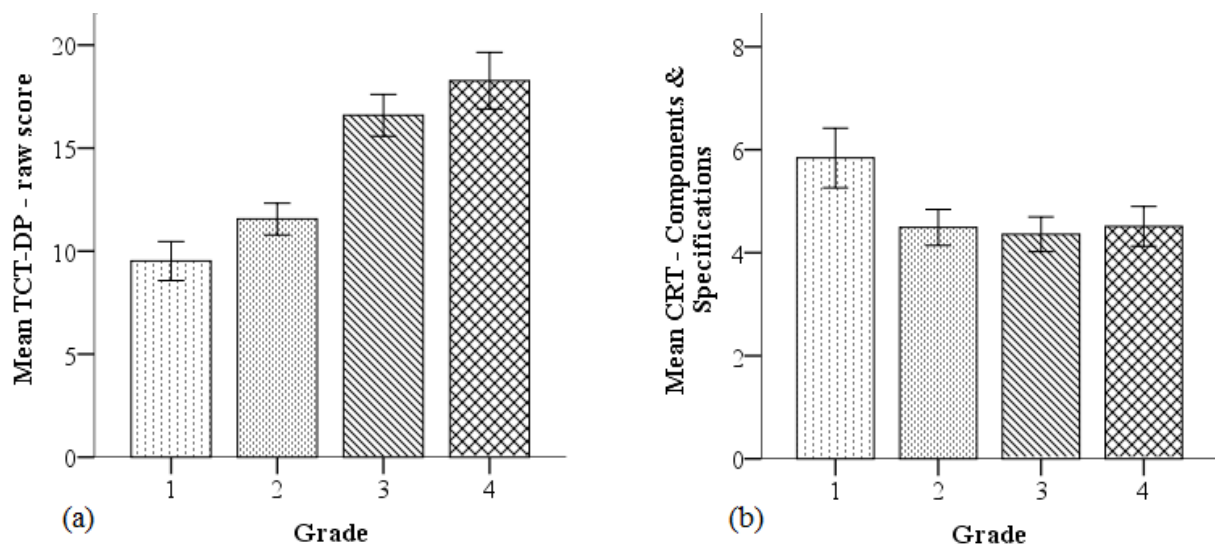


Figure 19. Means and standard errors of the classical creativity (a) and divergent thinking (b) measured by the TCT-DP and CRT Components & Specifications, respectively.

Although the fourth grade slump could not be confirmed within this sample, results may indicate that the development of classical creativity may not be as stable as classical intelligence. According to Houtz et al. (1978), this may be a consequence of educational curriculum, which, throughout grade levels, may have placed more emphasis on convergent production. Other reasons may be that this is a very stressful period for the children, with peer pressures and education directed to socialization and conformity (Axtell, 1966; Nash, 1974).

This implies that the school curriculum is very important and must to be carefully planned, in order to control for instability within the child's level of creativity.

The importance of encouraging creativity in the classroom is stressed within the literature (Beghetto, 2010; Smith & Smith, 2010; Torrance, 1972; 1987). Creativity should be encouraged in the classroom, where opportunities are provided learn, think, and discover with adequate guidance and without constant evaluation by the instructor (Torrance, 1977).

According to Beghetto (2010):

Encouraging creative thinking while learning not only enlivens what is learned but can also deepen student understanding. This is because, in order for students to develop an understanding of what they are learning, they need to go beyond simple memorization and recall of facts and be able to come up with their own unique examples, uses, and applications of that information. In order for this to happen, expectations for novel yet appropriate applications of learning need to be included in classroom assessments of student learning (p. 453).

The expectation that creativity and intelligence would differ with respect to development across grade levels was partially fulfilled. Classical creativity and divergent thinking showed a different pattern of development than classical intelligence. Divergent thinking also develops differently across grades than convergent thinking. However, classical creativity and convergent thinking showed a similar development throughout grades; both do present a significant increase from Grade 2 to Grade 3. This may imply that similar abilities are needed in solving both tasks, and that intelligence in open problem spaces requires more skills that typically are requested in creative task, such as the generation of ideas.

Finally, it must to be noted that care should be taken before generalizing results and implications to the population level. It is important to remember that the samples of different grade levels were not composed of the same children that were tested year after year. Thus, variables such as personality characteristics may have influenced results.

7.3 Conclusion

In this study, the development of intelligence and creativity across grade levels was investigated. The main expectation was that creativity and intelligence would present a different development across grades levels. Thereby, it was hypothesized that intelligence would present a continuous development throughout grades (Hypothesis 3a), whereas creativity scores would show a decrease in the fourth grade (Hypothesis 3b).

Hypothesis 3a could be confirmed for classical intelligence. Children's scores showed a continually growth throughout grades. Additionally, it was only partially confirmed for convergent thinking; scores increased from Grade 1 to Grade 4, but the increase was not constant across grade levels. Intelligence scores measured in open problems showed a more inconstant development over grades than the scores obtained by standard intelligence tests.

Hypothesis 3b could not be confirmed. A slump in the fourth grade received no support within this sample. The classical creativity results may suggest a possible stagnation, since scores from Grade 3 to Grade 4 were non-significant. Divergent thinking results may suggest a slump in the second grade and a stagnation thereafter. This result may be related to the fact that the divergent thinking scores depend on the convergent scores (CRT Relations). The use of more complex relations may imply the use of non-figurative elements, which may reduce the richness in details and the number of components used.

Overall, it was observed that (1) classical intelligence showed a more stable development across grades levels than convergent thinking and classical creativity, and (2) classical creativity and convergent thinking showed a pretty similar development throughout grades levels. The implications of this may be: (1) intelligence functions differently in open and closed problem space situations; and (2) similar abilities were required when solving both tasks and that intelligence in open problem spaces requires more skills that are usually required in creative tasks.

8. Study 4

This chapter presents the procedures applied to verify Hypothesis 4, which as previously mentioned, is complementary to Study 3 and refers to the development of intelligence and creativity presented by primary school children within a school year.

8.1 Experimental Procedure - Study 4

8.1.1 Participants

A total of 68 children from Grades 2 to 4 participated in this longitudinal study. These children were already tested at Time 1 and Time 2, at the end of the school year. Children were placed into three groups according to the Grade; Grade 1 participants were excluded from the study due to the small number of participants (see Figure 20). Regarding gender, 42 were male and 26 were female (Table 12).

Table 12 – Study 3 participant's sample by grade

Grade	<i>N</i>	Gender		Age
		Male	Female	<i>M (SD)</i>
2	12	12	0	6.83 (0.39)
3	32	16	16	8.03 (0.31)
4	24	14	10	9.17 (0.38)
Total	68	42	26	8.22 (0.90)

Note. *M* = mean, *SD* = standard deviation

8.1.2 Material

The tests used in this study were: Standard Progressive Matrices (SPM), Creative Reasoning Task (CRT), Test for Creative Thinking – Drawing Production (TCT-DP, Form A and B). For detailed information see Method section (4.2).

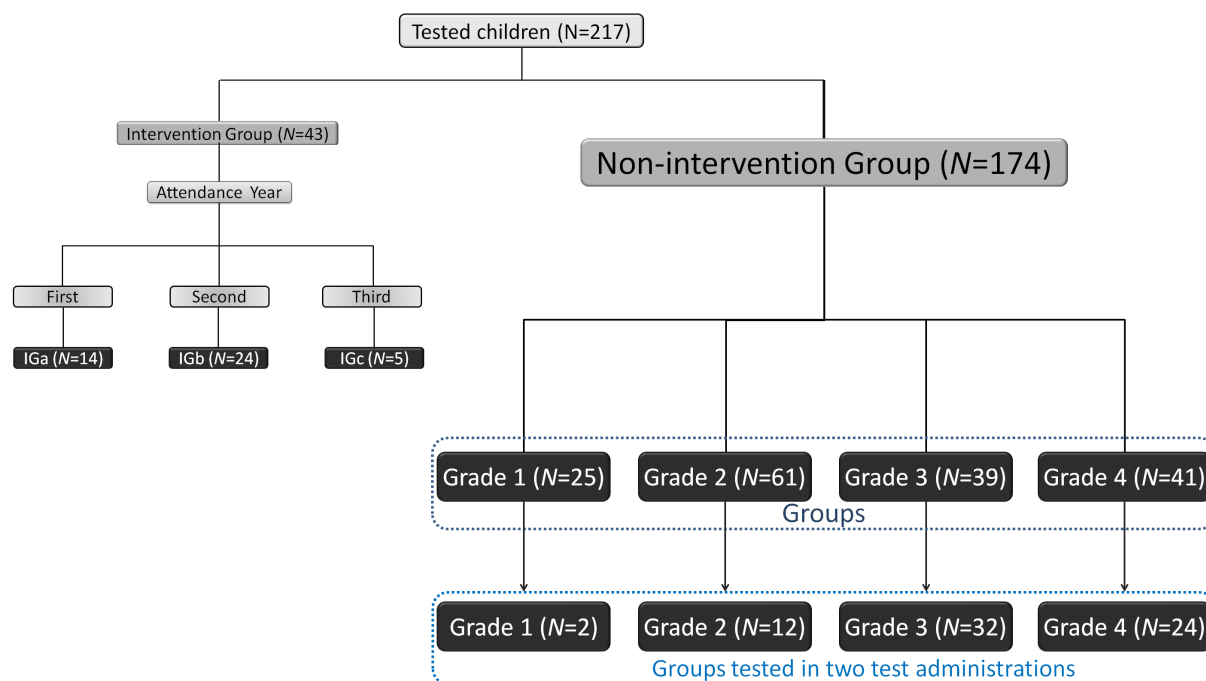


Figure 20. Group formation for the test of the Hypotheses 4, which refers to the development of the intelligence and creativity through grades within a school year. Eight participants from the non-intervention group were excluded from data analysis because of invalid test results. Therefore, they are not presented in this diagram. Grade 1 participants were excluded of the study because of the small number of participants.

8.1.3 Data Analysis Overview

Repeated measures ANOVA as well independent and related t -tests were used. The t -tests were performed according to the necessity presented.

8.2 Results and Discussion

Means and standard deviations are presented in Table 13. Repeated measures ANOVA showed, for classical intelligence, a main effect of time ($F(1, 65) = 7.544, p = .008, \eta_p^2 = .104$) and a main effect of grade ($F(2, 65) = 3.213, p = .047, \eta_p^2 = .090$). A related t -test showed that the improvement in classical intelligence from Time 1 ($M = 40.99, SD = 6.96$) to Time 2 ($M = 42.91, SD = 6.17$) was statistically significant, $t(67) = -3.126, p = .003, d = 0.29$. The mean score for classical intelligence (Time 1 and Time 2) for each grade level was: $M = 38.96, SD = 7.29$ for Grade 2, $M = 41.48, SD = 6.00$, for Grade 3 and $M = 44.06, SD = 4.85$ for Grade 4. An independent t -test ($\alpha = .025$) showed that children from Grade 4 performed

significantly higher than children from second grade, $t(34) = -2.509, p = .017, d = 0.91$ (Figure 21).

This result corresponded to the findings from Study 3 and is corroborated in the literature. It is largely reported that performances on intelligence tests are correlated with chronological and educational age (Brouwers et al., 2009; Ceci, 1991; Ceci & Williams, 1997; McArdle et al., 2002; Neisser et al., 1996). Child performance on the SPM presents a great increase across childhood (Brouwers et al., 2009). As reported on Study 3, this may occur because the performance on SPM requires abilities that are trained in school (Jaarsveld et al., 2012), and to the way the SPM was designed. The increase in item difficulty benefits older children, as they are challenged, and in turn, develop and strengthen abilities such as those related to memory (Jaarsveld et al., 2012).

Table 13– Means and standard deviations of the four grade levels for all the dependents variables in Time 1 and Time 2

Test		Grade 2		Grade 3		Grade 4	
		Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
SPM	<i>M</i>	38,08	39,83	40,38	42,59	43,25	44,88
	<i>SD</i>	8,82	6,38	6,98	6,02	5,27	5,78
CRT Relations	<i>M</i>	9,17	7,58	19,88	23,38	20,29	21,25
	<i>SD</i>	13,62	9,88	18,02	20,87	23,51	21,39
CRT Components & Specifications	<i>M</i>	5,42	3,58	4,06	4,41	4,38	4,50
	<i>SD</i>	2,78	1,83	1,95	2,00	2,41	2,17
TCT-DP	<i>M</i>	9,75	13,33	16,59	15,38	17,13	16,17
	<i>SD</i>	4,88	6,56	6,85	5,80	9,24	7,65

Note. *M* = mean, *SD* = standard deviation

Regarding convergent thinking, a main effect of grade was displayed, $F(2, 65) = 3.302, p = .043, \eta_p^2 = .092$. In an independent *t*-test ($\alpha = .025$), children from Grade 3 ($M = 21.63, SD = 16.27$) and Grade 4 ($M = 20.77, SD = 17.96$) presented significantly higher scores

than children from Grade 2 ($M = 8.38$, $SD = 7.53$), $t(42) = -3.676$, $p = .001$, $d = 0.94$ and $t(34) = -2.909$, $p = .006$, $d = 0.83$, respectively.

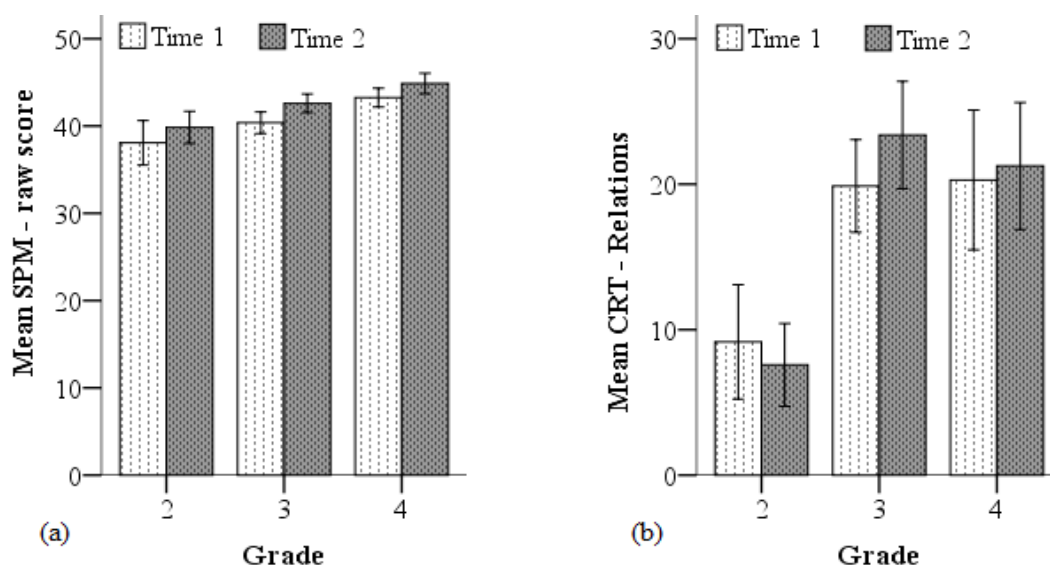


Figure 21. Means and standard errors of classical intelligence (a) and convergent thinking (b) measured by the SPM and by the CRT Relations, respectively, for the three grades levels groups and the two tests administrations.

The presence of a large difference between the scores of participants from Grade 2 and Grade 3 on the previous study (Study 3) was attributed to developmental differences. The transition from the seventh to the eighth year of life, where children are thought to begin to think logically (Piaget, 1966a), could be the reason why older children scored higher on convergent thinking. Older children may use more complex relations and sometimes more than one, and as a result, show higher scores.

However, if the above-mentioned statement were accurate, than scores for second graders scores should be expected to increase from Time 1 to Time 2, since children became older. However, it was not the case. Indeed, they presented a slight decrease. Since there is still a significantly large difference between the scores of Grade 2 participants in Time 2 and the scores of Grade 3 children in Time 1, this result was not consistent with the previous explanation. This discrepancy may originate from specific individual characteristics such as persistence and motivation. Recall that this sample consists of children from Study 3, but not

all of them. In order to have a better explanation, a longitudinal study using the same participants is needed.

