Dorota Maria Jankowska
Maciej Karwowski

TEST OF CREATIVE IMAGERY ABILITIES

TEST OF CREATIVE IMAGERY ABILITIES

Dorota Maria Jankowska
Maciej Karwowski

TEST OF CREATIVE IMAGERY ABILITIES

LIBER

Dorota Maria Jankowska, Maciej Karwowski
Test of creative imagery abilities

Reviewers:
Dr. Boris Forthmann (Universität Münster)
Dr. Richard W. Hass (Thomas Jefferson University)

Cover:
Dominika Karaś

Cover graphic:
shutterstock.com

Proofreading:
Wojciech Włoch

Typesetting and text makeup:
Studio DTP Academicon | Patrycja Waleszczak
dtp@academicon.pl, dtp.academicon.pl

This book was financed by the Maria Grzegorzewska University (BNS 11/20-P). The data presented in chapter 5 have been collected thanks to a grant funded by National Science Centre (Narodowe Centrum Nauki), grant number 2016/23/B/HS6/03898.

Warsaw: Wydawnictwo Liberi Libri, 2020
www.LiberiLibri.pl

ISBN: 978-83-63487-48-5
DOI: 10.47943/lib.9788363487485

Table of Contents

Foreword

Being a human, means being creative; at least potentially. Indeed, while only very few of us will achieve outstanding levels of creative achievement in any domain, almost all are able to develop ideas, propose solutions, and make the world around better. This—mundane—level of creativity is by no means less important. Quite the opposite, it serves as a necessary condition for accomplishments. Creative imagination is the main driver of both everyday creative behaviors and eminent creative achievement. To create, individuals must consider what is not yet here. Explore the unexplored. Transform ideas that have just been born. Imagination is fuel and the main component of creative potential; creative potential leads to creative behavior and achievement. While these links are by no means straightforward—they are rather mediated by confidence (Karwowski & Beghetto, 2019)—achievement without potential and potential without imagination appears unrealistic.

Virtually all of us are able to imagine things. Congenital aphantasia—a phenomenon of "no power of visualizing"—is extremely rare, happening in about 3% of the population (Faw, 2009). Most of us create more or less vivid images of things we have seen, but also those we have never encountered. What is more, we are able to transform and explore these images, improve them, make them richer, more detailed, and more original. While individual differences in the ability to create mental images were acknowledged, measurement of these differences has been overlooked.

On the one hand, assessment of individual differences in visual mental imagery has a long history in psychology and related fields (see Karwowski & Jankowska, 2019, for an overview). This interest spawned widely different methods and instruments for evaluating imagery ability. Emergence of divergent thinking tests reinvigorated the researchers' efforts in assessing creative imagery abilities. On the other hand, such tests have created some problems for the field of assessment, which is the problem of the distinction between creative imaginative abilities and creative thinking (and more broadly creativity; see Jankowska & Karwowski, 2015). An essential shift in this field has occurred with studies of the creative cognition approach (e.g., Finke, 1990; Finke et al., 1992), which provide a framework for understanding and interpreting creative aspects of visual mental imagery as part of the creative process. However, existing tests did not take into account the complexity

of visual mental imagery (Kosslyn et al., 2010) and its creative function. This was the impulse for developing the Test of Creative Imagery Abilities (TCIA), whose theoretical assumptions as well as aspects of validity and reliability we present in this book.

The first chapter provides an overview of definitional and theoretical issues on mental imagery developed in different subfields of psychology. This part of the book also explores the most important research and scientific reflection on the relationship between creativity and mental imagery as well as future directions of these studies. This is an introduction to the description of the applied model of creative imagery abilities; it provides insight into addressing the multidimensionality of mental imagery represented in the TCIA. Finally, we briefly describe and critically discuss the methods of developing and measuring selected tests of creative imagination, indicating the foundation for understanding how and why we created the TCIA. We believe that this coverage brings an empirical and theoretical context for understanding the constructs embodied in this instrument.

The second chapter focuses on the TCIA administration practices and provides insight into a practical framework for testing. We tried to provide useful (practical) materials to help researchers develop proficiency in the use of this test. More importantly, this chapter provides instruction in conducting an enterprise of creative imagery abilities research using the standard and short versions of the TCIA.

The third chapter is devoted to scoring and interpreting test results. This part provides an overview of the meanings given to the TCIA scales and scoring procedure imperative for sound assessment practice. We also discuss how to interpret the results of the TCIA correctly and how to use them effectively.

In the next two chapters, we present psychometric properties of the standard and short versions of the TCIA. We offer results on criterion validity research, juxtaposing TCIA's results with other measures of imagination and creative abilities and the discriminant validity of the TCIA, checking whether and to what extent its dimensions are related to intelligence and school achievement measured using standardized tests as well as GPA. Using aggregated data, we show construct validity of this test. We also demonstrate measurement invariance among women and men and the relations between age and creative imagery abilities.

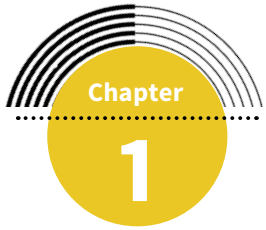
Our goal has been to produce an assessment procedure of the TCIA that is user-friendly. For this reason, we show examples of solutions in the test and present most accurately and insightfully how to assess them. While we acknowledge that scoring the TCIA may be problematic initially, we do hope that interested readers will find the examples provided insightful

and helpful in scoring. The closing chapter provides norms for the standard version of the TCIA as well as normative values for the TCIA-S.

We hope that this book will help develop proficiency in the use of the TCIA and will become a useful source of information for anyone who wishes to develop a deeper understanding of creative imagery abilities assessment. We believe that the assumptions for the TCIA can inspire researchers to pose new questions and explore fresh research ideas concerning creative imagery abilities.

Acknowledgments

All books are, in a sense, coauthored. This observation applies to this one as well. Although two authors are listed on the cover page, numerous people contributed to the project. We are indebted to several colleagues and friends who generously offered their time and expertise to assist us in data collection, discussed TCIA's assumptions, and provided comments to our interpretations of the findings obtained. We would also like to thank Reviewers for their valuable comments. Special thanks go to Aleksandra Gajda and Michał Jankowski, who created the TCIA booklets. Finally, we would like to thank those individuals who consented to have their responses included as examples throughout the book.



Creative aspects of visual mental imagery and its assessment

1.1. Mental imagery, visual images, and creativity

In psychological literature, mental imagery, colloquially referred to as 'seeing with the mind's eye,' 'hearing with the mind's ear,' or 'imagining the feel of,' refers to internal representations and the accompanying experience of sensory information without a direct external stimulus (e.g., Pearson et al., 2015; Wraga & Kosslyn, 2002). Such representations, the so-called 'mental images' or 'mental pictures,' result from actual perceptual experience and are recalled from memory. They can lead to re-experiencing a version of the original stimulus or some new combination of stimuli (Thompson et al., 2011). Although mental imagery can engage all senses, most empirical work in psychology focuses on visual mental imagery, likely because visual and auditory images are most frequently experienced (Kosslyn et al., 1990; Schifferstein, 2006; Tiggemann & Kemps, 2005).

One central debate in cognitive science (the so-called 'imagery debate') concerns the nature of internal representations that underlie mental imagery experience. The main controversy is whether mental images should be treated as pictures or linguistic descriptions (see Tye, 1991, for a review). Kosslyn, the leading advocate of "quasi-pictorial" theory, and other scholars (e.g., Brogaard & Gatzia, 2017; Kosslyn et al., 2010) perceive mental images as a kind of depictive representation and posit that mental images arise from perceptual representations. For this reason, mental images and perceived stimuli are represented similarly and can be processed in the same way (Borst & Kosslyn, 2008). Pylyshyn (1973, 2003) advocates a description theory, also known as the 'propositional theory,' which is based on the proposition that language-like representations account for all cognitive processes, including mental imagery. This issue has been debated since the late 1970s and, still, it seems to be open within the frame of the embodied

cognition approach (Palmiero et al., 2019) and perceptual activity theory (Thomas, 1999).

Mental imagery plays a vital role in everyday life (Nelis et al., 2014), school learning (Guarnera et al., 2019), sport (Martin et al., 1999), mental health (Blackwell et al., 2013), and in many other aspects of life. Much of the evidence (both anecdotal and empirical) calls for imagery-creativity connection (see, e.g., Intons-Peterson, 1993; LeBoutillier & Marks, 2003; for a review). From the 1960s (Schmeidler, 1965) until today (e.g., Jankowska & Karwowski, 2020), this relationship has been intensively explored in correlational studies, which most frequently employ individual difference measures in visual imagery and divergent thinking (LeBoutillier & Marks, 2003; for a review). The associations reported usually fall within the weak-to-moderate range, with mental imagery being slightly more strongly related to the figural than the verbal modality of creativity (LeBoutillier & Marks, 2003). Interestingly, the recent evidence has also shown associations (rs between .13 and .39) between visual mental imagery and creative self-beliefs (see Beghetto & Karwowski, 2017), which describe an individual's convictions about creativity (Jankowska & Karwowski, 2020). Preliminary empirical evidence on creative learning (for a discussion; see Beghetto, 2016; Karwowski et al., 2020) has also confirmed the link between visual mental imagery and creative-learning outcomes in language and math (Jankowska & Karwowski, 2020). Concerning the climate for creativity in a parent-child relationship, it has been shown that parents' visual mental imagery is positively related to parental acceptance of child and autonomy (Jankowska & Gralewski, 2020). These analyses open up new areas of investigation in the context of mental imagery-creativity connection.

Although important, correlational studies explain neither the causality, nor the mechanisms of this connection. Nevertheless, researchers are continually trying to determine the role of images in the creative process based on existing research findings and theories (Intons-Peterson, 1993; Shepard, 1978). Firstly, based on reports from creative persons about the processes contributing to their creative efforts, it has been emphasized that mental imagery is a better alternative than the structures imposed by language and traditional ways of thinking. Moreover, the nature of mental images (especially visual mental images) makes them amenable for intuition, more responsive to manipulation, reconstruction, and reinterpretations than language forms. Therefore, mental imagery seems crucial in the first stages of creative problem-solving. The first ideas, often intuitive, fantastic, and metaphorical, are easier to put into the mental image than in the linguistic representation. For example, Einstein began working on relativity theory by imagining a journey on a light beam, and a German chemist Kekule had

a somnolent vision of a snake biting its tail, which led to his formulation of the benzene ring structure (Miller, 2000; Shepard, 1978).

On the other hand, according to the dual coding theory proposed by Paivio (1978), mental images combined with verbalization can increase the effectiveness of mental imagery activation. Theoretically, it might also be assumed that there are logogens (i.e., information written in the perception code without verbal code equivalents), which have novelty characteristics and probably have an essential function in the creative process (Sadoski & Paivio, 2013). These assumptions require empirical confirmation in the area of creative tasks. In their experimental study, Helstrup and Anderson (1991) analyzed the effectiveness of mental imagery to construct novel patterns in visual synthesis tasks using visual or verbal strategies. Their findings suggest that visual strategies produce more mental discoveries than verbal strategies, yet the generated solutions' originality was not assessed in this study. Also, these most frequently cited anecdotal reports in the literature leave many questions unanswered. For example, we cannot determine whether vivid mental images precede the creative moment of discovery or whether creative realizations unfold in interaction with mental imagery (Intons-Peterson, 1993). To answer these questions, more processual-oriented studies are needed. One example of such an approach may utilize thinking-aloud protocols that could capture the nuances of using visual mental imagery to solve tasks that require creative performance (see Jankowska et al., 2018).

Another frequently cited hypothesis assumes that mental images engage affective and motivational systems more than verbal representations, especially when planning pleasant and rewarding or complex activities (e.g., Rawolle et al., 2017; Renner et al., 2019; Shepard, 1978), as well as when mental images are vivid and contain a rich amount of detail (Shepard & Cooper, 1982). In other words, mental images influence realization of the creative efforts' visualized effect by mobilizing individuals into action geared toward attaining it. Recent experiments (Rawolle et al., 2017) are concordant with this hypothesis. This study's authors compared an 'achievement condition' (relaxation with an achievement-related visionary mental image) with a 'no-vision control condition' (only relaxation). They showed that engaging in achievement-related visionary mental images resulted in higher achievement motive imagery and better mental concentration task performance. Other research showed that activating the mental imagery preceding divergent thinking tasks increases the fluency and flexibility of generated solutions to the problem (Soszyńska & Francuz, 2007). However, more research is needed, especially studies that will deepen the understanding of the mechanisms responsible for this relationship.

In conclusion, while most of the correlational results confirm the positive relationship between creativity and mental imagery, we still know very little about more nuanced relationships with specific cognitive processes involved in imagery (i.e., generation, maintenance, inspection, or transformation of images; see Kosslyn et al., 2010) and creativity-relevant constructs (e.g., creative abilities, creative personality, creativity-relevant motivation). Moreover, although the role of mental images in creativity has been theoretically supported, questions about the mechanisms underlying this relationship remain unanswered. We believe that the TCIA as a measure with appropriate psychometric properties and a strong theoretical basis can contribute to research development in the discussed directions.

1.2. The model of creative imagery abilities

Assessing individual differences in visual mental imagery, researchers use the term "imagery ability," which is defined as generation, control mental images, preference, and vividness of mental representations (McAvinue & Robertson, 2007). Following the same reasoning, we conceptualize creative (visual) imagery abilities as a quality of an individual's mental imagery and its creative function, which stems from engagement in the creative process. It is not a single undifferentiated general ability, but a complex and multidimensional set of abilities, similarly to mental imagery (see Kosslyn et al., 2010). In this regard, we define creative imagery abilities as an individual's ability to create, interpret, mentally transform, and represent visual images based on past observations, but also to transcend them. In the applied model of creative imagery abilities (see Dziedziewicz & Karwowski, 2015; Jankowska & Karwowski, 2015), we introduce three basic components, as depicted in Figure 1:

- **imagery vividness** –capability to evoke clear, lucid, and vivid visual images that are characterized by high detailedness,
- **imagery transformation** –capability to actively mentally manipulate and transform visual mental images,
- **imagery originality** – the capability to produce creative mental images characterized by uniqueness (newness).

Imagery fluency (i.e., the capability to generate visual mental images, including creative images) is the basis for creating mental images. Extending beyond imagery content, we assume that creative imagery abilities co-depend on affective, motivational, and other cognitive processes, as do visual imagery (Singh & Pande, 2017; for a review). This nuanced understanding of creative imagery abilities and its components was the basis for developing the TCIA measurement.

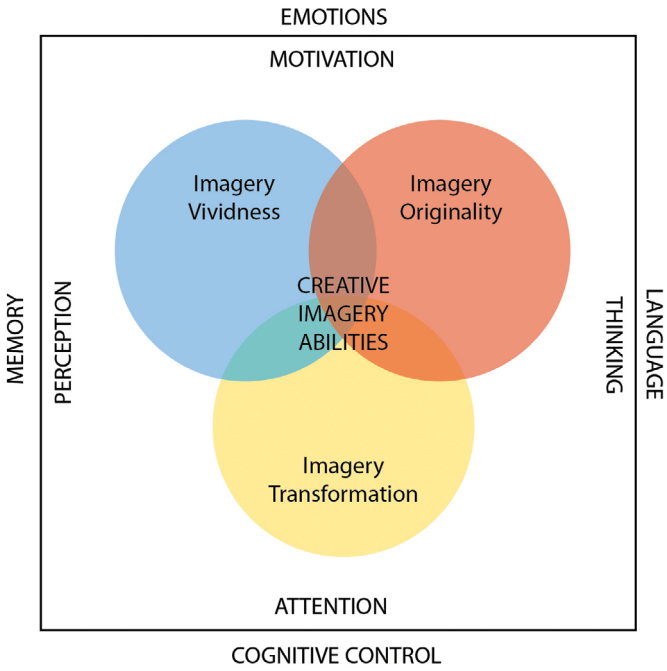


Figure 1. The applied model of creative imagery abilities

Imagery Fluency

Visual mental images are a function of the visual association cortex (e.g., D'Esposito et al., 1997). They can be generated in at least two ways. First, the mental image can be created directly from the actual perceptual experience. Based on some perceptual information such as a photo for example, people can create an image in the mind that can be successfully recreated in our imagination in the absence of related visual input. Second, an image can be created from previously stored information held in long-term memory (Pearson et al., 2013; Thompson et al., 2011). Image generation can result from both deliberate and involuntary recall processes. This path is often defined as echoes or reconstructions of actual perceptual experiences from their past, which may be more or less creative (Dziedziewicz & Karwowski, 2015). Thus, a distinction is made between mental imagery for reproductive images (i.e., evoking images for objects or events that are already known and based on the material of past observations) and transformed images, that evoke images for events that have previously not been perceived, including movements and transformations of previously seen objects (Finke et al., 1989; Jankowska & Karwowski, 2015). In this sense, the result of creating an image from stored information can be in form of creative visual images

that are significantly different from the view of reality that we keep in our memory (Finke, 1990).

In cognitive psychology and neuropsychological investigations, researchers consider image generation, image maintenance, image inspection, and image transformation as cognitive stages of mental imagery (see the computational theory of imagery, Kosslyn, 1994; Kosslyn et al., 2010). Imagery generation is the ability to create mental representations from immediate perceptual information without a perceived stimulus or stored information held in long-term memory. The generated mental image is subject to rapid decay and for this reason its maintenance is required to perform other imaging processes, such as inspection (exploring the created image to interpret it) and transformation (modification or alteration of the content of the generated mental image; see Pearson et al., 2013). In the model of imagery abilities that we propose, imagery fluency is defined as the ability to create visual mental images, and it is linked with the generativity (fertility) of imagination. The image fluency understood in this way includes volitional and deliberate image generation, image maintenance, and image inspection.

Imagery Vividness

Galton (1880) was probably the first researcher who observed "different degrees of vividness with which different persons have the faculty of recalling familiar scenes under the form of mental pictures, and the peculiarities of the mental visions of different persons" (p. 301). However, 20 years earlier Fechner described (more metaphysically than empirically) the question of differences in mental imagery across populations (see Karwowski & Jankowska, 2019). Currently, the vividness of visual mental imagery is likely the most commonly measured dimension of imagery ability in psychological research (Kihlstrom et al., 1991). It is considered the essence of visual imagery experience (McKelvie, 1995).

Vividness is an aspect of our conscious experience of imagery (Dean & Morris, 2003), related to the preservation of perceptual information and traditionally defined as a combination of clarity and liveliness of a mental image, as compared to the experience of actually seeing (D'Angiulli & Reeves, 2007; Marks, 1973; McAvinue & Robertson, 2007). These two defining criteria are equally as important (Marks, 2019). Clarity of mental images is characterized by the brightness of colors and sharpness of the outline and details, whereas liveliness reflects how dynamic, vigorous, and alive the image is (Marks, 1999, 2019). Recognizing these aspects of visual mental imagery, vividness has also been analyzed in terms of the imagery's realness (McKelvie, 1995). Our conceptualization of vividness of mental imagery

is based on two key elements of visual imagery experience, namely clarity and liveliness of a mental image, additionally taking into account detailedness— the amount of detail of created images (D'Angiulli & Reeves, 2007).

Transformations of mental images and their originality

Mental images are flexible and convertible, and thus they can be changed or modified in many ways. Research on image transformations mainly relates to spatial visualization ability, which refers to processing visual information about spatial relations between objects or their parts and to perform spatial transformations (e.g., Blajenkova et al., 2006; Kozhevnikov et al., 2002). For this reason, one of the most widely investigated ways of image transformations is mental rotation (i.e., the ability to rotate mental representations of two-dimensional and three-dimensional objects; see Shepard & Metzler, 1971; Tomasino & Gremese, 2016 for a review). The other two are image restructuring, in which the interpretation of a mental image is changed or modified in some way (Finke et al., 1989; Verstijnen et al., 1998), and mental synthesis, in which discrete parts of a mental image are transformed and manipulated to produce novel patterns, configurations, properties or allow new insights (Pearson et al., 2013). Active manipulation as well as transformation of mental images play a crucial role in creative thought (Finke et al., 1989), creative problem solving (Pearson, 2007), and discovery (Intons-Peterson, 1993). According to the creative cognition approach (Finke, 1990; Finke & Slayton, 1988; Finke et al., 1992), mental synthesis is a relevant and generative part of the creative process in terms of mental imagery, and for this reason, this imagery transformation mechanism is crucial for visual images generated through creative visualization.

Although not the first scholar who conducted experiments on mental synthesis, Finke (1990) certainly played a crucial role in linking mental synthesis to creativity (e.g., Finke & Slayton, 1988). In the context of creative cognition, creative mental synthesis (see the Genplore model of creativity; Finke et al., 1992) is considered a component of the generative process, which results in the generation of *preinventive mental structures* (i.e., ideas that precede the creation of a finished, creative product). According to this perspective, thanks to creative mental generation and exploration, individuals can generate original mental images to make creative (often unexpected) discoveries. These authors have demonstrated that simple patterns such as letters, numbers, and geometric forms can be combined in novel ways, leading to discovering creative patterns and symbols that result from such combinations.

Using the experimental paradigm of Creative Mental Synthesis, in the applied model of creative imagery abilities we conceptualize imagery transformation as capability to mentally manipulate and transform visual mental images to generate original mental representations. These transformations concern both conceptual and visual information of mental images. In this sense, creative mental images derive from creative synthesizing and reinterpretation of past experiences. However, we do not define originality of visual images by rarity of their occurrence, as in the assessment of divergent thinking (see e.g., Torrance Tests of Creative Thinking, TTCT; Torrance, 1974), but by uniqueness (novelty) of their content and characteristics, expressed by the extent to which this image differs from the perceptual information of real objects stored in memory.

When exploring imagery transformation, researchers have also investigated controllability (imagery control), otherwise known as the ease and accuracy with which an image can be manipulated mentally (e.g., Moran, 1993; Moreau et al., 2010; Pérez-Fabello et al., 2007; Richardson, 1969). When thinking about imagery control this way, it becomes evident that individual differences in the ability to control visual images might be related to the efficiency of image transformation processes. Hence, we theorize that active manipulation and transformation of visual mental images also require imagery control.

1.3. Test-based approaches in the assessment of creative imagery abilities

Historically, assessment of individual differences in mental imagery ability has been started using self-report measures of vividness; an attempt to extend Galton's study (see Bett's Questionnaire upon Mental Imagery; Betts, 1909). In 1922, Simpson presented one of the first test-based approaches to measuring creative imagery abilities (see Markey, 1935), namely the Test for Creative Imagination (Visual). In the test booklet, four small dots representing four corners of a square became a stimulus for creating drawings. Five such 'squares' were present on each of the ten sheets. Individuals were required to draw designs by adding 2 more dots and any lines they desired. Drawings were numbered in order of performance and notations were made as to whether the design was thought out or imagined by chance. The measure of creative imagination became the indicator of creative changes; it should be considered the prototype of imagery transformation ability. This measure was scored based on the product of the number of all drawings produced in the test and the number of changes between the drawings (i.e., the number of transition moments between different categories). Therefore,

the first definition of imagery transformation ability was positioned within the area of meanings and their interpretations, just like the flexibility of divergent thinking.

Early researchers on divergent thinking saw creative imagery abilities as a subset of the broader construct of creativity. For this reason, the assessment criteria of these so-called "imagination tests" were similar to the assessment criteria of the divergent thinking tests, as exemplified by the well-known TTCT (Torrance, 1974). Originally, this battery based on Guilford's (1956) four divergent thinking factors: (1) fluency—the total number of interpretable, meaningful, and relevant ideas, (2) flexibility—the number of conceptual categories from which ideas were generated, (3) originality—statistical rarity of the responses, and (4) elaboration—the amount of detail present in the responses. In the third edition of the TTCT from 1984 (Ball & Torrance, 1984), Torrance designed a new scoring procedure, the so-called 'streamlined scoring system,' which includes 13 criterion-referenced scores, of which four criteria directly related to the creative imagery abilities, namely richness of imagery, colorful imagery, unusual visualization, and fantasy (Torrance et al., 1992). Assessment of the richness of images in TTCT is based on the score of diversity, brightness, vitality, and intensity of drawings. Unusual visualization concerns seeing things in new, original ways. Colorfulness is defined by its appeal to different senses, including the sense of sight. Other descriptors might be unreal, spooky, and fantastic, such as a ghost, a devil, fantasy figures in literature, etc. Likewise, fantasy scoring notes a person's use of fantasy imagery to respond to the test tasks, using fantasy analogies in drawings and titles of characters from fables and myths, science fiction, and other fantasy literature for instance (Torrance et al., 1992). Some researchers indicate that the TTCT is not just a measure of divergent thinking or outbox (creative) imagination, but a comprehensive measure of creative potential (see e.g., Kim, 2017). Nevertheless, this post-Guilfordian approach in creativity assessment exerted considerable influence on testing creative imagery abilities. Many consecutively developed test measures had the assessment criteria nearly identical with those in typical divergent thinking tests. For example, flexibility, elaboration, and originality in the Visual Imagination Test (McHenry & Shouksmith, 1970); flexibility and originality in the Creative Imagination Test (Schubert, 1973); or flexibility, elaboration, originality, asymmetry, and abstraction in the first version of Franck Drawing Completion Test (Anastasi & Schaefer, 1971; Schaefer, 1970).