It was hypothesized in 4a that there would be an increase in the intelligence scores from Time 1 to Time 2 for all grades. Considering only classical intelligence, it can be reported that there was partial support for the stated increase. Generally, scores increased from Time 1 to Time 2. However, this did not occur for each individual grade level. Hypothesis 4a was unable to be confirmed concerning convergent thinking. There was no significant increase on the scores of CRT Relations from Time 1 to Time 2.

Regarding classical creativity, results showed a main effect of grade $F(2, 65) = 3.186$, $p = .048$, $\eta_p^2 = .089$. The mean scores (Time 1 and Time 2) of the TCT-DP shown by Grade 3 participants ($M = 15.98$, $SD = 5.30$) were significantly higher than the scores presented by Grade 2 children ($M = 11.54$, $SD = 4.23$) at the alpha level of .017 ($t(42) = -2.604$, $p = .013$, $d = 0.90$). However, Grade 3 and Grade 4 ($M = 16.65$, $SD = 7.36$) did not present a significant difference in their scores, $t(54) = -0.391$, $p = .697$). A related t -test showed that Grade 4 participants presented a slightly non-significant decrease, $t(23) = 0.557$, $p = .583$.

These results are consistent with the findings from a study conducted by Theurer et al. (2012). In a longitudinal investigation about the development of creativity, they tested German primary school children in three test administration times; at the beginning of the first school year, at the end of the second school year, and at the end of the fourth grade. Theurer et al. (2012) found a significant increase on the creativity scores measured by the TCT-DP, when considering the whole time period studied. However, when comparing the measurements within grades, it was found that children's scores from the beginning of the first school year (Time 1) were significantly lower than the scores presented in the other two measurements, but no change between Time 2 and Time 3 occurred. Children's creative performance stagnated after the end of the second year of primary school, thus implying a discontinuous development (Theurer et al., 2012).

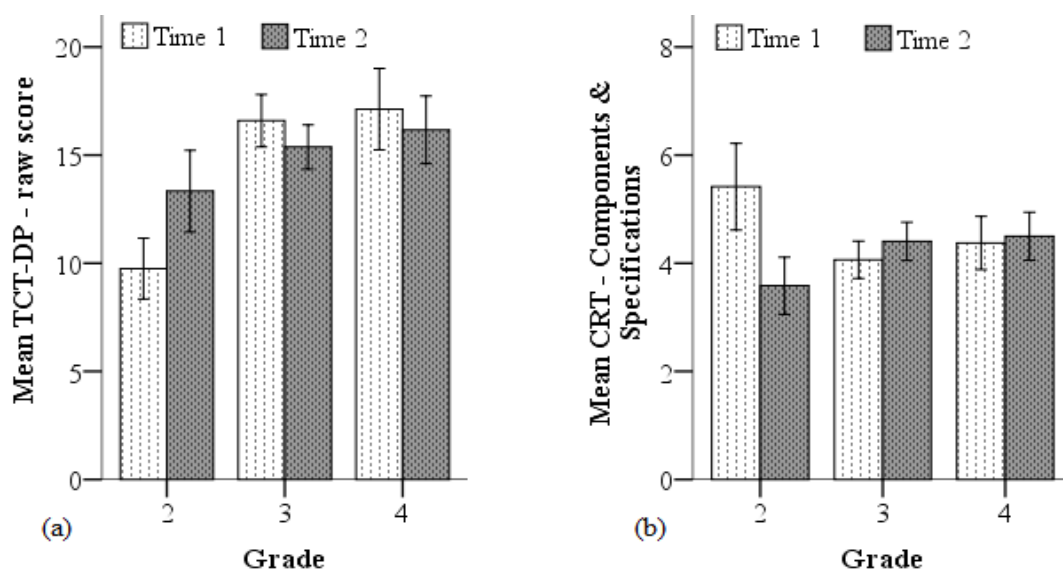


Figure 22. Means and standard errors of classical creativity (a) and divergent thinking (b) measured by TCT-DP and CRT Components & Specifications for the three grades levels groups and the two tests administrations

Grade influences on creativity scores were also observed by Besançon and Lubart (2008). They tested 211 French children in two test administrations. Within the first year of the study, children were from Grade 1 to Grade 4 and in the second year, from Grade 2 to Grade 4. Their results showed not only an influence of the grade, but also an influence of the testing year on the creative performance. According to them, in the second year of the study, children who went from third to fourth grade seemed to enhance less than children who advanced to Grade 2 or Grade 3, proving the presence of the fourth grade slump.

An interaction effect was displayed for divergent thinking measured by the CRT Components & Specifications, $F(2, 65) = 3.280$, $p = .044$, $\eta_p^2 = .092$. As presented in Figure 22, children from Grade 2 had a significant decrease in their scores from Time 1 to Time 2, $t(11) = 2.421$, $p = .034$, $d = 0.79$. This significant decrease could not be explained by the inference made in the previous study (Study 3). The notion that there is a negative correlation between divergent and convergent thinking scores which would manifest as divergent scores decreasing while convergent scores increase is invalid for the presented results. The divergent scores of second graders decreased significantly, but the convergent scores did not increase.

This result may be explained by individual differences combined with environmental factors (class room settings), and/or procedure effects (time of the test application).

It was anticipated in Hypothesis 4b that participants in Grade 4 would show a decline in creativity scores from Time 1 to Time 2 (Hypothesis 4b₁). Additionally, it was expected that the mean scores in creativity for third grade children would be higher than the scores of children from Grade 4 (Hypothesis 4b₂), indicating a slump.

Although the creativity scores from third and fourth graders decrease from Time 1 to Time 2, the fourth grade slump could not be completely supported because the referred decrease was statistically non-significant. As found in Study 3, results for classical creativity may indicate a possible stagnation in the development during third and fourth grade, since there is an increase in scores from second grade participants, but not from third and fourth graders. For divergent thinking, results may suggest a slump in the second grade. Children's scores remain constant after second grade.

These results reinforce the idea present within literature that schooling may not have a good influence on creativity, particularly within Grades 3 and 4. As reported in Study 3, this represents a time when there is change within the educational curriculum, as focus on convergent thinking increases (Houtz et al., 1978). It is also the time when children learn socialization skills and conformity (Axtell, 1966; Nash, 1974).

According to Runco (2005), teachers and parents should understand and be aware that as children grow, they tend to become more conventional in thinking. Many of them apparently realize that there are benefits to fitting in with the environment and so begin to adopt a conformist view of the world, mirroring society, thus lowering their originality level. In Runcos's view, the slump can be avoided if teachers and parents protect children from conformity and promote positive behaviors, ensuring enough self confidence and ego strength that are necessary to endure the pressure to conform. However, he also highlighted that

conformity is not completely bad; children should be able to express their uniqueness, but when appropriate they should also conform.

According to Besançon and Lubart (2008), “the main goals of most educational systems are to transmit knowledge, rigorous working habits, and societal values” (p. 381). This implies that the school curriculum needs to be carefully reviewed, so that children’s creativity can also be enhanced. There is consensus within researchers about the importance of creativity in the classroom. They emphasized the relevance of changing from a view that emphasizes recognition and memorization of information to another that challenges children to think creatively, to explore, and discover things (Beghetto, 2010; Smith & Smith, 2010; Torrance, 1972;1987). So that, they do not only play as spectators but that they participate, having an active role in the learning process. As emphasized by Kim (2011), in order to reverse the decline of creativity, children should be encouraged to find problems, rather than only offer them problems to solve. According to Vygotsky (2004),

We should emphasize the particular importance of cultivating creativity in school-age children. The entire future of humanity will be attained through the creative imagination; orientation to the future, behavior based on the future and derived from this future, is the most important function of the imagination. To the extent that the main educational objective of teaching is guidance of school children’s behavior so as to prepare them for the future, development and exercise of the imagination should be one of the main forces enlisted for the attainment of this goal.

The development of a creative individual, one who strives for the future, is enabled by creative imagination embodied in the present (pp. 87-88).

8.3 Conclusion

This study was complementary to Study 3. In here, the development of intelligence and creativity presented by primary school children within a school year was investigated. It

was hypothesized that intelligence would present an increase; participants of all grade levels were expected to show an enhancement on their intelligence scores (Hypothesis 4a). Whereas creativity would present a decrease; participants of Grade 4 were expected to show a decline on their creativity scores from Time 1 to Time 2 (Hypothesis 4b₁), and that the mean of the scores on creativity of the third grade children would be higher than the fourth grade children (Hypothesis 4b₂).

Considering only classical intelligence, it can be reported that there was partial support for the increase in intelligence scores stated in Hypothesis 4a. In general, SPM scores increased from Time 1 to Time 2. However, this is not the case for each grade individually. Hypothesis 4a could not be confirmed, when concerning convergent thinking, there was no significant increase in the scores from Time 1 to Time 2. Hence, intelligence measured as operating in closed problem spaces showed different results from intelligence measured as operating in open problem spaces.

Hypothesis 4 b₁ and 4b₂ could not be completely confirmed. As on the previous study (Study 3), results for classical creativity may indicate a possible stagnation in development during third and fourth grade, since scores remained constant during the considered period. Divergent thinking results may suggest a slump in the second grade; children's scores remained constant thereafter.

Overall, these results are in agreement with the findings of Study 3. Classical intelligence showed again a stable and continuous development whereas convergent thinking and creativity demonstrated more instability with periods of stagnation. They may suggest the importance of the schooling process on children's creativity and intelligence development. While school seems to have a great impact on children's intelligence, at least on classical intelligence, for creativity the effect of schooling may be not so positive. Schools must be made aware of this and should take reasonable and necessary steps to guide children in their creative development.

9. Study 5

This chapter presents the procedures applied to verify Hypothesis 5, which is about the comparison between the development of intelligence and creativity in above-average intelligent primary school children with and without treatment.

9.1 Experimental Procedures - Study 5

9.1.1 Participants

In a longitudinal study, children from the intervention group (children that participated in the *Entdeckertag* program, $N = 43$) were tested in two administration times: in the beginning of the program's school year (Time 1), and in the end of it (Time 2). The terms Time 1 and Time 2 were chosen instead of the terms pretest and posttest because some children already had a year of treatment before the first test administration was applied (see Figure 23).

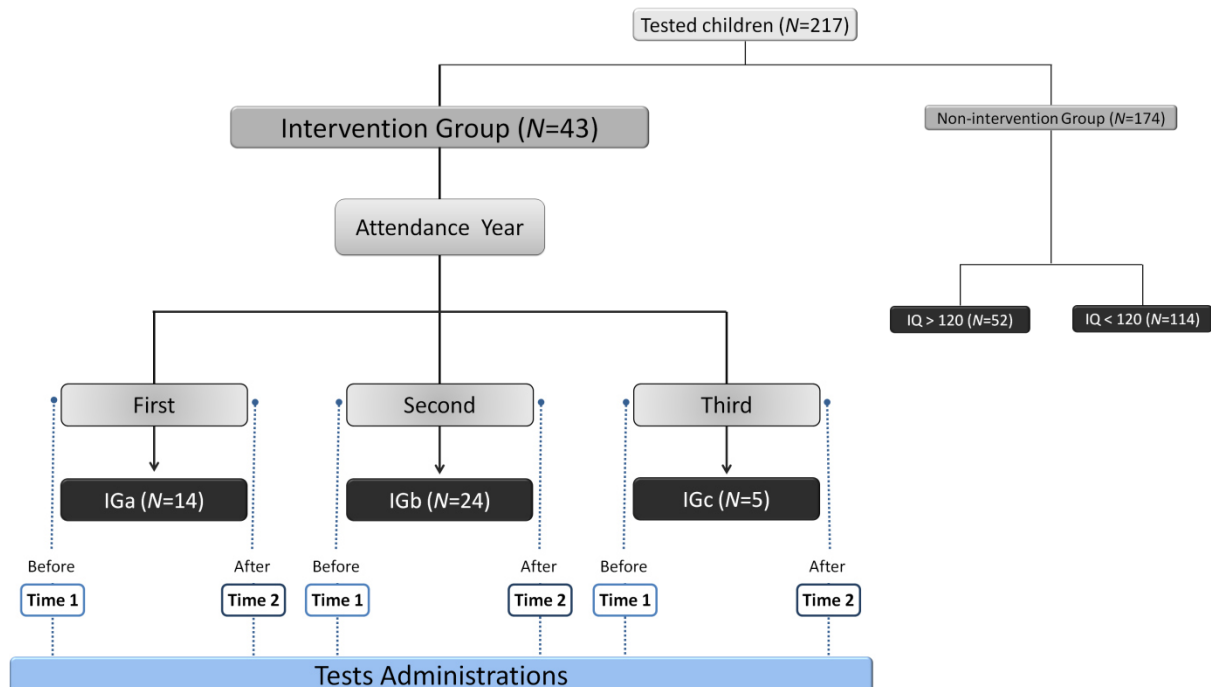


Figure 23. Intervention group formation and the respective tests time administrations.

As previously mentioned, in the Method section (4.2), participants were placed in different groups according to the *Entdeckertag*'s attendance year (Figure 23):

- IGa – children starting their first year in ET when the study was applied ($N = 14$);
- IGb – children beginning the second year ($N = 24$);
- IGc – children starting the third year in the program ($N = 5$).

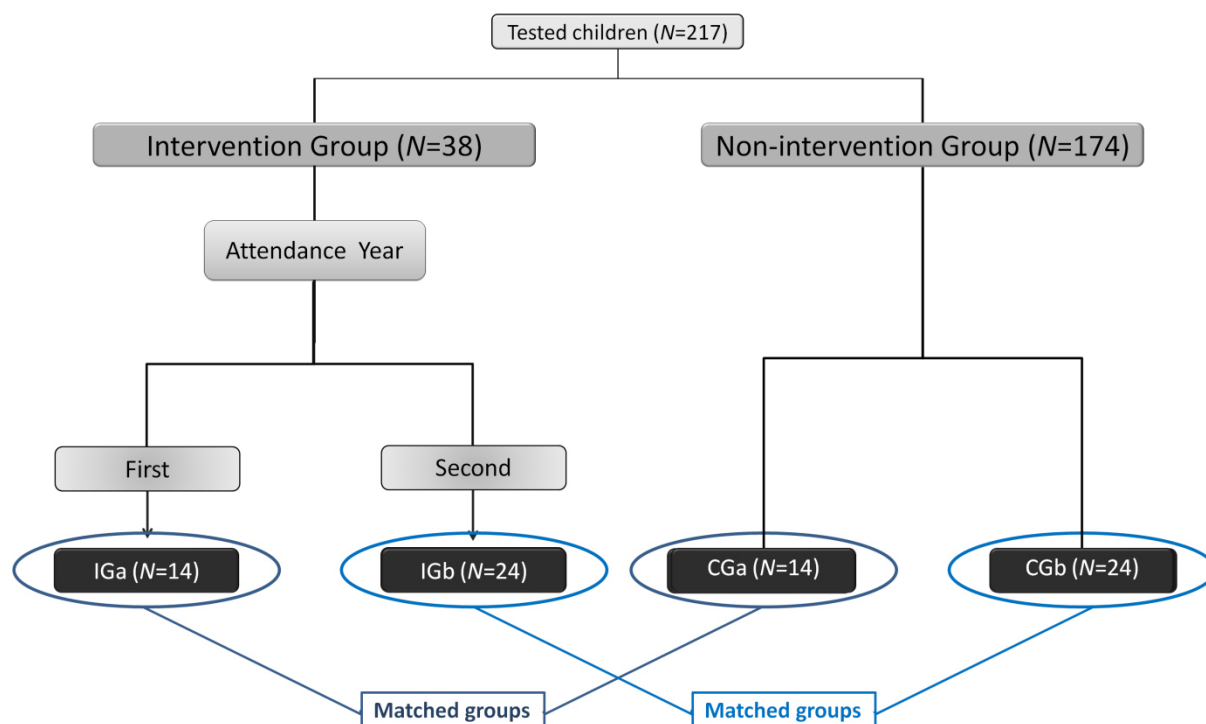


Figure 24. Group formation for the test of the Hypotheses 5, which refers to the comparison between the development of intelligence and creativity in above-average intelligent primary school children with and without treatment. Eight participants from the non-intervention group were deleted and excluded from data analysis because of invalid test results. Therefore, they are not presented in this diagram.

The third intervention group (IGc) was removed from the study due to the small sample size. The other two intervention groups (IGa and IGb) were compared against a group of children from the non-intervention group that was matched for gender, grade and, when possible, for IQ (see Figure 24). These groups (CGa and CGb) represented the control groups and were not particularly supported. They were equally large ($N = 14$ and $N = 24$, respectively). Thereby, the study's effective number of participants was 76. However, they

were divided in two samples: (a) children from groups IGa and CGa ($N = 28$) and (b) children from groups IGb and CGb ($N = 48$).

Table 14 – Study 5 participant's sample by grade

Grade	$N(a)$	Gender (a)		$N(b)$	Gender (b)	
		Male	Female		Male	Female
1	8	8	0	2	2	0
2	0	0	0	10	10	0
3	10	4	6	24	16	8
4	10	6	4	12	8	4
Total	28	18	10	48	36	12

Note. (a) = children from IGa and CGa; (b) = children from IGb and CGb. IGa group was formed by children that were participating in the first year of the *Entdeckertag* program, whereas the IGb was composed by children that were already on the second year. CGa and CGb were the respective control groups.

The mean age of the (a) sample was 7.82 ($SD = 1.28$), 18 participants were male and 10 female. For the (b) sample the mean age was 8.04 ($SD = 0.85$), 36 boys and 12 girls (see Table 14). As explained in the Method section (4.2), these children were indicated by parents and/or teachers and selected to participate of the *Entdeckertag (ET)* program by the ET team.

This selection was based on interviews with parents, teachers and children. Any kind of intelligence or creativity test was applied. As presented in Figure 25, almost 65% of the IGa group and more than 70% of the IGb group showed an IQ of 130 or above, while the majority of children from both groups presented an average creativity level.

9.1.2 Material

The tests applied in this study were: Standard Progressive Matrices (SPM), Creative Reasoning Task (CRT), Test for Creative Thinking – Drawing Production (TCT-DP, Form A and B). Detailed information is presented in the Method section (4.2).

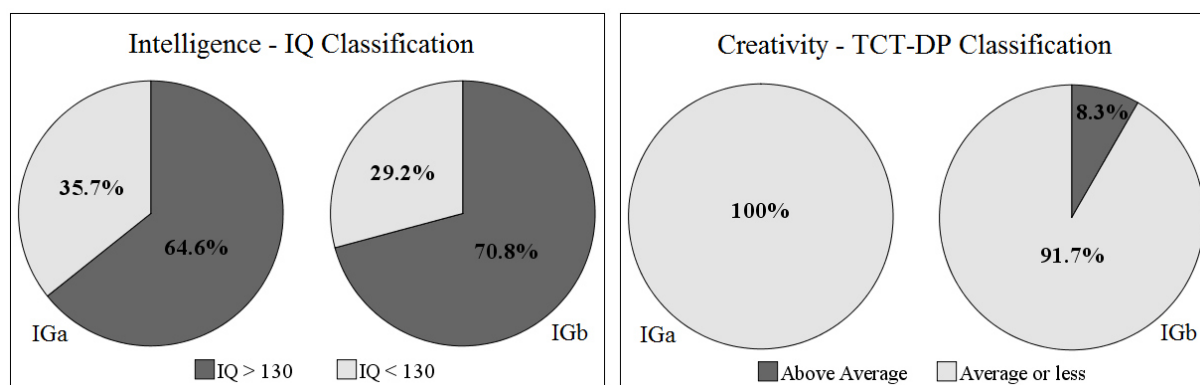


Figure 25. Diagram of children distribution for intelligence (right) and creativity (left) measured by SPM and TCT- DP, respectively, according to the given legends

9.1.3 Data Analysis Overview

Analogously to Studies 2 and 4, repeated measures ANOVA, and independent and related *t*-tests were carried out. The *t*-tests were performed according to the necessity presented. Since the major objective of this study was to ascertain the effect of ET and as the samples were small and significant interaction effects were hard to find, analyses of covariance were additionally applied in cases where the groups did not differ in Time 1.

9.2 Results and Discussion

Results were presented separately. First the IGa and CGa group's findings are presented, then, the outcomes of the IGb and CGb are introduced. Discussions can be found shortly following results.

9.2.1 IGa and CGa

Means and standard deviations are presented in Table 15. Regarding intelligence, analyses of variance with repeated measures did not show any statistically significant effect for classical intelligence nor for convergent thinking. Additionally, analysis of covariance did not display any significant effects for both intelligence measurements. Nevertheless, IGa participants improved their convergent thinking (CRT Relations) scores around 13 points

(Figure 26). Aside from this, their scores in Time 2 were 14 points higher than the ones of CGa participants.

Table 15 - Means and standard deviations of the two groups and the two tests administrations for all the dependents variables

Test		IGa (N = 14)		CGa (N = 14)	
		Time 1	Time 2	Time 1	Time 2
SPM	<i>M</i>	43.07	45.86	41.79	43.36
	<i>SD</i>	8.13	6.26	10.58	6.91
CRT Relations	<i>M</i>	22.00	35.86	21.36	21.43
	<i>SD</i>	22.40	33.49	26.09	22.37
CRT Components & Specifications	<i>M</i>	5.57	3.43	4.64	3.21
	<i>SD</i>	2.87	2.21	2.34	1.72
TCT-DP	<i>M</i>	14.57	14.29	15.43	17.50
	<i>SD</i>	5.58	6.85	9.65	6.06

Note. IGa group was formed by children that were participating in the first year of the Entdeckertag program, whereas the IGb was composed by children that were already on the second year. CGa and CGb were the respective control groups. *M* = mean, *SD* = standard deviation

Hypothesis 5 could not be confirmed for classical intelligence and convergent thinking. Any effect of one attendance year in the ET effect could be found for intelligence (both measurement methods). The low sample number could lead to the explanation of why no significant effect was observed.

Concerning classical creativity, IGa children showed a slight decrease. Whereas the CGa participants had an increase of more than 3 points in their scores (see Figure 27). Nevertheless, it was statistically non-significant. ANOVA with repeated measures showed a main effect of time, $F(1, 26) = 7.709, p = .010, \eta_p^2 = .229$, for divergent thinking measured by CRT Components & Specifications. As it can be seen in Figure 27, scores of both groups presented a decrease in Time 2. The mean of the CRT Components & Specifications had a statistically significant decrease between Time 1 ($M = 5.11, SD = 2.62$) and Time 2 ($M = 3.32, SD = 1.95$), $t(27) = 2.813, p = .009, d = 0.78$.

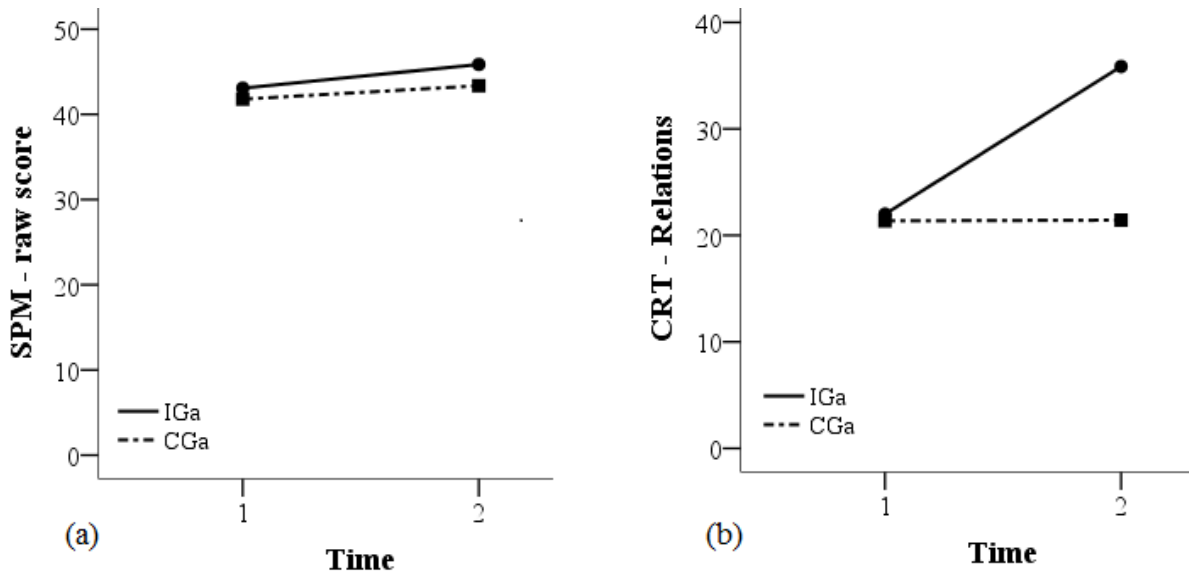


Figure 26. Classical intelligence (a) and convergent thinking (b) measured by SPM and CRT Relations, respectively, of the two groups and the two tests administrations.

For creativity as well as for intelligence, Hypothesis 5 could not be confirmed for any of the two cases. No effect of one attendance year on the ET program could be observed within this sample. However, the failure to find a significant effect may be a reflection of the small number of participants.

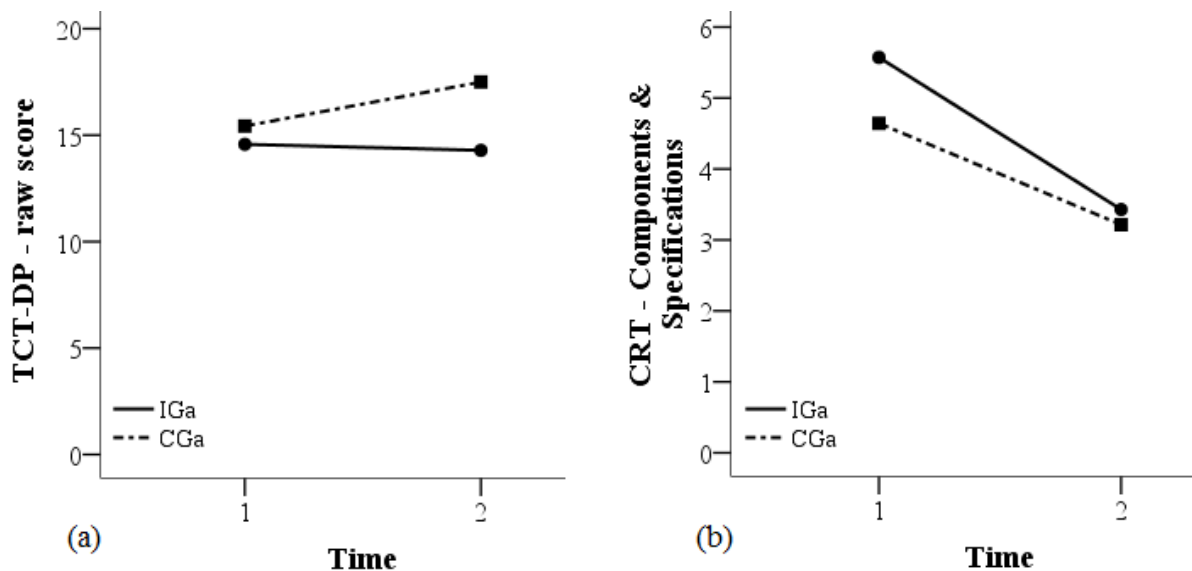


Figure 27. Classical creativity (a) and divergent thinking (b) measured by TCT-DP and CRT Components & Specification, respectively, of the two groups and the two tests administrations

9.2.2 IGb and CGb

Means and standard deviations are presented in Table 16. Analyses of variance with repeated measures showed a significant main effect of time $F(1, 46) = 8.099, p = .007$, regarding classical intelligence. Children's scores increased significantly from Time 1 ($M = 45.77, SD = 4.46$) to Time 2. ($M = 47.56, SD = 4.73$), $t(47) = -2.782, p = .008, d = 0.39$ (Figure 28). Analysis of covariance presented a significant effect of group on classical intelligence (SPM-Time-2–raw-score) after controlling for the effect of SPM-Time-1–raw-score, $F(1, 45) = 7.591, p < .008, \eta_p^2 = .144$.

Table 16 – Mean and standard deviations of the two groups and the two tests administrations for the entire dependents variable

Test		IGb (N = 24)		CGb (N = 24)	
		Time 1	Time 2	Time 1	Time 2
SPM	<i>M</i>	46.58	49.50	44.96	45.63
	<i>SD</i>	4.93	4.01	3.86	4.66
CRT Relations	<i>M</i>	23.67	27.92	19.88	22.00
	<i>SD</i>	23.71	23.85	20.69	21.78
CRT Components & Specifications	<i>M</i>	4.38	4.63	5.17	4.38
	<i>SD</i>	2.50	2.02	2.30	1.88
TCT-DP	<i>M</i>	17.13	15.58	15.04	16.92
	<i>SD</i>	5.39	7.35	9.17	8.38

Note. IGa group was formed by children that were participating in the first year of the *Entdeckertag* program, whereas the IGb was composed by children that were already on the second year. CGa and CGb were the respective control groups. *M* = mean, *SD* = standard deviation

Furthermore, ANCOVA results showed that the covariate, SPM-Time-1-raw-scores, was significantly related to the SPM-Time-2-raw-score, $F(1, 45) = 15.513, p < .001, \eta_p^2 = .256$. A related *t*-test ($\alpha = .025$) revealed that the IGb group had a statistically significant improvement from Time 1 to Time 2 $t(23) = -3.436, p = .002, d = 0.65$. Additionally, an independent *t*-test ($\alpha = .025$) showed that the IGb participants had higher intelligence scores

than the CGb in Time 2 $t(46) = 3.087, p = .003, d = 0.91$. No significant effects were found concerning convergent thinking as measured by the CRT Relations.

Hypothesis 5 could be confirmed for classical intelligence but not for convergent thinking. A second year of treatment seemed to be effective for the improvement of classical intelligence. An effect of the *Entdeckertag* program could be found for classical intelligence as measured by SPM, but not for convergent thinking which was measured by CRT Relations.

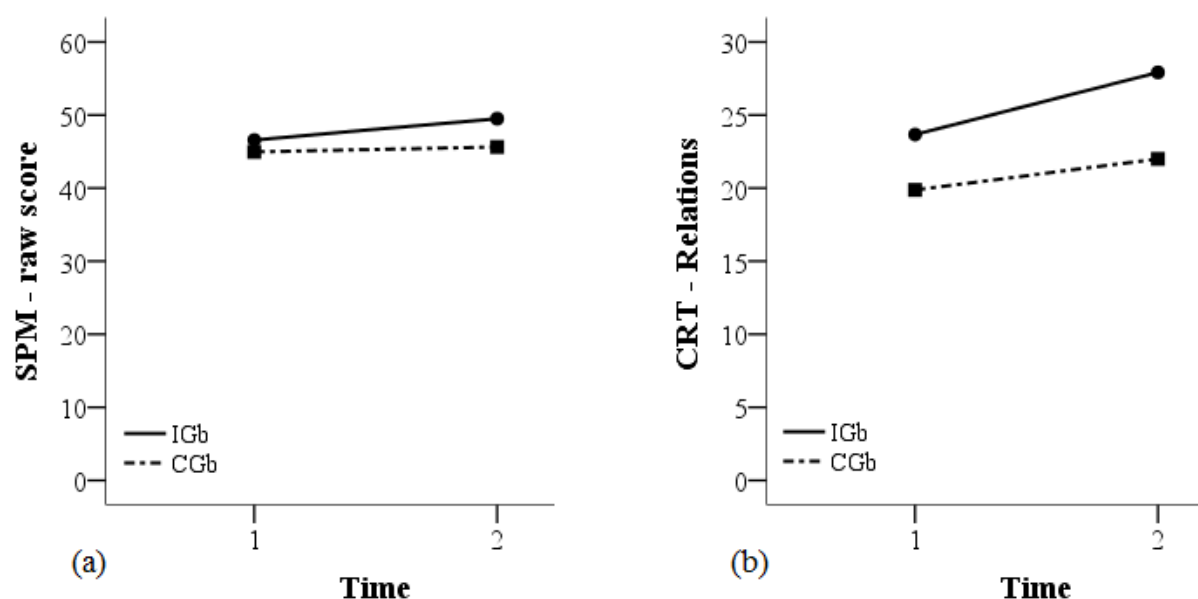


Figure 28. Classical intelligence (a) and convergent thinking (b) measured by SPM and CRT Relations, respectively, of the two groups and the two tests administrations.