Like the authors of Test of Creative Imagination, some scholars directly mentioned that developing their measure of creative imagery abilities 'drew upon the content and approach of creative thinking tests' (Ren et al., 2012 p. 2046). In this instrument's figural task, individuals are asked to draw some

interesting objects or pictures using lines or forms in each of the 10 frames and give titles to their drawings. In the verbal part, individuals are asked to write down as many different things as they can imagine happening in a certain scene: 'This is a story. Once upon a time, there were three penguins sitting at a table with a bowl of soup in front of them. Write down as many different things as you can imagine happening in this story' (Ren et al., 2012, p. 2046). According to the authors, this test measures four creative imagination dimensions: richness, flexibility, profundity, and originality. Meanwhile, for example, richness, defined as 'scope' of creative imagination,' is operationalized exactly as fluency in divergent thinking tests, or the number of suitable responses.

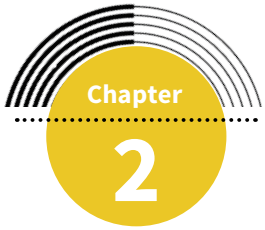
As mentioned, the assessment of creative imagery abilities is usually conceptually included in the measurement of creative thinking (or, more broadly, creativity). However, the name of the test, sometimes also its tasks, indicates the measurement of mental imagery abilities, but the evaluation criteria are typical for a divergent thinking test. For example, The Spanish Test de Abreacción para Evaluar la Creatividad by De la Tore (TAEC; in English: The Abreaction Test to Evaluate Creativity) has a similar structure to the FDCT. The test's task is to creatively use 12 unfinished, simple figures as a basis for drawings. This measure provides scores for 11 'creativity factors,' including three on creative imagery abilities, such as fantasy (the degree to which the image moves away from everyday experience, i.e., the objective novelty of the images created), imaginative scope (the degree to which the figure is a secondary element of the image), and richness of imagery (the degree of colorfulness, perspective, and representation of living or moving beings) (Garaigordobil & Pérez, 2002). On the other hand, another but also original Spanish-language measure, named Prueba de Imagination Creativa (PIC; in English: the Creativity Imagination Test), despite its name, evaluates verbal and graphic creativity considering the most relevant variables related to divergent thinking. This measure consists of 4 tasks (3 verbal and one figural). In the first verbal task, individuals look at a drawing and indicate all the possible things that might be happening in the scene presented. The second activity is a typical uses divergent thinking task—adaptation of Guilford's Test, called 'Uses for a Brick.' An individuals' task is to generate various uses for a rubber tube. The third task evaluates fantasy and imagination by presenting individuals with an unusual or imaginary situation and asking them to judge what might happen in this situation; for example, in the PIC-N (for children aged between 8 and 12), the situation is as follows: 'Imagine what would happen if all of a sudden every squirrel turned into a dinosaur.' In the figural task, the individuals have to make an original drawing from a few lines given. Although one of these tasks directly refers

to creative imagery abilities, this instrument, like the divergent thinking tests, measures fluency, flexibility, originality (in relation to the infrequency of occurrence of the category the response belongs to), and elaboration (Artola et al., 2004; Artola et al., 2008; Barraca et al., 2010).

Some instruments that measure creative imagery abilities have been modified to increase their validity. An example of such a test is the Franck Drawing Completion Test (Franck & Rosen, 1949), adapted by Barron (1958). Initially, referring to the construct of originality in Guliford's approach, the author proposed a seven-point originality scale assessing mental images generated based on 12 initial figures. In this version, the test was incorporated into the classic research of Torrance and team. At that time, the drawings created in this test were assessed on five scales: originality, abstraction, asymmetry, elaboration, and flexibility. As in divergent production tests, the test was limited in time to 10 minutes (Anastasi & Schaefer, 1971; Schaefer, 1970). Currently, the test booklet is composed of 12 initial figures, placed in separate 'windows.' The participants' task is to complete the initial figures, using imagination, so that they take the form of interesting drawings. There is no time limit to complete this task. The drawings are assessed on a three-point scale (0–1–2), which combines imagery vividness and originality ratings: no points are given for a conventional form, one point is given for quite a complex form, which partially stands out in its originality and unconventional approach, and two points are given for drawings with a rich, free, and unconventional form, which are not strictly based on the initial figure (e.g., Dziedziewicz et al., 2014; Dziedziewicz et al., 2013).

However, tests that measure the creative imagery abilities are not always more or less 'copies' of divergent thinking tasks. In the Test of Creative Imagination developed by Kujawski participants are requested to make schematic drawings of objects (concepts) that do not exist that should exist by using all or some of the simple figures given – four dots, four line segments, four semicircles, and four wavy lines (for examples, refer to Karwowski, 2009). In this sense, this activity is similar to the Creative Mental Synthesis task from Finke's experimental research (Finke, 1990). The creative mental images generated in this tool and shown in the drawing are assessed based on three scales: (a) Imaginative Fluency, (b) Elaboration, transformativeness, and visualization, as well as (c) Originality. Imaginative fluency is the number of created drawings qualified following the assumptions of the test. Elaboration, transformativeness, and visualization scales measure transformative capabilities as well as elaboration and extent of mental images. The originality scale has a subjective character and measures creative mental images (Karwowski, 2008).

Given some problematic issues associated with the measurement of creative imagery abilities, we decided to develop a new test. Drawing on the long tradition of research on visual and creative imagery abilities, we constructed the TCIA. Assumptions and evidence for validity and reliability are presented in the next sections of this book.



Administration practices for assessment using the TCIA

The TCIA administration practices discussed in this chapter are based on accepted codes and standards for educational and psychological testing (Standards for educational and psychological testing, 2014), the latest findings of creativity researchers, and the authors' experience.

2.1. Procedures before testing

To ensure that the TCIA produces results that accurately assess creative imagery abilities, it is recommended that the test's administrators follow the procedures below.

Maintaining Assessment Integrity

The test administrators should only use original testing materials. No adaptations, translations, modifications, or special versions may be made without permission from authors.

Preparing Test Administrators for Testing

Before administrating the test, the administrators should carefully read and examine the directions and any other materials provided for testing to become familiar with all aspects of the measurement. It is also recommended to make sure that sufficient testing materials are available for distribution to examinees during testing. Importantly, no special accessories are required for giving the test.

Instruction for printing the test booklet

The test booklet must be printed in a double-sided layout in A4 (8.27" x 11.69"). The printed booklet must be folded in half and stapled in the center. These materials must be printed in good quality black-and-white printing.

Scheduling Testing Session

The testing session should be scheduled at a time that encourages the best individual's performance. For example, a measurement session is not recommended during lunchtime or immediately after holidays or exciting events. Test administrators also should plan for enough time to complete the test. Although the TCIA is a time-unlimited test, allowing individuals to respond to every item without a time limit, this test usually requires approximately 20-25 minutes to administer (for the standard version of the test).

Selecting a Testing Environment

The testing room should have sufficient light and ventilation and be free from noise. The TCIA may be applied in individual and group settings. In group settings, the test should be administered to classroom-sized groups of about twenty-five individuals. In larger groups, the test administrator should have assistants. All participants should be seated in an arrangement that prevents them from seeing the work of other people.

2.2. Practices during testing session

Testing Materials

The test administrator is required to supply test booklets, pencils, or pens that individuals need to complete the assessment. Sections of the test that ask for personal data should be completed before test instructions are provided.

Test booklet

A standard version of the TCIA test booklet is in A3 format and consists of seven tasks. The short version of the TCIA contains four tasks. In each task, a simple graphic sign, called the initial figure, is used to generate, interpret, and transform created visual mental images.

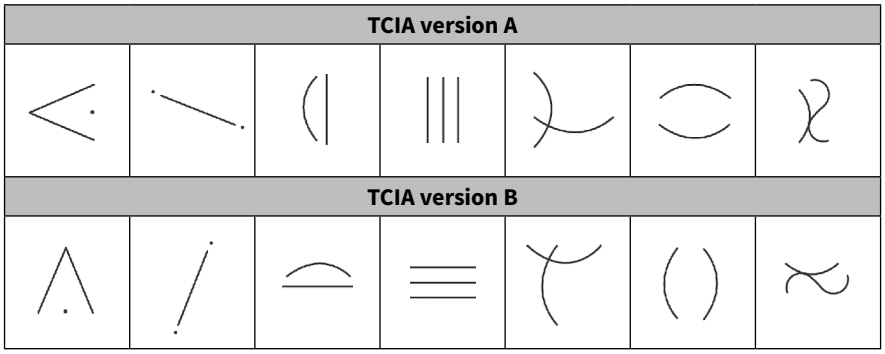


Figure 2. The initial figures from TCIA tasks

The first stage of solving each task has an exploratory character. The participant is supposed to write as many visual mental images generated based on the initial figure. Next, they select one of the images given and, on its basis, make a drawing and provide a brief description. The instruction stresses the possibility of elaborating and changing the selected mental image and adding in mind any elements to it in such a way as to create an original idea.

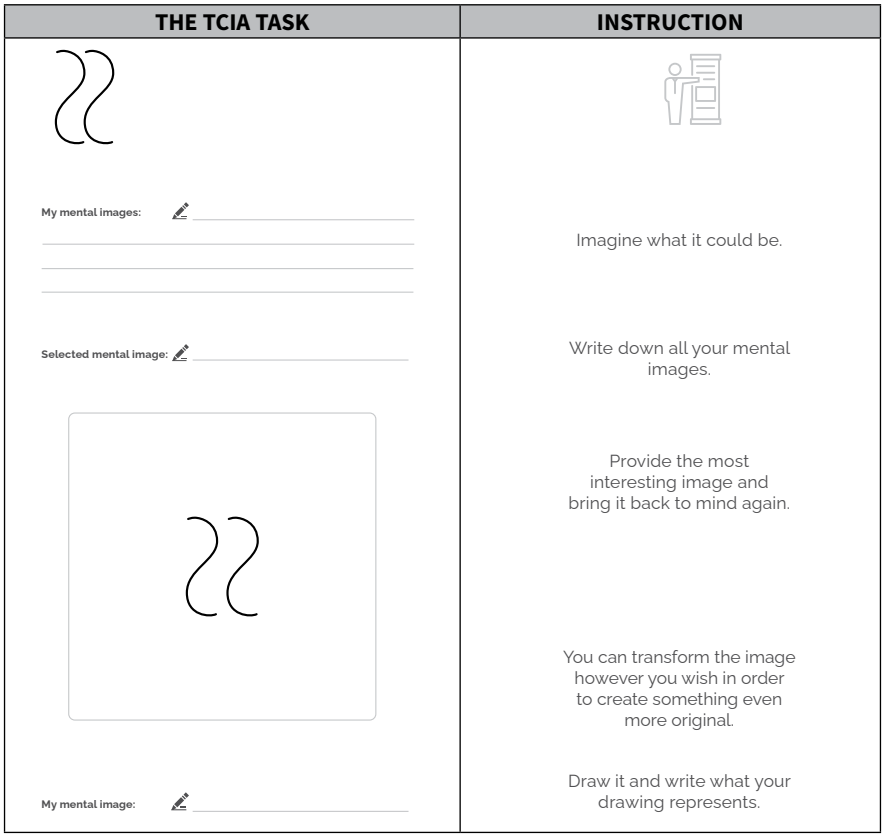


Figure 3. Example TCIA task

Reading Directions

The test administrator should read the directions precisely as written during testing, using a natural tone of voice and manner while enunciating clearly. The directions should not be repeated unless a mistake is made in the initial reading or the directions for administering the test say to do so. The TCIA may be applied in individual and group settings. When everyone is ready, the testing individual should read or say the following instructions (see Figure 4).

GENERAL INSTRUCTION
"There are seven (four for the short version of the TCIA, i.e., TCIA-S) tasks in your test booklet. Each task contains an initial figure. Please, take a close look at it and imagine what it could be. Write down all mental images that come to your mind. The more of them you imagine, the better. Then take the image you like most and bring it back to your mind again. Based on this, attempt to imagine something even more original and extraordinary. You have complete freedom of transforming the image and add new elements to it. Finally, draw your mental image as accurately as possible and write down what your drawing represents. Inside the booklet, you will see an example of how the tasks should be completed. Read it carefully. Write down the solutions with a pen or pencil. Remember that what counts is an interesting idea, not how neatly you draw. Use your imagination. Good luck!"

Figure 4. General instruction for the TCIA and TCIA-S

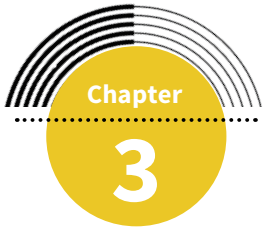
The test administrator may attempt to clarify any directions that students do not understand and repeat the instructions, if necessary. For questions about the type, the content of drawings, the way of making them, for example allowing the participants to draw outside of the drawing frame, manipulating the sheet of paper, the test administrator should respond pointing to freedom of interpretation: *You can draw whatever you want! / You can draw however you want!*

Observing Testing

While administering the assessment, the test administrator should be visibly engaged in the testing by observing all aspects of the process. When after a long while after providing the instruction, a sample person has trouble understanding what to do, or has not started completing the test for example, the test administrator should try to again quietly explain the instruction, but must not assist this individual in creating ideas in the test.

Collecting Testing Materials

To maintain security of the testing materials, test administrators should immediately collect all of the test booklets from the individuals at the end of a test session.



Scoring and reporting options

Drawings and descriptions of mental imagery made in the TCIA are assessed on three scales based on the conjunctional model of creative imaging ability, namely, the vividness scale, the originality scale, and the transformativeness scale (Dziedziewicz & Karwowski, 2015). There are seven tasks in the test (four in the short version of TCIA). Following the assessment criteria, it is possible to score 0, 1, or 2 points on each scale for a single task. Results on the scales are calculated by summing points scored on consecutive tasks. The overall score is a sum of points obtained on individual scales. A maximum score on the test is 42 (14 for each scale).

3.1. Scoring of imagery fluency

The imagination generativity score, defined as imaginative fluency, determines the number of created mental images. The following images (ideas) are qualified for this type of assessment:

- they are not repetitions;
- they are not self-plagiarism, namely, when we do not see repetitive ideas, such as a volleyball ball, basketball ball, rugby ball, etc.;
- they are not synonyms, such as an auto, car;
- they are not diminutive or augmentative, for example, dog; doggie;
- they are not translations into a different language, for example, "eye, oko (in Polish)" of previously provided images.

In the above situations, we only count the idea that was provided first. Ideas crossed off by the test-taker are not considered even if they make sense. The raw result is calculated by summing up the number of images created by the test's requirements.

3.2. Scoring for imagery vividness

The imagery vividness scale of the TCIA measures the degree of visualization and elaboration of mental images generated. The table below contains detailed assessment criteria on this scale.

Table 1

Assessment criteria on the imagery vividness scale of the TCIA

IMAGERY VIVIDNESS	Assessment criteria
Low level (0 points)	• The initial figure was not completed, but it was interpreted (i.e., it was titled). • Continuation, an extension of the lines of the initial figure with a continuous or dotted/dashed line. • Simple closing of the initial figure. • Adding to the unchanged but interpreted initial figure a small drawing element that has a new quality to it. • Slight completion of the initial figure – adding an individual line, a point, or a simple graphic element.
Moderate level (1 point)	• Adding to the unchanged but interpreted initial figure a larger drawing element/drawing elements that have the new quality to it/them. • Simple, often schematic completion of the initial figure. • Simple, often schematic completion of the initial figure with an added, relatively independent object/objects. • Simple, often schematic presentation of abstract content (e.g., definitions), symbolic content (e.g., letters, mathematical symbols), metaphorical, or philosophical content (e.g., poetic comparisons).
High level (2 points)	• Sophisticated completion of the initial figure, rich in detail. • Sophisticated completion of the initial figure, rich in detail, with an added relatively independent object / objects. • Presentation of a short dialogue story, a drawn story, or an action paused "in a frame." • Evident animation of the drawing, portrayal of dynamics, motion. • Complex, rich in detail presentation of abstract content (e.g., definitions), symbolic content (e.g., letters, mathematical symbols), metaphorical, or philosophical content (e.g., poetic comparisons).
	Note. Drawings that scored 0 or 1 point but move outside of the frame obtain an extra point on this scale.

3.3. Scoring for originality of images

The imagery originality scale of the TCIA measures novelty of the mental images generated. The table below contains detailed assessment criteria on this scale.

Table 2

Assessment criteria on the imagery originality scale of the TCIA

IMAGE ORIGINALITY	Assessment criteria
Low level (0 points)	• Presentation of generally known objects (things, plants, animals, people, places) with unaltered structure, functions, properties, and typical activities, processes, states, and events. • Presentation of known symbolic content (e.g., letters, mathematical symbols). • Presentation of known literary, film, computer-game characters, or public persons. • Presentation of objects as well as activities, processes, states, and events that are generally considered nonexistent.
Moderate level (1 point)	• Individual, simple modifications of structure, functions, and properties of generally known objects (things, plants, animals, people, places) and typical activities, processes, states, and events. • Modification of known symbolic content (e.g., letters, mathematical symbols). • Modification of an image, character traits, and/or way of being of known literary, film, computer-game characters or public persons. • Modifications of objects as well as activities, processes, states, and events that are generally considered nonexistent or visualization of an oxymoron. • Presentation of abstract content (e.g., general ideas or definition, metaphoric and philosophical content, such as poetic comparisons) with the use of close associations. • Presentation of the products of culture (titles and content of literary works, newspapers and periodicals, musical tunes, games, works of art), historical events as well as geographical names with the use of close associations. • Presentation of known sayings, advertising slogans, and multi-word expressions with the use of close associations.

IMAGE ORIGINALITY	Assessment criteria
High level (2 points)	• Complex modification of structure, functions, and properties of generally known objects (things, plants, animals, people, places) and typical activities, processes, states, and events that significantly depart from reality. • Presentation of new objects (things, plants, animals, people, places) as well as untypical activities, processes, states, and events. • Presentation of new symbols and surprising and untypical presentation of abstract content (e.g., general ideas, metaphoric and philosophical content, such as poetic comparisons) with the use of distant associations. • Surprising and untypical presentation of the products of culture (e.g., titles and content of literary works, newspapers and periodicals, musical tunes, games, works of art), historical events as well as geographical names with the use of distant associations. • Surprising and untypical presentation of known sayings, advertising slogans, and multi-word expressions using distant associations and/or complex analogies. • Presentation of new sayings, comparisons, and neologisms. • Witty and comic presentation of content that indicates high level of a sense of humor.
	Note. Drawings that scored 0 or 1 point but were created using sheet modification of at least 45 degrees obtain an extra point on this scale.

3.4. Scoring for imagery transformation

The imagery transformation scale measures the level of ability to modify the mental images generated. Assessment of TCIA products also makes it possible to analyze basic operations of transforming visual images, such as multiplication or increasing the numbers of a particular element of an image, hyperbolization or exaggerated distortion of proportions with the use, for instance, of exposing a certain aspect of the image, or amplification, or adding detail to the image (see Chapter 6). Table 3 contains detailed criteria for the assessment on this scale.

Table 3

Assessment criteria on the imagery transformation scale of the TCIA

IMAGERY TRANSFORMATION	Assessment criteria
Low level (0 points)	• Precise reproduction of the initial object. • Simple completion of the initial object or its simplification. • Multiplication of the initial object.
Moderate level (1 point)	• Completion of the initial object (reintegration) and its simple modification (e.g., enriching, detailing the image). • Reproduction, completion or multiplication of the initial object and adding to it a relatively independent object/objects. • A simple metamorphosis (transformation into something completely different) of the initial object (e.g., a change of one thing into a different thing, a change of a living organism into another living organism).
High level (2 points)	• Complex modification of the initial object – adding detail to many of its aspects. • Modification of the initial object (simple or complex) and adding to it a relatively independent object/objects. • Modification indicating a surprising combination of 2 or more initial objects belonging to different domains. • Clear dynamization of the initial object, its completion or modification. • Complex metamorphosis (transformation into something completely different) of the initial object often with philosophical, metaphorical, abstract dimension (e.g., change of an object into a general concept).
	Note. Transformations may take the form of figural transformation (transformation of images) and/or semantic transformation (transformations of words and their meanings).

3.5. The total scoring and reporting options

Summarizing the results, we can use the total score in the TCIA (i.e., the raw sum of points obtained on three basic scales: Imagery Vividness, Imagery Originality, and Imagery Transformation). Additionally, the analysis may also cover the index of imagery generativity – results in the Imagery Fluency scale.

To establish the structure (type) of imagery abilities characteristic for a particular person, TCIA scores can be subjected to profile analysis. The profile analysis to assessing strengths and weaknesses on ability tests has been repeatedly applied to many types of psychological tests, including cognitive ability tests (e.g., Rizza et al., 2001). In this ipsative way, the typological approach in the TCIA focuses on the relationship between three crucial creative imagery abilities, namely, vividness, transformation

of mental images, and their originality. A typological approach results in at least four main types of creative imagery abilities: (1) creative imagery abilities (high vividness of imagery, high originality, and high imagery transformation), (2) pro-creative imagery abilities (high originality, high imagery transformation, and low vividness), (3) passive imagery abilities (high imagery vividness, high originality, and low imagery transformation), and (4) vivid imagery abilities (high vividness, high imagery transformation, and low originality of mental images).

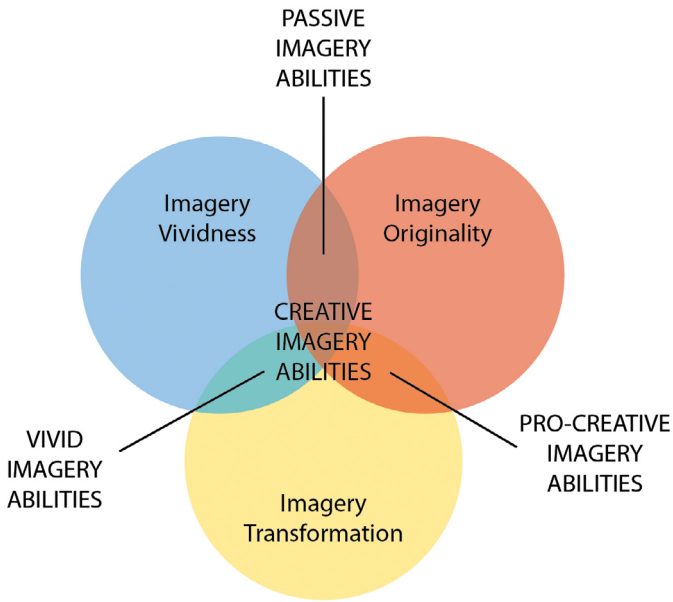


Figure 5. Types of creative imagery abilities

The typological approach of creative imagery abilities can be useful in predicting further development of imagery abilities and deciding on the direction of interventions in a concordant profile with the profile of individual differences. For example, in vivid imagery abilities, the imagery generated is expressive but imitative—it is almost an exact reflection of previously perceived and memorized images. In cases of this kind, people should be inspired to creatively combine, non-typically link, and modify the generated images to give them novelty features. Individuals with pro-creative imagery abilities should be encouraged to create expressive imagery, add detail, and make it dynamic. By contrast, in the case of a passive imagery abilities profile, stimulatory interventions should focus on developing imagery transformation in unconstrained and miscellaneous ways.

Psychometric overview of the standard form of TCIA

In eight studies, we tested criterion validity, juxtaposing TCIA results with other measures of mental imagery and creative abilities (Studies 1–4) and the discriminant validity of the TCIA (Study 5), verifying whether and to what extent TCIA dimensions are related to intelligence and school achievement measured with the use of standardized tests as well as grade point average. We also show measurement invariance of the TCIA among women and men and the relations between age and creative imagery abilities. Using aggregated data, we tested the construct validity of the TCIA by performing confirmatory factor analysis.