Regarding creativity, analyses of variance with repeated measures did not show any statistically significant effect for classical creativity (TCT-DP – raw score) nor for divergent thinking (CRT Components & Specifications) (Figure 29). Hypothesis 5 could not be confirmed within this sample for classical creativity and divergent thinking. No effect for a second year of attendance in the ET program could be found for creativity.

Before considering the implications of this study, it is important to note that care should be taken when generalizing from the results. For the reason that the sample size was

relatively small, and because children that were tested the in the first year of ET were not the same as the children tested the in the second year of ET.

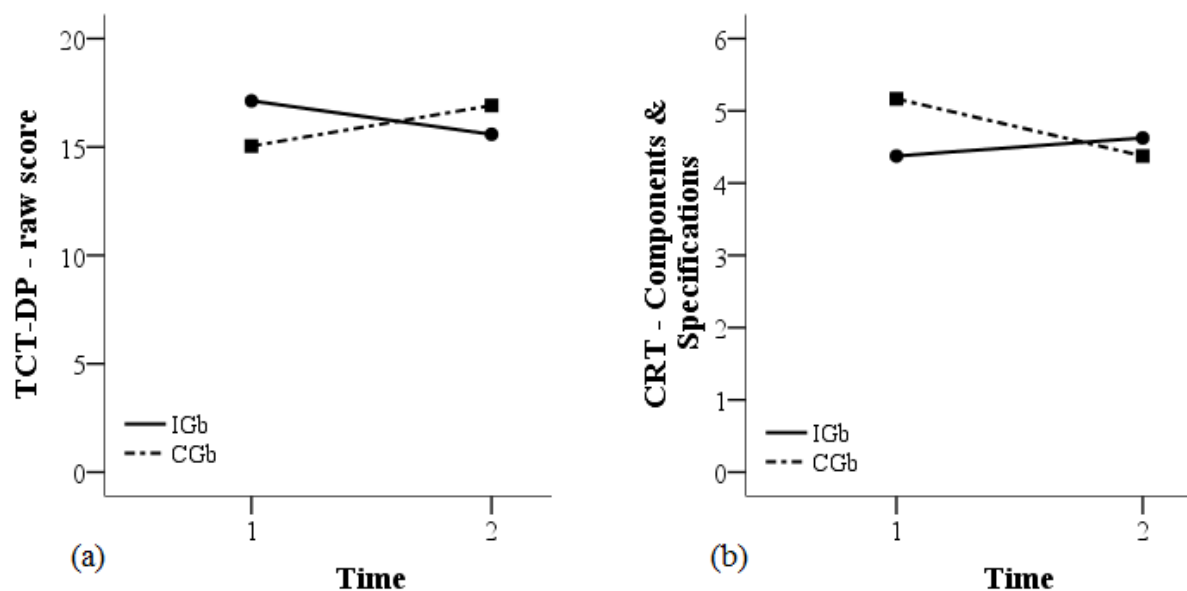


Figure 29. Classical creativity (a) and divergent thinking (b) measured by TCT-DP and CRT Components & Specification, respectively, of the two groups and the two tests administrations

Nevertheless, the present study demonstrated that the focus on development, especially directed to the study of mathematics, languages and science, along with the teaching method of the ET program, provide a good result. Children's classical intelligence increased after two years of participation in the program. As presented in the literature, enrichment practices were effective in the instruction of gifted students, especially when teaching and curriculum were properly adjusted (Gentry & Owen, 1999; Gentry, 1999; Kulik, 1992).

It seemed that, when referring to classical intelligence, the ET program had the appropriate teaching and curriculum to enhance children's performance. However, this appears to not have occurred with creativity, perhaps for two reasons: identification/selection criteria and curriculum, presented below.

(1) Identification and selection of gifted children:

First, creative children may not have been selected. Figure 25 demonstrated that ET participants were highly intelligent children, most of them with an IQ above 130. However, concerning creativity, they presented an average level or even below it. This statement refers only the classical view of both constructs. The method of identification used by the ET program may be being flawed, in that creative children may be being left out of it.

There is also a possibility of parents and teachers harboring a selection bias by choosing only children with an above-average school performance. As it is known, intelligence is a good predictor of academic performance (Ceci, 1991; Neisser et al., 1996). According to Freeman (2005), “the teachers often kept a mental image of a gifted pupil who would have exceptionally good logical reasoning, quick comprehension, and intellectual curiosity - in combination with good school grades” (p. 82). To him, highly creative children are generally less comfortable and less conforming in conventional school settings than the highly intelligent ones.

Hany and Heller (1990) found that German teachers did not see creativity as an indicator of giftedness. They reported that teachers generally focus on interest, cognitive abilities, work practice, and also emphasize on characteristics they believe children need to develop good teamwork and to achieve goals. They concluded, “this indicates that the teachers want to have the successful and ‘easy to handle’ students in their courses. Critical thinking and having original ideas – signs of creativity – are not ranked highly” (p. 76). Sommer, Fink, and Neubauer (2008) correlated estimates of intelligence and creativity given by parents and teachers with the results obtained in tests of intelligence and creativity. They observed that parents and teachers could better identify high intellectual skills rather than detect abilities of high creativity.

While reviewing literature on the topic, Renzulli (1982) concluded that there were two types of giftedness: the schoolhouse giftedness and the creative-productive giftedness. Taking in consideration these two kinds of giftedness, it can be inferred that most of the ET

participants were what Renzulli defined as schoolhouse giftedness (good grades and test scores). He also highlighted that not surprisingly; special programs for the gifted are full of this type of giftedness. This type of giftedness is the most noticeable by teachers. However, there is still the second type of giftedness that does not seem to be represented in the ET program. According to Renzulli (1982), both are important and special programs should provide support for these two kinds of giftedness.

Second, in consequence of this identification issue, it may be possible that children's creativity did not improve because they had such a low level when they entered the program. Children with a slightly higher level of creativity may avail themselves more of the program and demonstrate improvements. To Besançon and Lubart (2008) the development of children's creativity might be influenced not only by the school environment, but also by their preliminary level of creativity and the interaction between both conditions.

Third, it may be possible that, as suggested by some authors in the field, a very high level of intelligence is an obstacle to creativity. It becomes more and more difficult for a person who is accustomed to viewing things in a certain manner to see them otherwise (Sternberg & Kaufman, 2010). According to Sternberg et al. (2011) extremely high IQ individuals may have difficulties with creativity because of their high analytical abilities. To them, "those who have very high IQs may be so highly rewarded for their IQ-like (analytical) skills that they fail to develop the creative potential within them, which may then remain latent" (p. 88).

(2) Curriculum:

Intelligence and creativity may be independent constructs; increasing intelligence does not mean that creativity will increase. In addition, the program may be training only classical intelligence. The present results may indicate that not only regular school curriculum focuses on the encouragement of classical intelligence, as previously suggested (see Study 3 and Study 4), but also special programs for the gifted as the *Entdeckertag* do as well.

Logical reasoning skills that are needed to perform the SPM seem to be trained by ET. According to Raven (2000), the SPM measures *eductive ability* (clear thinking and enforce meaning on confusion) and *reproductive ability* (store and reproduce acquired information). Overall, the ET curriculum may emphasize recognition and memorization of information, rather than using activities based on imagination, experimentation, exploration, among others, which would foster creative thinking.

Given the results and based on previous literature, some criticism and suggestions can be made for the ET program. The absence of a curriculum which does not promote creative abilities is troubling on the present society. Literature in the field is unanimous when it comes to recognizing the importance of training in creativity. To Hunsaker (2005):

Training in creativity is assumed to benefit students in their academic experiences, as well as in work and other aspects of life. Humans are constantly faced with change. A life becomes more complex, the ability to manage change with equanimity becomes increasingly important. Approaching creativity as a life skill can be invaluable as a result (p. 292).

The intention is not to condemn the ET program, but rather, the aim is to offer ideas to improve the program. The principal objective of this study was to verify the program's effectiveness, aiming to aid in the detection of its strengths and weaknesses. As result of the program's improvement, participants receive better quality care, which brings benefits not only to themselves but to the society. For this reason, a change in the identification/selection process and curriculum is suggested. It is congruent with previous literature. According to Sternberg et al. (2011):

The problem with traditional labeling is that it is very much oriented toward only one aspect of giftedness, namely, the academic side. Academic skills are certainly important, especially during the school years, when children are largely evaluated in terms of their academic accomplishments. But are these skills the only ones or even

the primary ones that will matter later in life? After the school years, few people will be taking either IQ or achievement tests, and the ability to get grades, unless it is transformed into something else, will not matter a great deal for future life outcomes. People will need to be able to adapt to rapidly changing environments; to work as parts of teams; to resolve conflicts with their peers, spouses, and children; and to maintain their health to the extent they can. Will academic still matter? Sure. People need to read prescription and nutritional labels, evaluate claims of advertisers and politicians, and make sense of their finances. But academic skills are only part of what leads to the realization of gifted potential (p. 11).

Furthermore, the need for the development of creativity is also highlighted by Renzulli and Renzulli (2010). They affirm that in today's world marked by many problems such as poverty, disease, pollution; the need is clear for creative solutions. In this situation, the lack of improvement opportunities for the development of creative potential of students is very problematic (Renzulli & Renzulli, 2010). As well, Torrance (1984) believes that creativity has been the common attribute of individuals that have made notable contributions in both artistic and scientific level, thus contributing to technological innovations and social improvement. Currently, there are many reasons that prove the importance of the enhancement of creativity, so it is necessary to give a fair chance to creative children (Torrance, 1984).

It is highly recommended that the ET team revise its curriculum by adding activities that encourage creative thinking. In an investigation with 44 students of Early Education, Alfonso-Benlliure et al. (2013) found that children's convergent and divergent thinking scores increased after their participation in a six week (one session per week) training program that promoted cognitive processes (problem finding, problem formulation, conceptual combination, among others). They highlighted the importance of training both convergent and divergent thinking in a parallel and interactive approach.

9.3 Conclusion

In this study, the comparison between the development of intelligence and creativity in above-average intelligent children with and without treatment was investigated. It was hypothesized that intelligence would present an increase from Time 1 to Time 2 only for the *Entdeckertag* program participants (Hypothesis 5). When considering the participation of children within one year of the ET, Hypothesis 5 could not be supported for intelligence (both measurement methods) and for creativity (both measurement methods). No effect of the ET program could be observed. The low sample number could be the explanation of why any significant effect could be found.

When considering the participation of children within two years of the ET, Hypothesis 5 could be confirmed for classical intelligence but not for convergent thinking as well as for creativity (both measurement methods). A second treatment year was found to be effective in improving of the classical intelligence. Any effect of the ET program could be observed, neither for convergent thinking nor for creativity (both measurement methods).

It seems that the ET is not only focusing on classical intelligence, but also leaving creative children out of the program. At the same time that the results showed the effectiveness of the program for classical intelligence, the absence of a curriculum that promotes creative abilities in children should be taken as a criticism, as this highly relevant issue is neglected. Therefore, it is highly recommended to revise the curriculum and the identification/selection process.

Furthermore, care should be taken in the identification/selection process. Teachers should be informed and trained so that they are better equipped to identify gifted children, especially those with high creative potential.

Finally, more longitudinal studies should be carried out with a greater sample size and the same children over the years in the ET program. Additionally, more ET schools should be involved, so that comparison between schools can also be made.

10. General Discussion

This section provides a general discussion of all the findings obtained in this work, considering the five studies together. First, it can be inferred that, as already reported in the literature (section 2.3), the relationship between intelligence and creativity is very complex, just as complex as each individual construct itself.

Study 1 investigated the relationship between classical intelligence and classical creativity. The main question was whether the threshold theory could be confirmed – the expectation was that it could be. However, this expectation was not fulfilled. No proof of the threshold theory could be found within the studied sample. Intelligence and creativity correlation was found to be linear, meaning that the non-linearity suggested by the threshold theory (Guilford, 1967; Lubart, 2003; Runco, 2007) was not supported. Results showed that intelligence did not correlate more weakly with creativity in the $IQ > 120$ group than in the $IQ < 120$ group. The threshold theory may in fact be caused by a statistical artifact, as suggested by some researchers (Runco & Albert, 1986; Sligh et al., 2005). This finding is relatively common in the literature. Many studies also did not find any support for the threshold theory (Jauk et al., 2013; Kim, 2005; Preckel et al., 2006; Runco & Albert, 1986; Runco et al., 2010; Sligh et al., 2005; Theurer et al., 2011).

Intelligence and creativity were not significantly related. Additionally, they demonstrated that intelligence was able to account for only a little of the variance in creativity. Less than 1% of the variability within creativity could be attributed to intelligence. This study indicates that there are other variables that account for the variability presented by creativity, such as gender and grade/age.

The second study was carried out in tandem with Study 1 and their results are supposed to corroborate to each other. The main question was how the development of classical intelligence and classical creativity would devolve within the threshold theory in the

period of a school year (at the start, Time 1 and at the end, Time 2). To attain this objective, the development of creativity and intelligence for above-average and average intelligent primary school children was compared.

According to the threshold theory, creativity increases as a function of intelligence until an IQ threshold of 120 (Karwowski & Gralewski, 2013; Sligh et al., 2005). Therefore, it was expected that if there would be an increase in classical intelligence scores from Time 1 to Time 2, then an increase in classical creativity scores should also be expected, when $IQ < 120$. This expectation was not fulfilled. There was no support for the expectation that intelligence scores could be useful for predicting creative performance. Intelligence itself was an unsatisfactory explanation for the variation in creativity scores. Clearly, if the threshold theory has no validity (as concluded in Study 1), this result is not surprising.

The aforementioned findings are in accordance with previous research. Russo (2004) inferred that intelligence may be necessary for creative performance, but is by no means sufficient. Theurer et al. (2011) reported a high amount of independence between both constructs; previous intelligence scores were unable to act as a precursor for future levels of creativity. Furthermore, Wallach and Kogan (1965) found that creativity was quite independent of the construct of intelligence; the correlation between both constructs were extremely low ($r = .1$).

The studies of the relation between creativity and intelligence indicate that the two constructs are modestly related. Correlations between the two are found in the range of $r = .20- .40$, suggesting that approximately 5-20% of the variance may be accounted for. Even with corrections for reliability, it is unlikely that these two traits will ever be thought of as synonymous, although they are clearly related (Batey & Furnham, 2006, pp. 380-381).

Results indicate that the development of creativity could not be explained by the development of intelligence. There are, of course, other important variables that may affect

creative performance. This is in accordance with prior research (Alfonso-Benlliure et al., 2013; Batey & Furnham, 2006; Lubart & Georgsdottir, 2004; Russo, 2004; Theurer et al., 2011).