The other objective of our analyses was to test reliability of the TCIA. In Study 6, we demonstrate consistency of trained judges' evaluations on the TCIA based on this manual. Study 7 is devoted to the analysis of test-retest reliability, and in Study 8, we present test-retest relations, with version B of the TCIA used apart from version A. We conclude the reliability analyses by reaching for aggregated data from all the studies presented in this book, and we present internal consistency of TCIA scales assessed using a more traditional method (Cronbach's α) as well as composite reliability (H; Hancock & Mueller, 2001), which is the outcome of confirmatory factor analysis. Table 4 provides an overview of all studies with descriptive statistics[1].

1 This chapter is partially reprinted from Jankowska, D. M., & Karwowski, M. (2015). Measuring creative imagery abilities. *Frontiers in Psychology.* https://doi.org/10.3389/fpsyg.2015.01591

Table 4
Summary of studies presented in this chapter, together with sample sizes, instruments and descriptive statistics

Goal	Study	N	Method used	Dimension assessed by other instruments	Vivid *M* (*SD*)	Orig. *M* (*SD*)	Transf. *M* (*SD*)
Criterion validity	1	100	Vividness of Visual Imagery Questionnaire (*M* = 119.87, *SD* = 19.46)	Vividness of Visual Imagery	7.87 (2.13)	2.25 (2.02)	6.29 (3.92)
	2	57	Franck Drawing Completion Test (*M* = 9.60, *SD* = 3.48)	Creative imagination	7.20 (2.07)	1.95 (1.48)	4.38 (5.41)
			Generating Imaginary Animals (*M* = 0.85, *SD* = 2.19)	Creative cognition			
	3	226	Verbal Alternate Uses Task, scored for: Fluency (*M* = 10.41, *SD* = 7.70) Flexibility (*M* = 6.62, *SD* = 3.70) Originality (*M* = 103.29, *SD* = 76.32)	Divergent Thinking	6.45 (2.51)	1.87 (2.03)	3.55 (3.19)
	4	741	Torrance Tests of Creative Thinking – figural test, scored for: Fluency (*M* = 8.53, *SD* = 7.76) Flexibility (*M* = 3.19, *SD* = 3.43) Originality (*M* = 43.63, *SD* = 50.16)	Divergent Thinking	6.89 (2.20)	1.75 (1.93)	5.17 (3.92)

Goal	Study	N	Method used	Dimension assessed by other instruments	Vivid *M* (*SD*)	Orig. *M* (*SD*)	Transf. *M* (*SD*)
Discriminant Validity	5	230	Raven's Progressive Matrices ($M = 100$, $SD = 15$)	Intelligence	6.22 (1.97)	1.48 (1.43)	3.22 (2.72)
			Test of School Achievement ($M = 100$, $SD = 15$)	School Achievement			
			Grade Point Average ($M = 4.19$, $SD = 0.81$)				
Interjudge Reliability	6	4 judges	Version A of TCIA	-	4 judges: 6.24 (1.76) 7.05 (2.06) 6.61 (2.17) 7.20 (2.30)	4 judges: 2.21 (1.41) 1.57 (1.54) 2.09 (1.71) 2.13 (1.69)	4 judges: 4.39 (3.21) 4.44 (3.89) 4.51 (3.24) 3.48 (2.52)
Test-retest reliability	7	86	Version A of TCIA used twice with 3 weeks interval	-	Test: 6.51 (2.18) Retest: 7.05 (1.99)	Test: 1.50 (1.74) Retest: 1.98 (1.90)	Test: 5.35 (3.53) Retest: 5.67 (3.35)
Correlation between parallel versions of TCIA	8	39	Version A and B of the TCIA used with 5 weeks interval	-	Ver. A: 7.20 (2.07) Ver. B: 7.13 (1.62)	Ver. A: 1.95 (1.48) Ver. B: 1.75 (1.30)	Ver. A: 4.38 (3.41) Ver. B: 4.08 (3.20)

Method

Participants

Study 1. 100 students (all of them female) aged 19–40 years (M = 22.73, SD = 4.71) participated in Study 1. They were students of social sciences at several universities in a big city in central Poland.

Study 2. 57 female students of education aged 20–24 years (M = 20.85, SD = 0.59) participated in Study 2. They studied at a university of education in Warsaw, the capital of Poland.

Study 3. 226 individuals (171 women) aged 11–30 years (M = 13.10, SD = 6.04) participated in Study 3. They were students of elementary, middle, and high schools as well as university students from all over Poland.

Study 4. 741 individuals (425 women) aged 15–25 years (M = 18.30, SD = 3.04) participated in Study 5. They were students of middle and high schools as well as university students from all over Poland.

Measures and Procedure

In all studies, version A of the TCIA was used. Apart from that we used different questionnaires and tests measuring characteristics directly related to creative imagination or creative abilities. In each study, the instruments were presented in random order. The instruments used in particular studies are listed below.

Study 1. Perceived efficacy in using visual imagination was measured by the Vividness of Visual Imagery Questionnaire (VIVIQ) (Marks, 1973, 1995). The questionnaire consists of 32 items that measure the degree to which the participant believes themselves to be capable of using imagination efficiently. An example item is: "In answering items 1 to 4, think of some relative or a friend whom you see frequently (but who is not with you at present) and consider the picture that comes before your mind's eye. (1) The exact contour of the face, head, shoulders, and body." Reliability of the VIVIQ was high (α = .90).

Study 2. Creative imagination was measured using the Franck Drawing Completion Test (FDCT), successfully applied in earlier research on creativity (Dziedziewicz et al., 2013, 2014). FDCT is composed of 12 figures, placed in separate "windows." The participants' task is to complete the initial figures to take the form of interesting drawings. There is no limit on the time taken to complete the task. The test is assessed on a three-point scale (0-1-2):

no points are given for a conventional form, one point is given for a fairly complex form that partially stands out in its originality and unconventional approach, and two points are given for drawings with a rich, free, and unconventional form that are not strictly based on the initial symbol. A maximum score on the test is 24 points. Reliability of the FDCT was high (α = .83).

In the second study, we also used a task that is a classic one in experiments concerning creative imagination. It consists of drawing animals "from a different planet" (Generating Imaginary Animals; Ward, 1994). The participants were asked to list 20 animals that came to their mind (Listing Real Earth Animals). Next, they were to imagine a planet, completely different from Earth, on which various plant and animal species existed. Based on the imagery generated, they made a detailed drawing of an imaginary creature as seen from the front and the side, they gave it a name, and named all the parts of its body. The images were assessed using an index applied in earlier studies (Ward, 1994; Ward & Sifonis, 1997; Ward et al., 2002)—the presence of untypical sense organs (creature attributes).

Study 3. In Study 4, we used the verbal Alternate Uses Task inspired by Minnesota Tests of Creative Thinking (Torrance, 1962). The task was to develop unusual uses for a can within a specified time (3 min). This task was scored in terms of fluency, flexibility, and originality of thinking.

Study 4. The circle test from the Torrance Tests of Creative Thinking (TTCT; Torrance, 1974) was used to measure divergent thinking (DT). The test consists of 20 empty circles arranged in 5 rows of 4 on the test sheet. The task is to create interesting drawings in them, trying to use all the circles within 10 min. The total number of circles used minus the number used for recurring themes gives an index of fluency (range: 0 to 20 points). This index is generally considered to be absolutely reliable, because it relies on mechanical counting. Flexibility is indexed by the number of categories of themes considered. Originality is indexed by the inverse of the frequency of occurrence of each concept in the entire sample (unique ideas score highest). The total originality score is the sum of originality scores for each circle response generated by the participant (see Silvia et al., 2008 for the advantages and limitations of different originality scoring methods). The participants were informed about the study and could withdraw at any time. All tests were scored by 3 research assistants (graduate students of psychology and education), trained in creativity tests scoring.

Results and Discussion

Correlations between the three scales of TCIA and the dimensions of creative imagery abilities and creative thinking are presented in Table 5.

Table 5

Criterion Validity Analysis – Correlations of TCIA With VVIQ, FDCT, and Creativity Tests

	Imagery Vividness	Imagery Originality	Imagery Transformation
Study 1 (*N* = 100)			
VIVIQ	.42*** [.24,.57]	.36*** [.18,.52]	.31** [.12,.48]
Study 2 (*N* = 57)			
Generating Imaginary Animals	.02 [-.24,.28]	.45*** [.21,.64]	.32* [.06,.54]
FDCT	.48*** [.25,.66]	.30* [.04,.52]	.18 [-.08,.42]
Study 3 (*N* = 226)			
Verbal fluency	.13* [.00,.26]	.26*** [.13,.38]	.13* [.00,.26]
Verbal flexibility	.19** [.06,.31]	.26*** [.13,.38]	.15* [.02,.28]
Verbal originality	.14* [.01,.27]	.26*** [.13,.38]	.13* [.00,.26]
Study 4 (*N* = 741)			
Figural fluency	.14*** [.07,.21]	.05 [-.02,.12]	.07^ [.00,.14]
Figural flexibility	.14*** [.07,.21]	-.04 [-.11,.03]	.02 [-.05,.09]
Figural originality	.16*** [.09,.23]	.01 [-.06,.08]	.04 [.-.03,.11]

Note. 95% confidence intervals are provided in parentheses.
^p < .10; *p < .05; **p < .01; ***p < .001

In the case of measures of creative imagery abilities (VIVIQ, FDCT, and Generating Imaginary Animals), seven out of nine correlation coefficients turned out to be statistically significant, with a generally substantial effect (median r = .32). Visual mental imagery measured using VIVIQ turned out to correlate fairly consistently and with similar strength with all the three criteria—most strongly with vividness (r = .42) and slightly less strongly with originality (r = .36) and image transformation (r = .31). We obtained quite a similar picture of the relationship in the case of FDCT—the scores in this test were mainly linked with vividness (r = .48), less strongly with originality (r = .30), and most weakly (as well as not significantly) with the transformation of images (r = .18). By contrast, the number of untypical sense organs in the Generating Imaginary Animals task was independent of the vividness of images (r = .02), but strongly related to originality (r = .45) and image transformation (r = .32).

Interestingly, the measures of creative imagery abilities were almost completely unrelated to the classic scoring criteria of creative thinking tests (fluency, flexibility, originality) in the case of the figural test (only fluency was weakly related to vividness, r = .13). As regards the verbal test, the scores were most consistently related to imagery originality, which was related

in an identical way (r = .26) to verbal fluency, flexibility, and originality. Relations between vividness and imagery transformation and the measures of creative abilities were weaker, though significant (.13 r 0.18).

Results from Studies 1–4 support criterion validity of the TCIA. Stronger relationships between the results obtained in the new test and established measures of creative imagery abilities (VIVIQ, FDCT, Generating Imaginary Animals), compared to classic measures of creative abilities, support the statement that, measuring characteristics important for creativity, the TCIA focuses to a greater extent on mental imagery than on the characteristics of thinking. Admittedly, correlations between vividness, originality, and imagery transformation and measurements using other instruments developed for measuring creative imagery abilities are not spectacularly high (the highest being r = .48 between FDCT and the vividness of images), but they are consistent enough to be treated as confirming criterion validity of the new measure. What is essential, the obtained profile of various relations between the scales of the TCIA and other measures also constitutes an argument supporting the new instrument's validity. It is easy to notice that the attempts made so far to study creative imagery abilities have focused only on its selected elements. For example, the FDCT (Dziedziewicz et al., 2013) measures vividness and, to a particular (smaller) extent, originality of mental images, but it does not measure image transformation and modification. The task of Generating Imaginary Animals (Ward, 1994; Ward & Sifonis, 1997; Ward et al., 2002) reveals much about originality and next to nothing about vividness. The new test makes it possible to systematically analyze all three components necessary for the functioning of creative imagery abilities without duplicating the measurement performed using any previous instruments and remaining relatively independent of creative thinking.

4.2. Discriminant validity

The next step in our analyses was to determine discriminant validity of the TCIA. For that purpose, we used general intellectual ability (intelligence) measures and school achievement in different areas. Previous studies and meta-analyses (Gerwig et al., 2021; Karwowski & Gralewski, 2013; Kim, 2005) show that the relations between creativity and intelligence are not particularly strong (however, see Silvia, 2015, for an alternative position), and neither are the relations between creative abilities and school achievement (Gajda et al., 2017; Gralewski & Karwowski, 2012). This is why we devoted Study 6 to verifying the new test's discriminant validity, correlating the results obtained in it with intelligence and school achievement.