According to Batey and Furnham (2006), along with intelligence, the variation of creativity can be explained by a myriad of other features. Preckel et al. (2011) discuss the possibility that a third variable, such as the speed of processing, may explain the correlation between intelligence and creativity, however, most of the existing studies did not control for possible ambiguities. In an investigation of the relationship between divergent thinking and reasoning ability, these authors observed that both constructs were moderately correlated. However, this correlation was found to be essentially due to the variance that both phenomena share with mental speed (Preckel et al., 2011).

Moreover, creativity is influenced by many issues that can inhibit or enhance its development (Alfonso-Benlliure et al., 2013; Lubart & Georgsdottir, 2004) such as personality traits (Batey & Furnham, 2006; Houtz et al., 1978; Shaughnessy, 1998), motivation (Collins & Amabile, 1999; Runco, 2008; Russo, 2004), environmental factors (Lubart, 1999; Runco & Pagnani, 2011), and others. Batey and Furnham (2006) also included other factors that may contribute to creative accomplishment such as birth order, specific developmental aspects, general or specific knowledge domain, resources access, presence of a mentor, and serendipity. To Russo (2004), definite degrees of drive, motivation, and energy may be more constantly associated with creativity than any other cognitive ability.

The third study was about the development of intelligence and creativity across grade levels. The main expectation was that creativity and intelligence would present different development across grades, from Grade 1 to Grade 4. Thereby, it was hypothesized that intelligence would present a continuous development throughout grade levels (Hypothesis 3a), whereas creativity would show a decrease in the fourth grade (Hypothesis 3b).

Hypothesis 3a could be confirmed for classical intelligence. Scores showed a continual growth through grade levels. However, this was only partially confirmed by convergent thinking. The scores increased from Grade 1 to Grade 4, but the increase was not constant throughout the grades. Intelligence scores measured in open problem spaces showed a more inconstant development over grade levels than the scores obtained by standard intelligence tests, which operate in closed problem spaces.

Hypothesis 3b could not be confirmed. A slump in creativity in the fourth grade could not be established within this sample. Results with classical creativity tests may suggest a possible stagnation, whereas divergent thinking results may suggest a slump in the second grade. This result may be related to the fact that divergent thinking scores depend on convergent scores. The use of more complex relations may imply the use of non-figurative elements, which may reduce the richness of details and the number of components applied.

Study 4 was complementary to Study 3. Here, the development of intelligence and creativity through four grade levels within one school year was investigated. It was hypothesized that intelligence would present an increase. Participants of all grades were expected to show an enhancement of their intelligence scores (Hypothesis 4a); whereas creativity scores would present a decrease. Fourth grade participants were expected to show a decline in their creativity scores from Time 1 to Time 2 (Hypothesis 4b₁), and the mean of the scores on creativity from third grade children would be higher than the scores for fourth grade children (Hypothesis 4b₂). This would then indicate the so called slump in the fourth grade (Torrance, 1967; 1968).

Considering only classical intelligence, there was partial support for the increase in scores stated in Hypothesis 4a. In general, SPM scores increased from Time 1 to Time 2. However, this is not the case for each grade individually. Hypothesis 4a could not be confirmed for convergent thinking. There was no significant increase in the scores from Time 1 to Time 2. Hypothesis 4b₁ and 4b₂ could be partially confirmed. Results for classical

creativity may indicate a possible stagnation in the development during third and fourth grade. Divergent thinking results may suggest a slump from the beginning of the second grade.

Overall, these results are in agreement with the findings of Study 3. Creativity and intelligence presented a different development across grades levels. Classical intelligence showed a stable and continuous development whereas convergent thinking and creativity demonstrated instability with a period of stagnation. This is confirmed by literature. Intelligence develops gradually and increasingly with age whereas creativity develops irregularly, decreasing as childhood progresses (Alfonso-Benlliure et al., 2013).

Results may suggest the importance of the educational process on the development of a child's creativity and intelligence. While education appeared to have a great impact on classical intelligence, for creativity the effect of schooling may be not so positive. Creativity scholars emphasize that the importance and great impact that educational environment has on creativity (Lubart & Georgsdottir, 2004; Maker et al., 2008). According to Theurer et al. (2011), it is necessary to examine aspects of the educational institution, methods of instruction, and social environment, in order to verify the extent of impact these factors have on the development of creativity.

Finally, Study 5 was about the comparison between the development of intelligence and creativity in above-average intelligent children who participated in the ET program with an age-and-class matched control group. It was hypothesized that intelligence would increase from Time 1 to Time 2 only for the ET program children (Hypothesis 5) during their participation. When considering the participation of children within one year of the ET, Hypothesis 5 was rejected for intelligence (both measurement methods) and for creativity (both measurement methods). No significant effect was found for intelligence or for creativity. The low sample number could be the explanation for this result.

When considering two years of participation in the ET program, Hypothesis 5 could be confirmed for classical intelligence only. A second year of treatment seemed to be effective

for the improvement of classical intelligence. If on the one hand results showed the effectiveness of the ET program for improving classical intelligence, on the other hand the absence of a curriculum that did promote creative abilities of children can be criticized due to the current importance of creative thinking.

This fact is of concern, since, as concluded by Batey and Furnham (2006), the variance in creative achievement cannot be explained by intelligence only. Lewis Terman studied the life of approximately 1,500 children most with an IQ above 140 (Feldhusen, 2005; Reis & Renzulli, 2011). According to Batey and Furnham (2006), the most relevant finding of Terman's study was that high level of intelligence did not automatically result in prominent accomplishment later in life. None of the studied gifted children made an eminent creative contribution to society, but two of the children that were excluded from the study, later in life became Nobel Prize winners (Batey & Furnham, 2006).

Therefore, it must be made known to teachers and school administrators that: (1) when identifying gifted children according to the performance on intelligence, highly creative children may be left out of the selection; and (2) when promoting intelligence, creativity is not automatically supported. According to Brown et al. (2005), the procedures for identifying gifted children are some of the most debated topics in the literature. The pursuit of objectivity in establishing levels of IQ and aptitude test dominated the way in which giftedness was identified for most of the last century. The problem with this identification process is that children with high creativity abilities frequently were among the unselected ones. To Torrance (1963), "no matter what measure of IQ is chosen, we would exclude about 70% of our most creative children if IQ alone were used in identifying giftedness" (p. 182) (cited in Batey & Furnham, 2006, p. 372).

Since creativity has proven to be of vital relevance at the present time, a change in this view is suggested (Beghetto, 2010; Smith & Smith, 2010; Torrance, 1972, 1987). Educational institutions should provide opportunities to children to learn, think, and discover under

adequate supervision (Torrance, 1977). According to Russ and Fiorelli (2010), children have the potential to be creative and aiding in this development of creativity increases the possibility of an important creative achievement.

Creativity is unique and responsible for the complete transformation of planet Earth (Gabora & Kaufman, 2010). The history and culture of mankind can be traced in large part thanks to the creative contributions made by the most gifted people in the world (Renzulli, 2002). Hence, it is important to study the circumstances of creative actions, but it is also relevant to seek active enhancements to the development of creative thinking (Funke, 2009). Socialization institutions such as family, schools and universities, can to a large extent enhance creative performance (Funke, 2009). According to Sternberg and Lubart (1999), in order to be creative, people need an environment that is favorable to and gratifies creative ideas. A person may have all the resources necessary to be creative, but without support from the environment, creativity may never be displayed (Sternberg & Lubart, 1999).

In a world that is increasingly complex, the development of creativity becomes now more vital than ever before (Runco, 2004). Additionally, researchers agree that creativity has an existential meaning for the life of a person, while immensely and beneficially contributing to society (Albert & Runco, 1990). Therefore, the importance of the finding that intelligence and creativity are not synonymous is not only theoretically relevant, bringing light to some unclear issues presented in research, but also is of practical importance. If researchers can have a better understanding concerning the underlying mechanisms governing the relationship between both constructs, and how to improve the quality of gifted education, then society can improve greatly and more rapidly.

According to Beghetto (2010), creativity researchers play a key role in the insertion of creativity into the regular curriculum. Beghetto believes there are several important directions that researchers can take in trying to achieve this objective. The most important is, perhaps the need to assist in the development, the testing, and the implementation of new pedagogical

models that support both the development of creative potential and academic learning (Beghetto, 2010). He also emphasized that future research on creativity in the classroom is complex and challenging. However, there are important and interesting opportunities in which researchers can engage to help educators address and replace the already long-standing barriers that creativity has encountered in the classroom (Beghetto, 2010). Research in creativity is much recommended. According to Isaksen and Murdock (1993):

The investigation of creativity can help shed light on some of the most challenging aspects of behavioral science and human existence. There are challenges within many facets of society to which an immediate or single correct response cannot be found. The increasing complexity of life and demand for new solutions to old problems or continuing problems call for a more creative type of thinking. Many of these challenges are of the utmost importance because they deal with our survival. Not only is creativity important for our survival as a human race, it can also help us better understand how the individual can reach higher levels of productivity and satisfaction (p. 16).

Finally, it is important to note that all the previous comments are made taking into consideration classical intelligence and classical creativity, respectively. However, in this study, intelligence showed different results when measured operating in closed or open problem spaces, although knowledge domain was identical for both problems. These results confirm the statement made by Jaarsveld et al. (2010) and Jaarsveld et al. (2012). For a better understanding of this outcome, the conduction of more studies is highly recommended.

11. General Conclusions

The present work investigated three important constructs in the field of Psychology: creativity, intelligence and giftedness. Although there were several studies on these topics, their results remain unclear and inconclusive. This essay was an effort to better understand these topics, and an attempt to fulfill the lack of clarity in research. Taking into account the important role that creativity, intelligence, and giftedness play in the current society and have been playing along the development of the humankind, the relevance of research on these topics becomes evident. The general conclusions of this study were:

- Classical creativity and classical intelligence were not significantly related.
- The threshold theory was not confirmed. Intelligence and creativity did not correlate more weakly within the high IQ group than in the average IQ group.
- With the addition of variables such as gender and grade, a change in the pattern of the relationship between creativity and intelligence changes (girls from fourth grade presented a nonlinear correlation).
- Intelligence accounted for less than 1% of the variance within creativity and early intelligence could not predict later creativity.
- Since intelligence can only account for only a small part of the variability in creativity, other variables may be responsible for that and must be taken into consideration.
- The development of classical intelligence and classical creativity through grade levels (Grade 1 to Grade 4) presented a different pattern. Intelligence develops continually, whereas creativity presented a stagnation after the third grade.
- Intelligence performance as measured operating in closed problem spaces was different from the intelligence performance measured operating in open problem spaces.
- The curriculum of the host school may have been better in promoting children's classical intelligence than their creativity. The same can be inferred about the ET curriculum.

- Highly creative children may have been left out of the *Entdeckertag* program; most children presented a high IQ, but average or below-average level of creativity.
- The ET program proved to be beneficial for classical intelligence after two years of attendance, but not for creativity.

Additionally, the following possible conclusions may be of immediate practical usefulness:

- Organizations and institutions such as schools should not look solely to intelligence performance, especially when looking to identify or promote gifted or creative individuals.
- The understanding of the relationship between intelligence and creativity is relevant for the assistance of the gifted population. The establishment of a universal knowledge and information about the characteristics of gifted children is required to meet the needs of gifted students, in order to develop procedures to identify them and to promote their potentials properly. In this case, the comprehension of the relationship between both constructs is a step toward this purpose.
- Creativity should be included in the school curriculum, in order to encourage and support students in developing their creative potential and their welfare and success in the school context and later in life. This applies to both cases, enrichment programs offered for gifted children and regular schooling.
- Information, continued training, and support for educational professionals are essential so that they can identify and serve gifted students properly, implementing instructional strategies in the classroom.

Suggestions for future research

Based on the realization of this work, some suggestions can be provided for future research:

- These studies should be replicated using larger sample sizes in order to increase the power of statistical tests. Accordingly, results obtained here can serve to estimate the appropriate sample size for each study. A larger sample size would increase external validity.
- Replication of these studies using other tests to measure intelligence and creativity, in order to evaluate other facets of both constructs such as the verbal component.
- Planning a specific study to verify the lack of effect of ET in increasing creativity. For this purpose, a statistical hypothesis testing of the Type II error ($1-\beta$) should be considered.
- Complementing the ET study presented in this work subjecting children of average intelligent to the program. This would favor a complementary control group for comparison with the results for children with an above-average intelligence, as obtained here.
- More longitudinal studies should be carried out with a greater sample size and the same children over the years under the ET program, in order to obtain a greater insight into the effect of the program over time.
- Conduct research on the program at the state level, involving more ET schools, in order to verify whether the effects of the program are identical for participants from other schools, so that comparisons between schools and methods can be made; verifying whether different teaching methods or teachers may influence results.
- Perform studies controlling for other variables that may influence creativity and intelligence relationship, such as motivation and personality traits.
- More longitudinal studies accompanying the same children over the years, especially regarding creativity.
- Longitudinal study with the CRT, in order to improve the understanding of intelligence as assessed in open problem spaces.

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Appendix A

Table A 6: Age norm for children in the primary school – Transformation of raw scores to percentile ranks

Tabelle A 6: Altersnormen für Schüler/innen der Grundschule und Sekundarstufe
Transformation von Rohwerten (RW) in Prozentränge (PR)

Alter	7	8	9	10	11	12	13	14	15	16	17	18	19	Alter
RW	PR	PR	PR	PR	PR	PR	PR	PR	PR	PR	PR	PR	PR	RW
5	.	1	1	.	.	.	.	.	.	.	.	.	.	5
6	.	.	.	.	.	.	.	.	.	.	.	.	.	6
7	1	.	.	.	.	.	.	.	.	.	.	.	.	7
8	.	.	2	.	.	.	.	.	.	.	.	.	.	8
9	2	2	.	1	.	.	.	.	.	.	.	.	.	9
10	.	.	.	2	.	.	.	.	.	.	.	.	.	10
11	3	3	3	.	.	.	.	.	.	.	.	.	.	11
12	4	4	5	.	1	.	.	.	.	.	.	.	.	12
13	10	5	.	.	.	.	.	.	.	.	.	.	.	13
14	12	.	.	.	.	.	.	.	.	.	.	.	.	14
15	13	.	6	3	2	.	.	.	.	.	.	.	.	15
16	14	.	.	.	.	.	.	.	.	.	.	.	.	16
17	16	9	.	.	.	1	.	.	.	.	.	.	.	17
18	19	11	.	.	.	.	.	.	.	.	.	.	.	18
19	23	.	7	.	.	.	.	1	.	.	.	.	.	19
20	25	16	8	.	.	.	.	.	.	.	.	.	.	20
21	27	.	9	.	.	.	.	.	.	.	.	.	.	21
22	29	18	11	.	3	.	.	.	.	.	.	.	.	22
23	30	21	.	.	.	.	.	.	.	.	.	.	.	23
24	35	22	12	.	.	.	.	.	.	.	.	.	.	24
25	41	23	13	4	.	.	.	.	.	.	.	.	.	25
26	46	26	.	5	.	.	.	2	.	.	.	.	.	26
27	52	29	14	.	4	.	.	.	.	.	.	.	.	27
28	58	31	15	6	6	.	.	.	.	.	.	.	.	28
29	60	32	19	.	.	.	.	.	.	1	.	.	.	29
30	63	33	23	.	7	.	.	.	.	.	.	.	.	30
31	66	38	26	7	.	.	.	.	1	.	.	.	.	31
32	68	45	31	8	.	.	1	3	.	.	.	.	.	32
33	70	53	34	10	.	.	.	.	.	.	.	.	.	33
34	76	56	42	14	8	2	.	.	2	.	.	.	.	34
35	78	59	48	16	.	3	.	4	3	.	.	.	.	35
36	80	62	51	19	10	4	.	6	.	.	.	.	.	36
37	86	66	53	26	.	5	2	7	4	2	.	.	.	37
38	89	68	57	29	11	6	3	8	.	.	.	.	.	38
39	93	75	65	32	13	.	5	9	5	.	.	.	.	39
40	94	80	70	35	15	8	7	10	.	.	1	.	.	40
41	95	86	76	48	19	12	8	12	6	4	2	.	.	41
42	99	91	83	51	23	19	11	13	.	.	3	.	.	42
43	99,5	94	89	54	28	21	13	16	9	6	4	.	.	43
44		96	96	57	34	25	15	19	12	9	5	1	.	44
45		99	98	61	38	31	18	25	16	10	9	3	.	45
46			99,5	65	45	36	22	33	21	15	10	.	.	46
47				70	50	45	27	38	25	20	11	.	.	47
48				82	54	51	36	41	27	25	13	4	1	48
49				87	63	58	41	48	34	32	20	5	11	49
50				92	70	68	50	50	41	36	28	7	13	50
51				96	80	74	57	59	45	42	30	10	15	51
52				98-99	85	83	68	63	54	51	34	17	16	52
53					90	87	78	65	61	59	45	28	22	53
54					93	90	87	70	70	68	53	31	28	54
55					95	94	91	75	78	77	62	37	39	55
56					97	97	93	85	84	85	72	39	50	56
57					98	.	96	90	88	92	83	59	61	57
58					99,5	99	98	94	93	96	89	73	73	58
59						99,5	99	.	98-99	97	96	83	83	59
60								98-99	99	99,5	93-99	89-99		60

Anmerkung: fettgedruckte Zahl = Median, unterstrichene Zahl = Wert vor dem Median.