Method

Participants

Study 5. Elementary school students participated in Study 5. The sample was composed of 110 boys and 120 girls (total $N = 230$), whose mean age was 13.88 years ($SD = 0.36$). The participants were fifth-grade students from elementary schools across Poland.

Measures and Procedure

Apart from the TCIA, all participants solved an intelligence test and a school achievement test. To measure intelligence, we used Raven's Progressive Matrices (RPM) (Raven et al., 2003). Reliability of the RPM in this study was high ($\alpha = .85$). The grade point average (GPA) for all school subjects from the semester preceding the research was used as a measure of school grades. Students provided the GPA. As a measure of school achievement, we used a school achievement test developed by the Educational Research Institute. This test measures three spheres of school achievement—math, reading, and overall language awareness. The test was developed and scaled according to item response theory (Rasch models is a one-parameter and graded partial credit model; Rasch, 1980) and has very good psychometric properties—all items are well-fitted to the Rasch model (infit and outfit measures between 0.8 and 1.2). Moreover, the test information function at the average level of θ (a latent trait of the measured achievement) was high, and the standard error of measurement was low—translating into reliability between .86 and .88, depending on the scale (Jasińska & Modzelewski, 2012).

Results and Discussion

Correlations between intelligence and school achievement measures and the three scales of TCIA are presented in Table 6. As opposed to the relations with creative abilities reported earlier, this time, the results' profile is less clear. Vividness turned out to be a consistent correlate of intelligence ($r = .29$), GPA ($r = .33$), and achievement test scores in math ($r = .28$), reading ($r = .24$), and language awareness ($r = .23$). However, in originality and imagery transformation, the relations were less unambiguous and weaker. Originality of images was significantly and positively, though weakly, related to school achievement in reading and language awareness, whereas imagery transformation was related to GPA ($r = .21$) and competence in math ($r = .20$).

Table 6

Discriminant Validity Analysis – Correlations with Intelligence and School Achievement

Study 5 (*N* = 230)	Image Vividness	Image Originality	Image Transformation
IQ	.29***	.10	.08
GPA	.33***	.09	.21**
SAT Math	.28***	.05	.20***
SAT Reading	.24***	.17*	.09
SAT Language Awareness	.23***	17*	.11

*$p < .05$, **$p < .01$; ***$p < .001$

Study 5 brings 15 correlations, of which only nine are statistically significant, and the mean correlation coefficient (as well as the median) obtained between intelligence and measures of imagination is $r = .17$. This result provides arguments in favor of the TCIA discriminant validity. Consistently positive relations found between intelligence, school achievement, and vividness also suggest that their cause is not only vividness itself but also by the related ability to work persistently and thoroughly, which is closer to elaboration (Dziedziewicz & Karwowski, 2015). What may also be interesting is the role of the transformation of mental images in learning math (probably especially geometry), which is confirmed by the relations found between skill in performing transformations in the imagination and achievement in math.

4.3. Interjudge reliabity

Method

Participants

Study 6. Four judges (all female, mean age M = 26 years) trained in TCIA scoring were the participants.

Measures and Procedure

All judges took part in a training devoted to TCIA scoring details and acquainted themselves with the test manual. Next, each of them scored 100 test sheets.

Results and Discussion

For each of the three TCIA scoring criteria, we computed intercorrelations between the judges' ratings and their consistency using Cronbach's α and the intraclass correlation coefficient (ICC) (Table 7).

Table 7

The Reliability of Judges Scoring 100 Randomly Selected Images Generated in TCIA

Study 6 (*N* = 100 drawings)	**Judge 1**	**Judge 2**	**Judge 3**	**Judge 4**
Imagery Vividness (α = .91, ICC = .89)				
Judge 1	1			
Judge 2	.78	1		
Judge 3	.82	.76	1	
Judge 4	.64	.60	.67	1
Imagery Originality (α = .90, ICC = .89)				
Judge 1	1			
Judge 2	.74	1		
Judge 3	.61	.67	1	
Judge 4	.75	.76	.69	1
Imagery Transformation (α = .92, ICC = .91)				
Judge 1	1			
Judge 2	.84	1		
Judge 3	.88	.84	1	
Judge 4	.70	.53	.68	1

Interjudge consistency was very high and comparable between the criteria. In all cases, α was equal to or higher than .90 (imagery originality α = .90, imagery vividness α = .91, and imagery transformation α = .92), with slightly lower but still acceptable ICC values (vividness and originality ICC = .89, transformation of images ICC = .91).

The fact that briefly trained judges equipped with example assessments of TCIA products can score the products of this test very similarly testifies to its good reliability. High consistency is a precondition of precise measurement. It is worth noting that the values we obtained are similar to those usually obtained in the case of other creativity tests, such as the TCT-DP (Kālis et al., 2014) or the TTCT (Dziedziewicz et al., 2013). This makes it legitimate to believe that even though TCIA scoring is a multifaceted and seemingly complex and difficult process, following our recommendations and using the examples provided does make it possible to obtain highly reliable data.

4.4. Test-retest reliability

In the next two studies, we tested reliability of the TCIA in time: in Study 7, we used the same version of the test twice, whereas in Study 8, we used version B. In the final step, using aggregated data from all the studies described in this paper, we present data on internal consistency of the TCIA.

Method

Participants

Study 7. 86 individuals (43 women) aged 13 to 15 years (M = 14.02, SD = 0.84) participated in Study 6. They were high-school students from a large city in central Poland.

Study 8. 39 individuals (29 women) aged 13 to 14 years (M = 13.75, SD = 0.47) participated in Study 7. They were middle-school students from a big city in central Poland.

Measures and Procedure

In Study 7, the TCIA version A was used twice with a 3-week interval. In Study 8, there were five weeks between the measurement sessions, using versions A and B of the TCIA.

Results and Discussion

Test-retest correlations between measurements, using the same version of the test with an interval of 3 weeks, were very high (r = .89 for imagery vividness, r = .91 for imagery originality, and r = .98 for imagery transformation, all p's < 0.001), testifying to very high measurement reliability (Table 8).

Table 8

Test-Retest Reliability and Internal Consistency of the TCIA

	Imagery Vividness	imagery Originality	Imagery Transformation
Study 7 (test-retest, 3 weeks) N = 86	.89***	.91***	.98***
Study 8 (A-B, 5 weeks), N = 39	.63***	.55***	.43***
Studies 1-5 (internal consistency)			
Cronbach's α	.79	.79	.81
H (CFA)	.82	.84	.87

***p < .001

In the case of studies with the use of versions A and B of the test, with an interval of 5 weeks between measurements, the correlations were still reasonably high—they ranged from $r = .43$ for the transformation of mental images through $r = .55$ for imagery originality, and $r = .63$ for vividness (all p's $< .001$). High values of test-retest correlations, especially those from Study 7, combined with high interjudge consistency presented earlier, testify to good reliability of TCIA measurement.

4.5. Construct validity

All studies summarized above were based on the assumption that the test's three-factor structure, assumed by the presented theoretical model is reproduced in the data. To verify this assumption, in the next step, we tested construct validity of the TCIA, subjecting its results to confirmatory factor analysis as well as testing measurement invariance among men and women.

Method

Participants

Studies 1–5 Aggregated. The analysis covered data collected from 1,328 individuals of different ages who participated in in Studies 1–5. The sample consisted of 890 women (69%) and 396 men (31%); 42 participants did not reveal their gender. The participants' age ranged from 10 to 55 years ($M = 16.33$, $SD = 4.72$); most of them were students or university students taking part in various research projects using TCIA.

Measure and Procedure

Sometimes, the participants completed TCIA together with other tests, and sometimes it was the only test conducted.

Results and Discussion

In the first step, the data collected were subjected to confirmatory factor analysis in a design involving many traits and many methods. More specifically, we tested the fit of the three-factor model assumed based on theory while at the same time controlling the effect of the test's individual items (Figure 6).

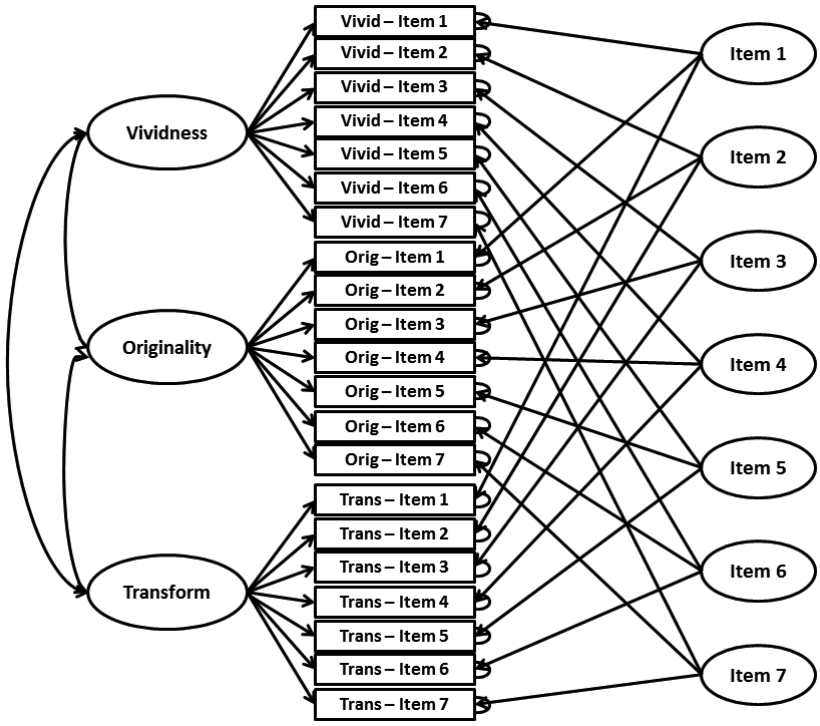


Figure 6. Multi-trait, multi-method confirmatory factor analysis model testing for construct validity of the TCIA.

The assumed theoretical model was confirmed (Table 9). Comparing the measures of fit with the commonly used criteria (Hu & Bentler, 1999; Kline, 2010), the values obtained should be considered excellent.

Table 9

CFA Model Fit Parameters

Measures	Parameters
CFI / *TLI*	.99 / .99
RMSEA (90% *CI*)	.018 (.012, .023)
Correlations between latent variables	
Imagery Vividness-Imagery Originality	.55***
Imagery Vividness-Imagery Transformation	.40***
Imagery Originality-Imagery Transformation	.59***

Measures	Parameters
Factor loadings	
Range of loadings on Imagery Vividness (mean)	.55-.68 (.63)
Range of loadings on Imagery Originality (mean)	.55-.71 (.65)
Range of loadings on Imagery Transformation (mean)	.61-.73 (.69)
Items loadings (Imagery Vividness, Originality, and Transformation)	
Item 1	.55, .60, .61
Item 2	.59, .72, .71
Item 3	.66, .55, .68
Item 4	.67, .66, .59
Item 5	.66, .71, .73
Item 6	.68, .72, .69
Item 7	.65, .60, .70

****p* < .001

4.6. Effects of gender and age

The next step in analyses was to test the TCIA's measurement invariance according to gender. The fit of consecutive models with constraints introduced is presented in Table 10. The sample being large, we performed invariance assessment not on the basis of differences in the range of values of chi-squared (which is sensitive to sample size), but by comparing the values of the CFI and the RMSEA between models. Following the recommendations found in the literature on the subject (Chen, 2007; Cheung & Rensvold, 2002), we consider a model to be invariant if CFI change between consecutive models does not exceed .01 and if the change in the RMSEA does not exceed .02.

Table 10

Analysis of Test Equivalence According to Gender – Invariance Analysis (CFA)

Model	*CFI*	*RMSEA* (90% *CI*)
Configural invariance	.981	.023 (.016, .028)
Metric invariance	.979	.023 (.017, .028)
Scalar invariance	.980	.022 (.016, .027)

Even the most constrained model that tested scalar invariance had a very good fit, and differences in CFI between the models did not exceed .01, though comparing more and less constrained models does bring a decline

in fit, slightly exceeding critical values. However, given that the change in the RMSEA between the least and the most constrained model is only .001, there are significant grounds to consider the models well-fitted and the test itself invariant according to gender.

The next step was to verify the existence of gender differences in terms of creative imagination characteristics. For this purpose, three latent variables: vividness, originality of images, and imagery transformation, were predicted by gender. The model was well fitted to data (CFI = .990, RMSEA = .016) and the effect of gender in all three cases turned out to be statistically significant. More specifically, women exhibited a higher level of vividness of images (β = .25, $p < .001$), imagery originality (β = .19; $p < .001$), and imagery transformation (β = .18, $p < .001$). These differences are illustrated on Figure 7.

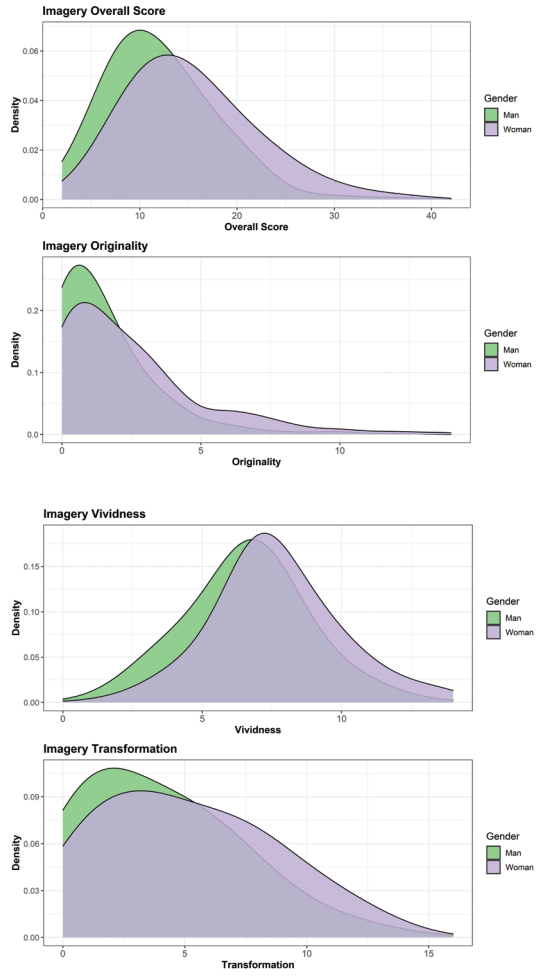


Figure 7. Distribution of TCIA scales' results across participants' gender

An analogous model with age as a predictor was also well fitted (CFI = .99, RMSEA = .019); age was a statistically significant positive predictor of imagery vividness (β = .24, $p < .001$), imagery originality (β = .20, $p < .001$), and imagery transformation (β = .29, $p < .01$).

The analyses presented above confirm construct validity of the TCIA. As assumed, the test has a three-factor structure and the three components of creative imagery are significantly and moderately correlated. Simultaneously, however, correlations between them are not strong enough to make them indistinguishable from one another. Individual items load on the latent variables strongly enough to justify the conclusion about their criterion validity. These data testify to reasonable validity of the measure.

4.7. Internal consistency

The final step of our analyses was to test the internal consistency of each scale of the TCIA. For this purpose, we used aggregated data from all the studies presented in this paper.

Method

Participants

Studies 1–5 Aggregated. The analysis covered data collected from 1,328 individuals of different ages who participated in Studies 1–5. The sample consisted of 890 women (69%) and 396 men (31%); 42 participants did not reveal their gender. The participants' age ranged from 10 to 55 years ($M = 16.33$, $SD = 4.72$); most of them were students or university students taking part in various research projects using the TCIA.

Measures and Procedure

All participants solved the TCIA, sometimes together with other tests and self-report measures, and sometimes as the only test.

Results and Discussion

We assessed internal consistency using the values of Cronbach's α and the H coefficient—composite reliability specific to confirmatory factor analysis (Hancock & Mueller, 2001). The scale on which the criteria were measured being short (0-1-2 in the case of each criterion and each item), we computed internal consistency based on the matrix of polychoric correlations estimated in *psych* package in R (Revelle, 2020).

The two methods yield similar estimations of internal consistency: imagery vividness: $H = .82$, $\alpha = .79$, originality: $H = .84$, $\alpha = .79$, and imagery transformation: $H = .87$, $\alpha = .81$. These values demonstrate the test's good reliability, especially as each scale of the TCIA consists of a relatively small number of items (7).

4.8. Item response theory properties

Our final set of analyses utilized Item Response Theory to estimate items' and scales' parameters. All analyses were conducted in R package mirt (Chalmers, 2012). Consistently with our theoretical model, we started with a multidimensional IRT model with three scales modelled as related yet independent. A graded response model (Samejima, 1969) fit the data well (*CFI* = .95, *TLI* = .92, *RMSEA* = .06). Subsequent univariate models were estimated for vividness, originality, and transformation, resulting in an excellent fit of each of these three models (vividness: *CFI* = .99, *TLI* = .99, *RMSEA* = .03; originality: *CFI* = 1, *TLI* = 1, *RMSEA* = .00; transformation: *CFI* = 1, *TLI* = 1, *RMSEA* = .00).

Scales information and IRT-estimated reliability are presented in Figure 8.

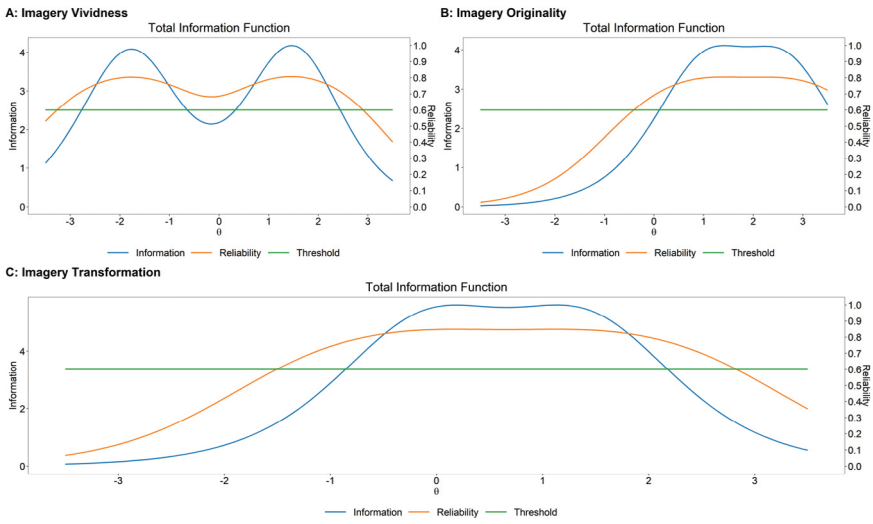


Figure 8. Scales information and reliability for the full version of the TCIA

As presented in Figure 8, the information provided by each of the three TCIA scales tended to differ. More specifically, imagination vividness was most effectively measured at relatively low and relatively high levels of the latent trait intensity (albeit the reliability was acceptable for the broad range of the theta values (from -3 to +3). In originality, it became apparent that

this scale was difficult, and the TCIA tends to effectively measure high originality, yet struggles with the differentiation of low level of originality. In the case of imagery transformation, the measurement was most effective around the average levels of theta, namely, between -1 and +2 standard deviation units. In general, however, the measurement's reliability was appropriate in a broad range of latent traits' levels.

Table 11 summarizes item parameters for all TCIA items. The items had at least adequate discrimination and boundary locations that captured a reasonably large trait range. Figures 9-11 provide a detailed illustration of items' boundary locations.

Table 11

Items Parameters obtained in Graded-Response IRT Model.

Item	Imagery Vividness			Imagery Originality			Imagery Transformation		
	a	b_1	b_2	a	b_1	b_2	a	b_1	b_2
1	1.36	-2.41	1.26	1.33	0.70	2.65	1.26	-0.34	1.61
2	1.57	-1.78	1.29	1.56	0.91	2.34	1.72	-0.18	1.28
3	1.61	-1.75	1.47	1.20	0.72	3.13	1.68	-0.13	1.52
4	1.67	-1.41	1.48	1.71	1.14	2.56	1.86	-0.13	1.30
5	1.46	-1.78	1.54	1.41	1.12	2.82	1.79	0.02	1.39
6	1.62	-1.90	1.71	1.70	1.22	2.64	1.79	0.09	1.51
7	1.55	-1.89	1.51	1.30	0.92	2.96	1.89	-0.05	1.34

*Note***.** *n* = 1323. The items were completed on a 0-2 scale. a refers to the IRT discrimination *a* parameter; the b_1-b_2 values are the graded response model boundary locations for the three response options.

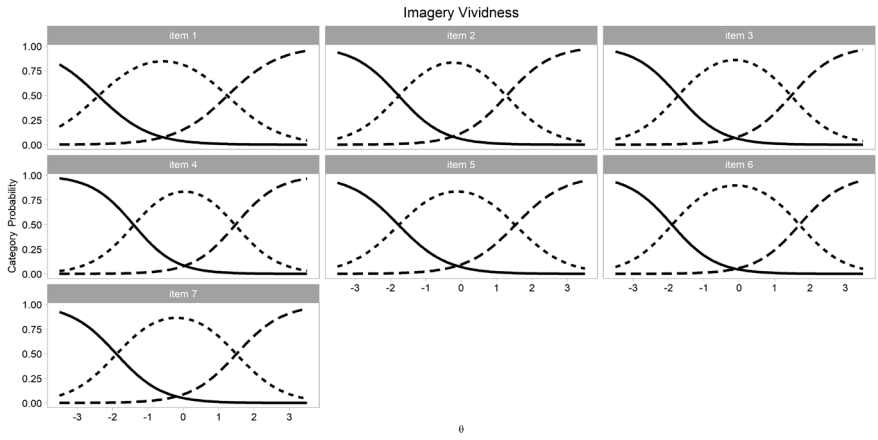


Figure 9. Imagery Vividness Items parameter boundary locations. The solid line represents the score of 0, the short, dotted line indicates score 1, and the longer, dotted line shows score 2

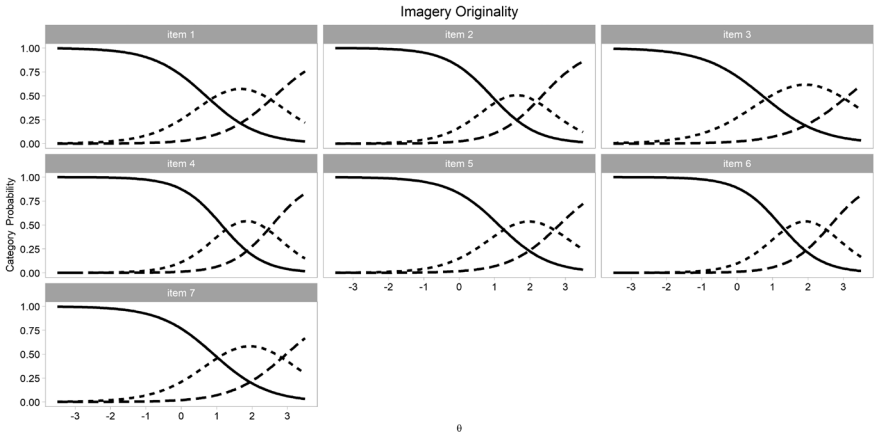


Figure 10. Imagery Originality Items parameter boundary locations. The solid line represents the score of 0, the short, dotted line indicates score 1, and the longer, dotted line shows score 2

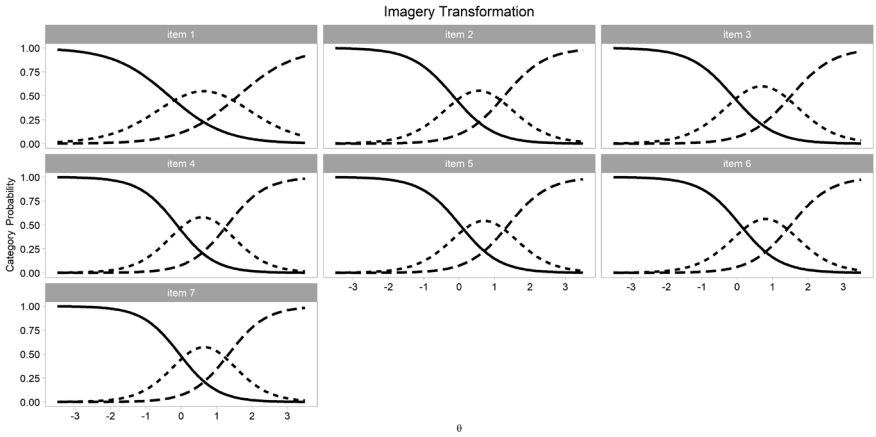
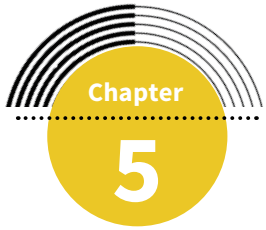


Figure 11. Imagery Transformation Items parameter boundary locations. The solid line represents the score of 0, the short, dotted line indicates score 1, and the longer, dotted line shows score 2

To summarize the findings presented in this chapter, we emphasize that the theorized three-factor structure of the TCIA has been empirically confirmed by multi-trait-multi-method confirmatory factor analysis and multidimensional item response theory graded response model. Additionally, we provided evidence for measurement invariance across men and women and significantly higher scores as obtained by women. TCIA results were found to be correlated with participants' age, with older participants scoring higher in imagery vividness, originality, and transformation. In our validity studies, we obtained entirely consistent—albeit usually weak-to-moder-

ate—correlations with well-established measures of creative thinking and vividness of imagery and even weaker associations with intelligence or school achievement. The three main scales of the TCIA were thus valid and their reliability, assessed in terms of both internal consistency and test-retest stability, was very good. All in all, the evidence presented might be considered sufficient for the new test's validity and reliability.