Appendix B

Table A: Standard values scales – Transformation of percentile ranks to IQ

Tabelle A: Standardwert-Skalen (I)

<i>z</i>	<i>P</i>	<i>Z</i>	<i>T</i>	<i>L</i>	<i>C</i>	<i>N</i>	<i>IQ</i>	<i>z</i>	<i>P</i>	<i>Z</i>	<i>T</i>	<i>L</i>	<i>C</i>	<i>N</i>	<i>IQ</i>
-4,00	0,0032	60	10	-10	-3		40	+0,00	50,00	100	50	10	5	3,0	100
-3,95	0,0039							+0,05	51,99						
-3,90	0,0048	61	11					+0,10	53,98	101	51			2,9	
-3,85	0,0059							+0,15	55,96						
-3,80	0,0072	62	12	-9			43	+0,20	57,93	102	52	11		2,8	103
-3,75	0,0088							+0,25	59,87						
-3,70	0,0108	63	13					+0,30	61,79	103	53			2,7	
-3,65	0,0131							+0,35	63,68						
-3,60	0,0159	64	14	-8			46	+0,40	65,54	104	54	12		2,6	106
-3,55	0,0193							+0,45	67,36						
-3,50	0,0233	65	15		-2			+0,50	69,15	105	55		6	2,5	
-3,45	0,0280							+0,55	70,88						
-3,40	0,0337	66	16	-7			49	+0,60	72,57	106	56	13		2,4	109
-3,35	0,0404							+0,65	74,22						
-3,30	0,0483	67	17					+0,70	75,80	107	57			2,3	
-3,25	0,0577							+0,75	77,34						
-3,20	0,0687	68	18	-6			52	+0,80	78,81	108	58	14		2,2	112
-3,15	0,0816							+0,85	80,23						
-3,10	0,0968	69	19					+0,90	81,59	109	59			2,1	
-3,05	0,1144							+0,95	82,89						
-3,00	0,1350	70	20	-5	-1		55	+1,00	84,13	110	60	15	7	2,0	115
-2,95	0,159							+1,05	85,31						
-2,90	0,187	71	21					+1,10	86,43	111	61			1,9	
-2,85	0,219							+1,15	87,49						
-2,80	0,256	72	22	-4			58	+1,20	88,49	112	62	16		1,8	118
-2,75	0,298							+1,25	89,44						
-2,70	0,347	73	23					+1,30	90,32	113	63			1,7	
-2,65	0,403							+1,35	91,15						
-2,60	0,466	74	24	-3			61	+1,40	91,92	114	64	17		1,6	121
-2,55	0,539							+1,45	92,65						
-2,50	0,621	75	25		0			+1,50	93,32	115	65		8	1,5	
-2,45	0,714							+1,55	93,94						
-2,40	0,820	76	26	-2			64	+1,60	94,52	116	66	18		1,4	124
-2,35	0,939							+1,65	95,05						
-2,30	1,072	77	27					+1,70	95,54	117	67			1,3	
-2,25	1,222							+1,75	95,99						
-2,20	1,390	78	28	-1			67	+1,80	96,41	118	68	19		1,2	127
-2,15	1,578							+1,85	96,78						
-2,10	1,786	79	29					+1,90	97,13	119	69			1,1	
-2,05	2,018							+1,95	97,44						
-2,00	2,275	80	30	0	1	5,0	70	+2,00	97,725	120	70	20	9	1,0	130
-1,95	2,56							+2,05	97,982						
-1,90	2,87	81	31			4,9		+2,10	98,214	121	71				
-1,85	3,22							+2,15	98,422						
-1,80	3,59	82	32	1		4,8	73	+2,20	98,610	122	72	21			133
-1,75	4,01							+2,25	98,778						
-1,70	4,46	83	33			4,7		+2,30	98,928	123	73				
-1,65	4,95							+2,35	99,061						
-1,60	5,48	84	34	2		4,6	76	+2,40	99,180	124	74	22			136
-1,55	6,06							+2,45	99,286						
-1,50	6,68	85	35		2	4,5		+2,50	99,379	125	75		10		
-1,45	7,35							+2,55	99,461						
-1,40	8,08	86	36	3		4,4	79	+2,60	99,534	126	76	23			139
-1,35	8,85							+2,65	99,598						
-1,30	9,68	87	37			4,3		+2,70	99,653	127	77				
-1,25	10,57							+2,75	99,702						
-1,20	11,51	88	38	4		4,2	82	+2,80	99,745	128	78	24			142
-1,15	12,51							+2,85	99,781						
-1,10	13,57	89	39			4,1		+2,90	99,813	129	79				
-1,05	14,69							+2,95	99,841						
-1,00	15,87	90	40	5	3	4,0	85	+3,00	99,8650	130	80	25	11		145
-0,95	17,11							+3,05	99,8856						
-0,90	18,41	91	41			3,9		+3,10	99,9032	131	81				
-0,85	19,77							+3,15	99,9184						
-0,80	21,19	92	42	6		3,8	88	+3,20	99,9313	132	82	26			148
-0,75	22,66							+3,25	99,9423						
-0,70	24,20	93	43			3,7		+3,30	99,9517	133	83				
-0,65	25,78							+3,35	99,9596						
-0,60	27,43	94	44	7		3,6	91	+3,40	99,9663	134	84	27			151
-0,55	29,11							+3,45	99,9720						
-0,50	30,86	95	45		4	3,5		+3,50	99,9767	135	85		12		
-0,45	32,64							+3,55	99,9807						
-0,40	34,46	96	46	8		3,4	94	+3,60	99,9841	136	86	28			154
-0,35	36,32							+3,65	99,9869						
-0,30	38,21	97	47			3,3		+3,70	99,9892	137	87				
-0,25	40,13							+3,75	99,9912						
-0,20	42,07	98	48	9		3,2	97	+3,80	99,9928	138	88	29			157
-0,15	44,04							+3,85	99,9941						
-0,10	46,01	99	49			3,1		+3,90	99,9952	139	89				
-0,05	48,01							+3,95	99,9961						
0,00	50,00	100	50	10	5	3,0	100	+4,00	99,9968	140	90	30	13		160

z = normierte Merkmalswerte
P = Prozentrangwerte (entsprechend der GAUSS-Verteilung)
(Vgl. S. 122f. und S. 159f.)

Z = 100 + 10 *z* (z. B. IST)
T = 50 + 10 *z* (nach McCALL)
C = 5 + 2 *z* (nach GUILFORD)
L = 10 + 5 *z*
N = 3 - *z* (Schulnoten nach LIENERT)

Appendix C

Example of activities of the *Entdeckertag* Task Packet






Entdeckertag Pestalozzischule Kaiserslautern

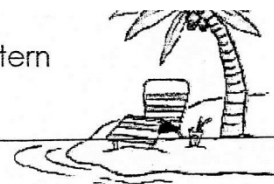
Schuljahr 10/11

Aufgabenpaket 13

von _____

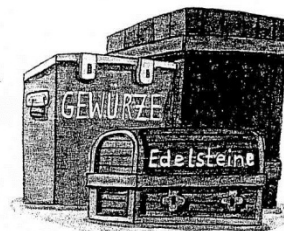
Datum: 8.06.2011 Abgabe: 15.06.2011

	Fachbereich	Thema	😊	😐	☹️	Burg/ Wick
1	 Lesen	Verdächtige Gestalten				
2	 Schreiben	Fragen zum Text beantworten				
3	 Knobeln	<ul style="list-style-type: none"> ✓ Logical „Reif für die Insel“ ✓ Logical „Freizeitparks“ ✓ Logical „Weltkulturerbe in Europa“ ✓ Logical „Nachbarländer Deutschlands“ ✓ Knobelblatt 20 ✓ Knobelblatt 21 				
4	 Rechnen	<ul style="list-style-type: none"> ✓ Onkel Karls Schatz ✓ Eine Wanderkarte ✓ Urlaubsgrüße 				
5		<ul style="list-style-type: none"> ✓ Quer durch Europa ✓ Sudoku`s ✓ Kreuzworträtsel 				



Verdächtige Gestalten

Kapitän Jakobs steuerte nachdenklich das Schiff aus dem Kieler Hafen Richtung Danzig. Die Ladung, die er diesmal an Bord hatte, war besonders wertvoll. Er transportierte zehn grüne Kisten mit weißer Aufschrift, in denen sich Gewürze befanden, acht braune Kisten mit schwarzer Aufschrift, in denen sich Glasgut befand, und zwei ebenfalls braune Kisten, aber mit weißer Aufschrift, in denen Edelsteine gelagert wurden.



Diese Tatsache alleine hätte ihn noch nicht nervös gemacht. Schließlich war er es gewohnt, seine oftmals wertvollen Güter von Deutschland aus zunächst zu der polnischen Hafenstadt, dann nach Lettlands Hauptstadt Riga, schließlich nach Tallinn, der Hauptstadt Estlands, weiter nach dem russischen St. Petersburg und schließlich nach Helsinki, der Hauptstadt Finnlands, zu transportieren. Die letzte Anlaufstelle vor der Rückfahrt nach Kiel war dann immer Stockholm, die Hauptstadt Schwedens. Wenn er bis dahin alle Kisten im richtigen Hafen abgeliefert hatte, war er glücklich.

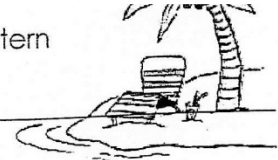


Was den Kapitän diesmal etwas beunruhigte, waren die drei neuen Matrosen an Bord. Der eine, Fred Johanson, mit seinen auffallend blauen Augen und den braungelockten Haaren, war äußerst wortkarg und förderte selten ein Lächeln zutage. Gerhard Neumann, die andere zwielichtige Gestalt mit der Narbe auf der Nase und dem blonden Lockenkopf, grinste zwar immerzu, war aber ebenfalls wenig gesprächig. Umso mehr quatschte Jens Fleischer, dessen schwarzgelockte Haarpracht bis über die Schultern reichte. Trotzdem kam er dem Kapitän verdächtig vor. Oftmals, wenn er ihn an Deck traf, erschrak Jens und reagierte verlegen, so, als habe er eben etwas angestellt.

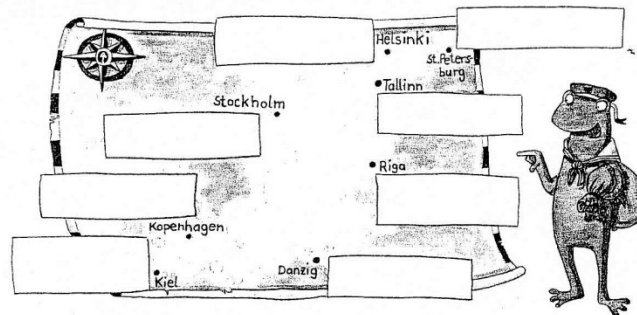
Die Edelsteine sollten eigentlich im vorletzten Hafen, den sie vor der Rückkehr nach Kiel anliefen, den Hafen verlassen. Das Glasgut war zur Hälfte für die Hauptstadt Estlands, zur anderen Hälfte für die schöne russische Stadt bestimmt. Die grünen Kisten sollten das Schiff in Danzig und Riga verlassen.

Schreiben

Entdeckertag Pestalozzischule Kaiserslautern
Aufgabenpaket 13



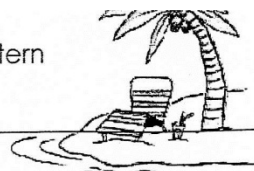
- ① Zeichne den Weg des Schiffes ein. Schreibe neben die jeweiligen Städte, welche Güter hier ausgeladen werden sollen.



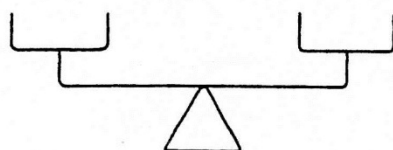
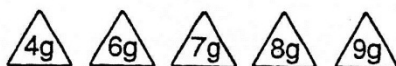
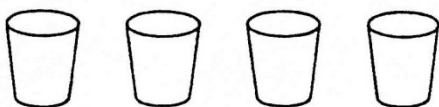
- ② Lies das Ende der Geschichte und setze die Lösungen ein.

Der neue braungelockte Matrose mit dem Vornamen _____ lud drei braune Kisten mit schwarzer Aufschrift und eine braune Kiste mit weißer Aufschrift in Tallinn aus. An der zweiten Haltestelle, nämlich in _____, schaffte der Matrose mit der Narbennase fünf grüne Kisten mit weißer Aufschrift und eine braune Kiste mit schwarzer Aufschrift vom Schiff. Vier braune Kisten mit schwarzer Aufschrift wurden im vierten Anlaufhafen, nämlich in _____, durch den redseligen Matrosen _____ von Bord gebracht. Zwei braune Kisten, einmal weiß und einmal schwarz beschriftet, verließen in Finnlands Hauptstadt _____ durch das tatkräftige Zutun des Mannes mit den blauen Augen, dessen Name _____ lautete, das Schiff. Kapitän _____ hatte also Recht behalten: Einer der neuen Matrosen hatte eine Kiste Edelsteine in _____ unerlaubter Weise von Bord gehen lassen. Und der Name dieses Matrosen war _____.

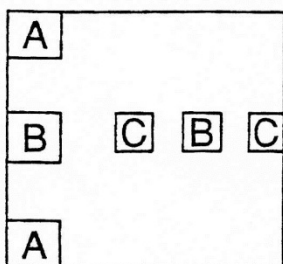
Knobeln

Entdeckertag Pestalozzischule Kaiserslautern
Aufgabenpaket 13

- 1** In diesen 4 Bechern sind zusammen 46 Bonbons. Wie viele Bonbons sind in den einzelnen Bechern, wenn in jedem Becher 3 mehr sind als im vorigen?



- 4** Zeichne Wege von
- A nach A
 - B nach B und
 - C nach C.
- Die Wege dürfen sich nicht berühren, einander nicht kreuzen und nicht aus dem Kasten herausgehen.



Arbeitsblatt 21

- 2** Ein Zaun ist 21 Meter lang. Die Pfähle stehen 3 Meter auseinander. Wie viele Zaunpfähle gehören zu dem Zaun?
- 3** Verteile die Gewichte auf die Waagschalen, sodass sie im Gleichgewicht sind.

SUPERKNACKER

Verteile die Zahlen 1, 2, 3, 4, 5 und 6 so auf die Kästchen, dass die Additionsaufgabe stimmt.

$$\begin{array}{r}
 \square \square \square \\
 + \square \square \square \\
 \hline
 9 \quad 6 \quad 6
 \end{array}$$



Rechnen

Entdeckertag Pestalozzischeule Kaiserslautern
Aufgabenpaket 13

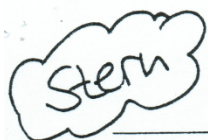


 $\begin{array}{r} 4036 \\ - 2 \cdot 70 \\ + 3 \cdot 40 \\ \hline \end{array}$	 $\begin{array}{r} 4086 \\ - 60 \cdot 3 \\ + 20 \cdot 30 \\ \hline \end{array}$	 $\begin{array}{r} 4506 \\ + 14 \cdot 2 \\ - 40 \cdot 40 \\ \hline \end{array}$	 $\begin{array}{r} 4435 \\ + 10 \cdot 20 \\ - 12 \cdot 5 \\ \hline \end{array}$
 $\begin{array}{r} 2934 \\ - 30 \cdot 20 \\ + 50 \cdot 3 \\ \hline \end{array}$	 $\begin{array}{r} 2935 \\ - 8 \cdot 70 \\ + 20 \cdot 60 \\ \hline \end{array}$		

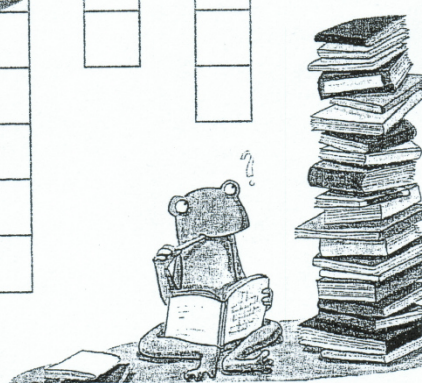
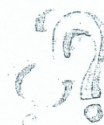
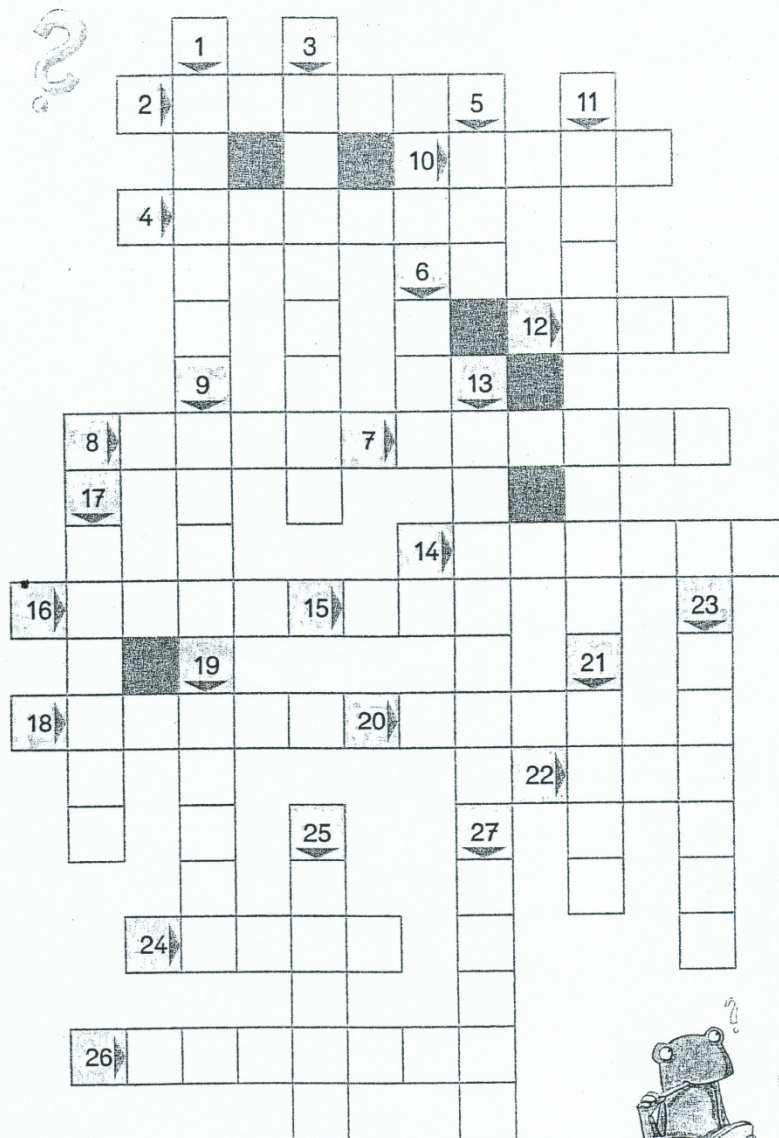
- 24 „Sieh doch nur unsere Spur an!“, rief Xenia aufgeregt. „Die Spur sieht aus wie eine Zahl,
 25 nämlich die “, staunte Christin. „Wahnsinn, dein Urgroßonkel war genial!“, lobte
 26 Xenia. Etwas leiser fügte sie hinzu: „Auch wenn ich noch nicht weiß, was er uns damit
 27 sagen wollte.“
 28 „Hm, lass uns einfach mal weitergehen“, schlug Christin vor. „Vielleicht finden wir wieder
 29 irgendwelche Zahlen.“ Tatsächlich war es so. Mit einem Mal standen sie vor einem
 30 Labyrinth, auf dessen Wegen Rechnungen standen.
 31 „Und welchen Rechenwegen sollen wir jetzt folgen?“, fragte Xenia. „Die Spuren im Sand
 32 vorhin haben die Zahl ergeben. Also schlage ich vor, wir folgen den Wegen, deren
 33 Rechnungen ebenfalls die Zahl als Ergebnis haben.“

$70 \cdot 70 - 120 + 30 \cdot 7$ (3)
 $60 \cdot 4 - 20 \cdot 5 - 9 \cdot 9 - 52$
 $80 \cdot 80 + 20 \cdot 10 - 190$ (7)
 $810 : 90 + 560 : 70 - 3$ (4)
 $720 : 80 + 540 : 90 - 180 : 90$ (5)
 $240 : 30 - 240 : 30 + 0 : 0 + 0 : 0 + 5$ (9)

- 34 „So, jetzt kommen wir bei der Zahl heraus. Und nun?“



Entdeckertag Pestalozzischule Kaiserslautern
Aufgabenpaket 13



Appendix D

(1) SPM – Verbal instruction

2.1.3 Sprachliche Instruktion

Wenn jede Testperson einen Bleistift oder Kugelschreiber bereit hat, sagt der/die TL:

„Ich werde gleich Testhefte und Antwortblätter austeilern. Die Testhefte müssen zunächst geschlossen bleiben. Es kommt darauf an, möglichst genau und zügig zu arbeiten.“

Jetzt werden die Testhefte und Antwortblätter ausgeteilt. Anschließend tragen die Testpersonen nach den Anweisungen des/der TL ihre Personalien auf dem Antwortblatt ein (statt der Namen ist erforderlichenfalls eine Kenn-Nummer anzugeben).

Wenn alle Testpersonen damit fertig sind, sagt der/die TL:

„Bitte jetzt die Stifte ablegen!“

Der/die TL hält ein Testheft in die Höhe, schlägt die Seite mit Aufgabe A1 auf und sagt:

„Hier oben ist ein Muster mit einer Lücke.“ (*Zeigen!*) „Jedes der Teilstücke hier unten“ (*Der/die TL zeigt nacheinander auf die einzelnen Teilstücke.*) „paßt der Größe nach in die Lücke des Musters, aber nur ein einziges Teilstück ergänzt das Muster richtig. Alle Teilstücke müssen genau angeschaut werden. Nummer 1“ (*Der/die TL zeigt auf das Teilstück 1 und dann auf das Muster.*) „ist falsch in der Musterung. Nummer 2“ (*Zeigen!*) „ist falsch, weil es überhaupt kein Muster hat. Nummer 3“ (*Zeigen!*)

„hat ein falsches Muster. Alle drei passen der Größe nach in die Lücke, aber sie haben nicht die richtige Musterung. Wie ist es mit der Nummer 6? Es stimmt zwar das Muster“ (*Zeigen!*), „aber die Musterung ist nicht vollständig“ (*Zeigen!*). „Welches ist das Teilstück, das genau richtig ist? Ja, Nummer 4 ist richtig. 4 ist die Lösung für die Aufgabe A1, also wird hier auf dem Antwortblatt“ (*Zeigen!*) „die 4 bei der Aufgabe A1 angekreuzt.“ (*Zeigen und Vormachen!*)

„Es gibt bei jeder Aufgabe immer nur eine richtige Lösung. Die richtige Antwort ist immer auf dem Antwortblatt anzukreuzen, auf gar keinen Fall im Testheft. Es ist darauf zu achten, daß die Ergebnisse an der richtigen Stelle im Antwortblatt eingetragen werden. Die Markierung einer Zahl muß immer eindeutig zu erkennen sein.“

„Wir schlagen jetzt alle im Testheft die Seite mit der Aufgabe A1 auf.“ ---

„Wir schauen die Aufgabe nochmals an und kreuzen auf dem Antwortblatt, nicht im Testheft, die eben besprochene Lösung 4 bei der Aufgabe A1 an.“ ---

Der/die TL prüft, ob alle die 4 bei A1 angekreuzt haben, und sagt dann:

„Bitte noch nicht weiterblättern! Auf jeder Seite des Heftes ist ein Muster mit einer Lücke. Die Aufgabe besteht darin, dasjenige Teilstück festzustellen, das genau richtig ist, um das Muster zu ergänzen. Wenn das richtige Teilstück gefunden ist, wird seine Nummer auf dem Antwortblatt angekreuzt. Die Aufgaben sind alle nach dem gleichen Prinzip aufgebaut. Am Anfang sind die Muster einfach und werden dann immer schwieriger.“

„Bitte jetzt die nächste Seite mit dem Muster A2 aufschlagen!“

(*Vormachen und Zeit für „Testbeginn“ notieren!*)

„Welches ist das Teilstück, das das Muster der Aufgabe 2 richtig ergänzt? Jeder sucht nun selbst das Teilstück, welches das Muster A2 richtig ergänzt?“ ---

(*Die Testpersonen sollten jetzt die Gelegenheit haben, diese Aufgabe zunächst selbständig zu lösen.*)

„Nummer 5 ist richtig. Auf dem Antwortblatt ist deshalb die Nummer 5 bei der Aufgabe A2 anzukreuzen.“

(*Vormachen und prüfen.*)

„Es stehen 45 Minuten Zeit zur Verfügung. Es kommt nicht in erster Linie darauf an, schnell zu sein, sondern möglichst viele von den Aufgaben richtig zu lösen. Wichtig ist: Es gibt bei jeder Aufgabe nur ein geeignetes Teilstück. Noch Fragen?“ ---

„Ab jetzt ist der Test selbständig weiterzubearbeiten bis zum Schluß.“

Wenn von einer Testperson nach einer Korrekturmöglichkeit gefragt wird, sagt der/die TL:

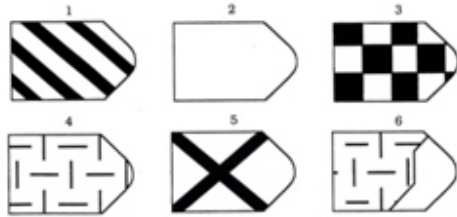
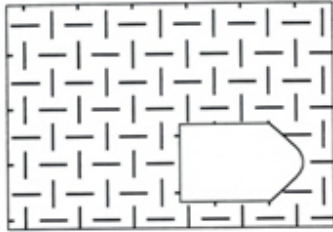
„Wer eine falsche Nummer angekreuzt hat, soll das falsche Kreuz deutlich durchstreichen und dann die richtige Nummer ankreuzen.“

Nach ca. 30 Minuten werden die Testpersonen gebeten, Zeichen zu geben, sobald sie fertig sind. Dann sollte die Testperson die Zeit für „Testende“ auf dem Antwortblatt eintragen und dieses sowie das Testheft abgeben.

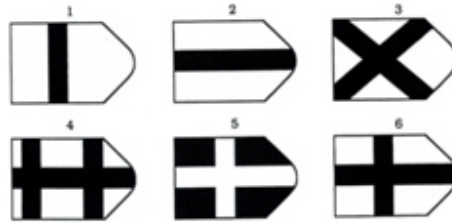
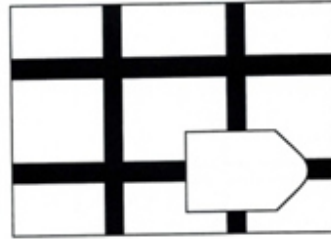
Spätestens nach 45 Minuten werden alle Antwortblätter und Testhefte eingesammelt.

(2) SPM – Task examples

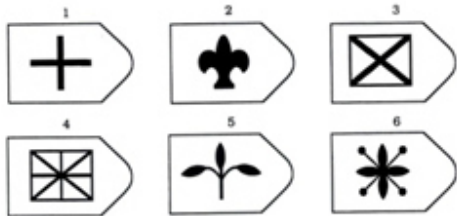
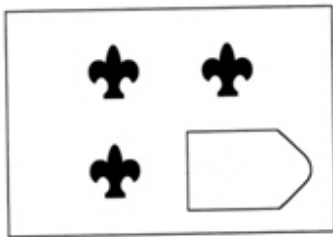
A1



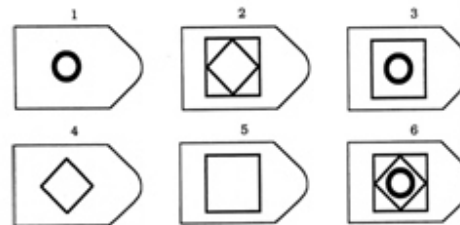
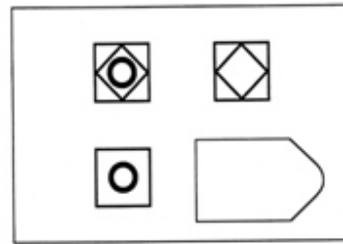
A7



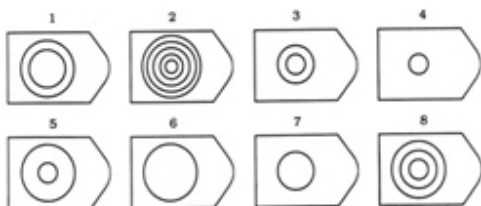
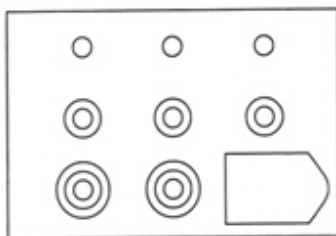
B1



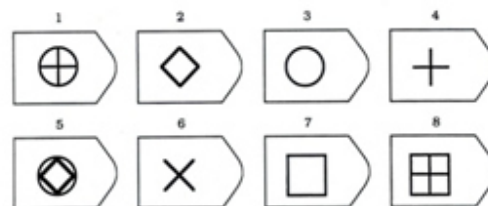
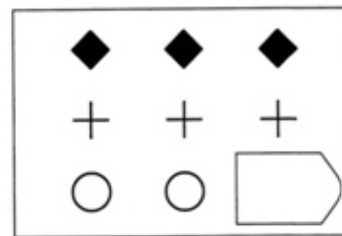
B12



C1



D1



(3) SPM – Answer sheet

Standard Progressive Matrices

SPM

Antwortbogen

Name			Vorname		
heutiges Datum				Testbeginn	
geboren am				Testende	

A

A1	1	2	3	4	5	6	7	8
A2	1	2	3	4	5	6	7	8
A3	1	2	3	4	5	6	7	8
A4	1	2	3	4	5	6	7	8
A5	1	2	3	4	5	6	7	8
A6	1	2	3	4	5	6	7	8
A7	1	2	3	4	5	6	7	8
A8	1	2	3	4	5	6	7	8
A9	1	2	3	4	5	6	7	8
A10	1	2	3	4	5	6	7	8
A11	1	2	3	4	5	6	7	8
A12	1	2	3	4	5	6	7	8

B

B1	1	2	3	4	5	6	7	8
B2	1	2	3	4	5	6	7	8
B3	1	2	3	4	5	6	7	8
B4	1	2	3	4	5	6	7	8
B5	1	2	3	4	5	6	7	8
B6	1	2	3	4	5	6	7	8
B7	1	2	3	4	5	6	7	8
B8	1	2	3	4	5	6	7	8
B9	1	2	3	4	5	6	7	8
B10	1	2	3	4	5	6	7	8
B11	1	2	3	4	5	6	7	8
B12	1	2	3	4	5	6	7	8

C

C1	1	2	3	4	5	6	7	8
C2	1	2	3	4	5	6	7	8
C3	1	2	3	4	5	6	7	8
C4	1	2	3	4	5	6	7	8
C5	1	2	3	4	5	6	7	8
C6	1	2	3	4	5	6	7	8

C (Fortsetzung)

C7	1	2	3	4	5	6	7	8
C8	1	2	3	4	5	6	7	8
C9	1	2	3	4	5	6	7	8
C10	1	2	3	4	5	6	7	8
C11	1	2	3	4	5	6	7	8
C12	1	2	3	4	5	6	7	8

D

D1	1	2	3	4	5	6	7	8
D2	1	2	3	4	5	6	7	8
D3	1	2	3	4	5	6	7	8
D4	1	2	3	4	5	6	7	8
D5	1	2	3	4	5	6	7	8
D6	1	2	3	4	5	6	7	8
D7	1	2	3	4	5	6	7	8
D8	1	2	3	4	5	6	7	8
D9	1	2	3	4	5	6	7	8
D10	1	2	3	4	5	6	7	8
D11	1	2	3	4	5	6	7	8
D12	1	2	3	4	5	6	7	8

E

E1	1	2	3	4	5	6	7	8
E2	1	2	3	4	5	6	7	8
E3	1	2	3	4	5	6	7	8
E4	1	2	3	4	5	6	7	8
E5	1	2	3	4	5	6	7	8
E6	1	2	3	4	5	6	7	8
E7	1	2	3	4	5	6	7	8
E8	1	2	3	4	5	6	7	8
E9	1	2	3	4	5	6	7	8
E10	1	2	3	4	5	6	7	8
E11	1	2	3	4	5	6	7	8
E12	1	2	3	4	5	6	7	8

Appendix E

(1) CRT – Verbal instruction

Pestalozzischule Entdeckertag 6. Oktober, 2010.

Anleitung zum Zeichnen eines Puzzle

- Du hast jetzt eine Menge von Puzzles selbst gelöst.
- Jetzt sollst du dir bitte selbst ein Puzzle ausdenken, das so ähnlich geht wie die Puzzles, die Du gerade gemacht hast.
- Bei den Puzzles, die du gerade gemacht hast, gab es verschiedene Arten. Es gab Puzzles in einem quadratischen Rahmen ohne Kästchen, oder in einem Rahmen mit vier Kästchen, oder in einem Rahmen mit neun Kästchen.
- Für dein neues, selbst gemachtes Puzzle musst du zuerst eine von diesen Möglichkeiten auswählen – ohne Kästchen, 4 Kästchen oder 9 Kästchen.
- Für deine Wahl benutze die Markierungen am Rahmen.
- Zeichne in das Kästchen unten rechts deine richtige Antwort.
- Du brauchst die Auswahlpuzzleteile nicht zu zeichnen.
- **Es ist sehr wichtig, dass du dein Puzzle so schwierig wie möglich gestaltest.**

(2) CRT – Answer sheets

1x1

	Klasse
	Datum
Name	Alter
Vorname	Mädchen <input type="radio"/> Junge <input type="radio"/>

2x2

Klasse

Datum

Name

Alter

Vorname

Mädchen Junge

	<table border="1"><tr><td></td></tr></table>	

3x3

Klasse

Datum

Name

Alter

Vorname

Mädchen Junge

		<table border="1"><tr><td></td></tr></table>	

Appendix F

(1) TCT-DP – Verbal introduction

PRAKTISCHER TEIL

5. Testdurchführung

Der Test sollte in einer ruhigen, angenehmen Atmosphäre stattfinden. Zeitdruck, Hektik, starke Ablenkungsmöglichkeiten sowie Lärm sollten ausgeschaltet werden. Die Gruppe sollte bei nur einem Testleiter nicht zu groß sein, höchstens 10-15 Teilnehmer, die ausreichend Platz zum Zeichnen haben müssen. Da in der Regel gleich nacheinander beide Testformen vorgegeben werden, sollte bei größeren Gruppen mindestens eine weitere Person anwesend sein, die beim Einsammeln der ersten Zeichnung und dem sofortigen Ausgeben des zweiten Testblattes (Form B) sowie dem Notieren der Zeit (siehe Punkt 3 und 5) hilft.

1. Jeder Teilnehmer hat vor sich den gefalteten Testbogen mit der Zeichnungsseite nach oben und einen schwarzen Filzstift (nicht zu dick) oder einen Bleistift. Es sollen keine Lineale oder Radiergummis benutzt werden!
Bei Bedarf läßt der Testleiter/Lehrer vorweg Eintragungen am oberen Blattrand vornehmen, wie Vorname, Name, Alter, Klasse, Geschlecht.
2. Der Testleiter/Lehrer liest (besser: spricht auswendig!) die folgende kurze Instruktion (bei Bedarf auch in der Anredeform mit "Sie") langsam und deutlich:

“Vor Dir siehst Du eine angefangene Zeichnung.
Der Zeichner hat aufgehört, bevor er wußte,
was daraus werden würde.
Du sollst jetzt einfach weiterzeichnen!
Du kannst so zeichnen, wie Du willst!
Du kannst also nichts falsch machen; alles ist richtig.
Wenn Du fertig bist, gib mir still ein Handzeichen;
dann hole ich Dein Blatt ab
(und gebe Dir ein zweites Blatt)!”

Eventuell kann er noch einmal wiederholen:

“Du kannst so zeichnen, wie Du willst.”
oder
“Bitte stellt keine weiteren Fragen;
alle können so zeichnen, wie sie wollen.”

3. Der Testleiter notiert die Anfangszeit.
4. Bei dennoch eventuell aufkommenden Fragen zwischendurch, geht der Testleiter/Lehrer **nicht** auf inhaltliche Fragen ein; z.B. auch nicht auf die Frage, was das Zeichen außerhalb des Rahmens bedeuten solle, ob es dazu gehöre oder ähnliche Fragen! Er kann lediglich noch einmal darauf aufmerksam machen:

“Du kannst alles so zeichnen, wie Du es willst!
Alles ist richtig; Du kannst nichts falsch machen!”

Auch Fragen nach der weiteren zur Verfügung stehenden Zeit sollten nicht direkt beantwortet werden.

Der Lehrer/Testleiter könnte z.B. sagen:

“Fangt erst einmal an. Wir werden sehen, wie lange Ihr braucht, bis Ihr fertig seid.”

Und eventuell:

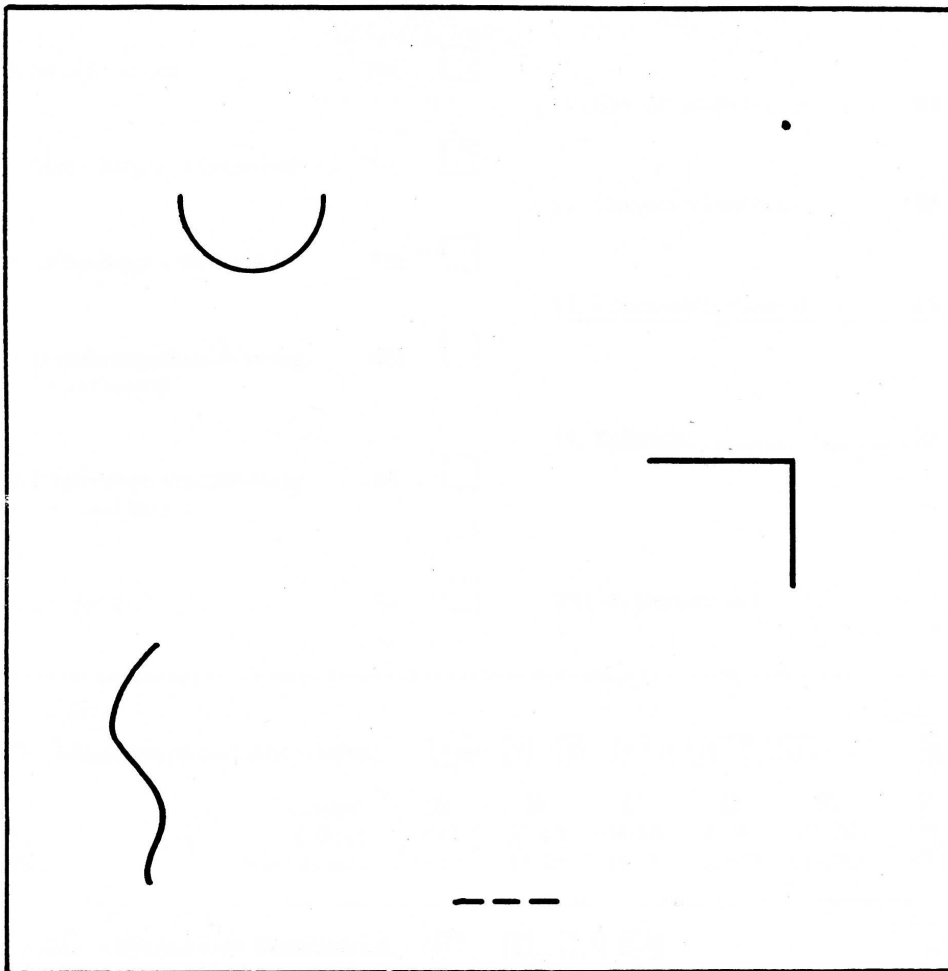
“Eine ganze Stunde haben wir allerdings nicht Zeit dafür.”

5. Der Testleiter/Lehrer notiert bei allen Teilnehmern, die **vor** Ablauf von 12 Minuten fertig werden, die benötigte Zeit auf dem oberen Rand des Testblattes und händigt das zweite Testblatt (Form B) aus. Es kann nützlich sein, die neue individuelle Anfangszeit (in Minuten, z.B. '36) in der rechten oberen Ecke des Blattes zu notieren; es reicht aber auch die zweite Abgabenerkennung, da die benötigte Zeit auch zurückgerechnet werden kann (Abgabe Form A = Beginn Form B).
6. Außerdem bittet er bei der Abgabe jeden Teilnehmer, ihm kurz zu sagen, was er gezeichnet hat (Überschrift, Thema), und notiert dies ebenfalls. (Dies kurze Gespräch soll möglichst so geführt werden, daß andere nicht gestört bzw. in ihrer Arbeit beeinflußt werden!) Insbesondere bei (größeren) Gruppen hat es sich auch bewährt, dann, wenn sich der erste fertige Teilnehmer meldet, alle Teilnehmer darauf hinzuweisen, **nach Möglichkeit** einen Titel/ eine Überschrift auf das Blatt zu schreiben; es besteht aber kein Zwang.
7. Nach 15 Minuten beenden alle, die noch auf dem ersten Blatt zeichnen, ihre Arbeit. Auch diese Teilnehmer werden noch einmal daran erinnert, nach Möglichkeit eine kurze Überschrift oder einen Titel oben auf das Blatt zu schreiben. Dann geben alle ihr Blatt ab.
8. Mit dem Testblatt Form B, das jeweils (in der Regel) gleich anschließend oder zu einem anderen Zeitpunkt gegeben werden kann, wird analog verfahren.

(2) TCT-DP – Answer sheets

Form A

A
TSD-Z
TCT-DP



C

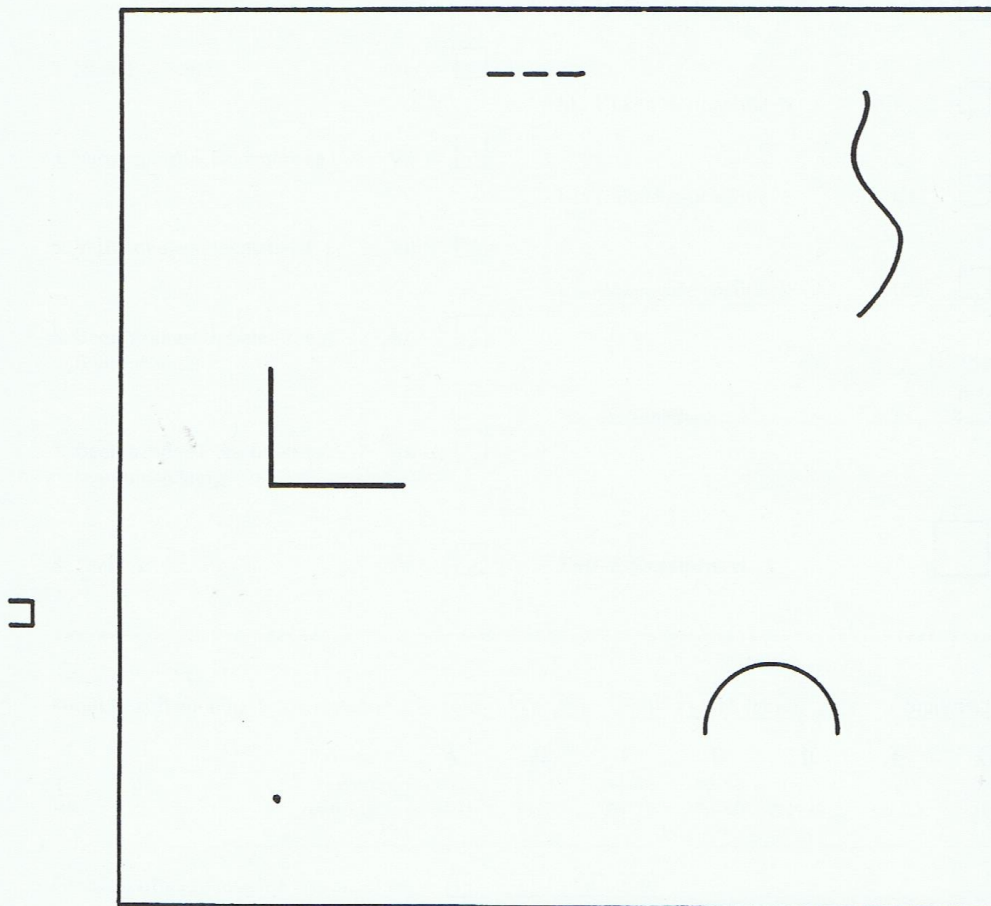
Test zum Schöpferischen Denken – Zeichnerisch (TSD-Z) von Klaus K. Urban und Hans G. Jellen†.

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Form B

B
TSD-Z
TCT-DP



Test zum Schöpferischen Denken - Zeichnerisch (TSD-Z) von Klaus K. Urban und Hans G. Jellen†.

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Curriculum Vitae

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Education and Professional Experience:

Since 2010	Doctoral student at the University of Kaiserslautern
05 – 08/2012	Academic Interchange at Torrance Center for Creativity and Talent Development– University of Georgia/USA
2008 –2009	Participation in research project “Management of Stress from Public Security Professionals of Santa Catarina” – UFSC – Brazil
2008 – 2009	Research Assistant at the Laboratory of Human Factor – Federal University of Santa Catarina – UFSC – Brazil Research Lines: Models and Methods of Diagnosis and Evaluation in Health and Human Development
2003 – 2007	Study at Psychology at the University of West of Santa Catarina – UNOESC – Brazil
1994 – 1999	High School Vocational and Technical Education (Schoolteacher) at the School Olavo Cecco Rigon – Brazil