Psychometric overview for the short form of the TCIA[1]

5.1. Introduction

The results presented in the previous chapter attest to the TCIA's validity and reliability. However, we acknowledge that the full version of the test may be too long in some situations. The time devoted to solving the TCIA is not restricted, yet it is rare to finish the test in a time shorter than 20 minutes, and the median time observed across our studies approached 30 minutes. Therefore, we decided to create a shortened version of the test, which would be particularly useful in all situations when the researcher is not interested primarily in creative imagery *per se*, but instead would like to include it as a control measure or one of the predictors of the variables under study.

Based on the previous set of analyses, we selected four items that covered a broad range of difficulty, having acceptable discrimination. The items included in the TCIA-short (TCIA-S) are presented in Figure 12.

The procedure applied to the assessment with the TCIA-S is the same as the one we applied to the longer version. Time is not restricted, yet it usually does not exceed 15 minutes.

1 The data presented in this chapter have been collected thanks to a grant funded by National Science Centre (Narodowe Centrum Nauki), grant number 2016/23/B/HS6/03898.

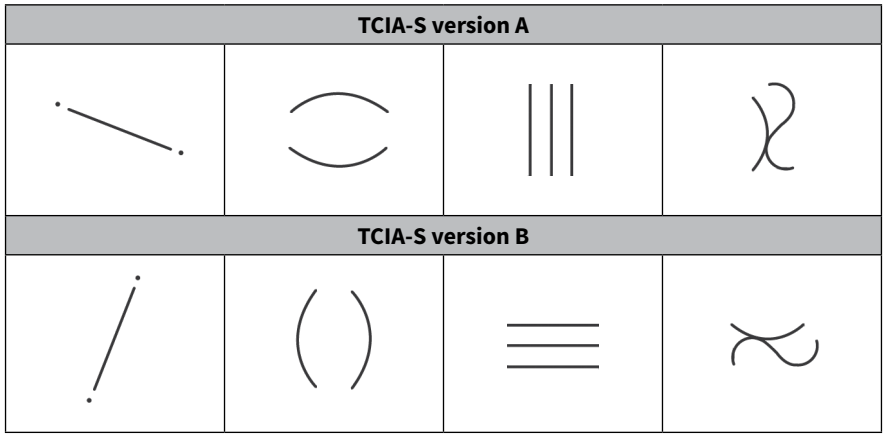


Figure 12. Objects used in the TCIA-S

5.2. Testing the psychometric properties of the TCIA-S

Study 9

We tested the properties of the TCIA-S in a large study devoted to school achievement. The TCIA-S was used as one of several measures that served as correlates of students' functioning in school settings.

Participants and Procedure

A total of 1,576 elementary (48%) and middle-school (52%) students (55% female) participated in Study 9. More than 70% of all participants (N = 1,130) solved the TCIA-S.

Results

Similarly as in the full version of the TCIA, we started with the CFA examining whether the theoretical, three-factor structure, with imagination vividness, originality, and transformation, fit our data. We estimated the MTMM CFA model in lavaan for R with WLSMV estimator and treated the items as measured on an ordinal scale. The model fit was excellent, *CFI* = .997, *TLI* = .995, *RMSEA* = .013, 90% *CI*: .00, .025, *SRMR* = .033. All items significantly loaded the scales and the standardized loadings were between .61 and .73 for vividness, between .37 and .81 for originality, and between .63 and .74 for transformation. Latent correlations were robust, yet not too strong: vividness-originality, r = .55, vividness-transformation, r = .29, originality, transformation, r = .50.

In the next step, we proceeded with IRT analyses. We started with the multidimensional IRT model; its fit was good, *CFI* = .97, *RMSEA* = .05, better than in terms of the unidimensional IRT model, *CFI* = .91, *RMSEA* = .06. However, given the appropriate fit of the unidimensional model and keeping in mind that in each scale of the TCIA-S is loaded by four items only, researchers may want to use the one general score rather than results in the three scales. As illustrated in Figure 13, the scales' information functions and their reliabilities closely resembled those reported for the full version of the TCIA. Having fewer items resulted in a less reliable measurement, which is troublesome, especially in the case of imagery vividness. In average vividness (theta around 0), the reliability tended to fall below the minimally acceptable level of .60. Still, generally speaking, the reliability tended to be appropriate across the broad range of the theta level. Table 12 shows item parameters that—apart from different samples—resemble those observed in the full version of the TCIA.

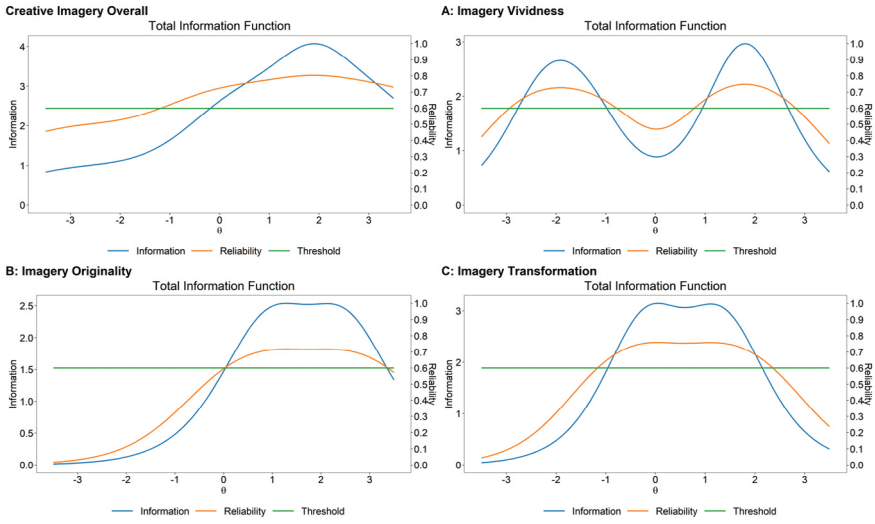


Figure 13. Scales information and reliability for TCIA-S

Table 12

Items Parameters obtained in Graded-Response IRT Model.

Item	Imagery Vividness			Imagery Originality			Imagery Transformation		
	a	b_1	b_2	a	b_1	b_2	a	b_1	b_2
1	1.40	-1.95	1.89	1.50	0.65	2.45	1.37	-0.33	1.54
2	1.95	-1.35	1.85	1.59	0.91	2.31	1.93	-0.17	1.21
3	2.01	-2.23	1.68	1.17	0.73	3.15	1.68	-0.14	1.52
4	1.48	-2.11	2.05	1.79	1.12	2.48	1.82	-0.13	1.32

Note. n = 1125, after list-wise deletion. The items were completed on a 0-2 scale. a refers to the IRT discrimination a parameter; the b_1-b_2 values are the graded response model boundary locations for the 3 response options.

Figures 14-16 provide a detailed illustration of items' boundary locations.

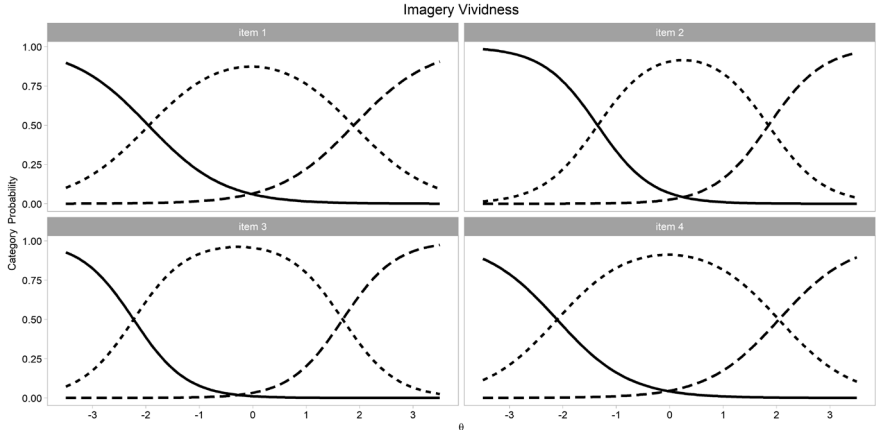


Figure 14. Imagery Vividness Items parameter boundary locations. The solid line represents the score of 0, the short, dotted line indicates score 1, and the longer, dotted line shows score 2

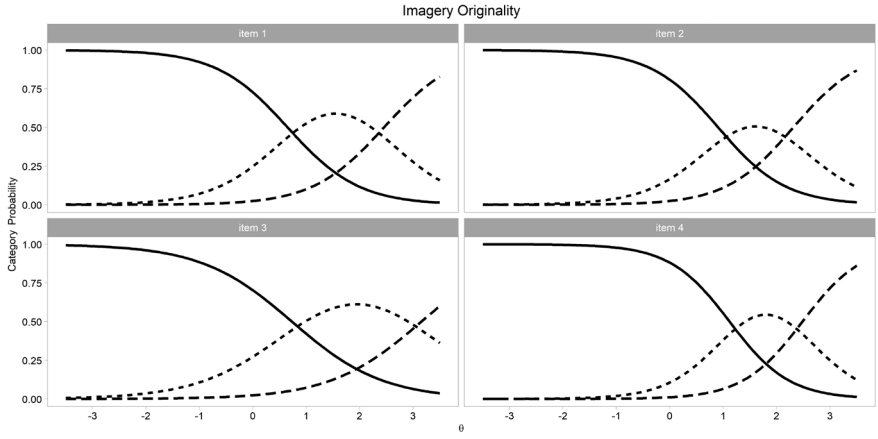


Figure 15. Imagery Vividness Items parameter boundary locations. The solid line represents the score of 0, the short, dotted line indicates score 1, and the longer, dotted line shows score 2

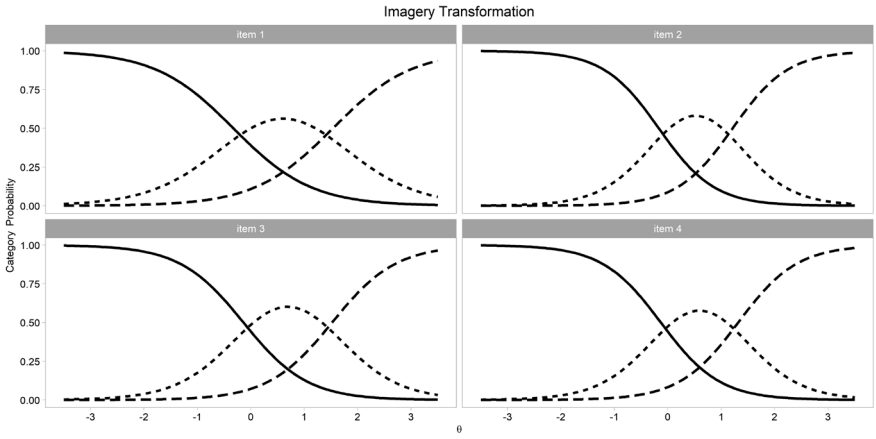


Figure 16. Imagery Vividness Items parameter boundary locations. The solid line represents the score of 0, the short, dotted line indicates score 1, and the longer, dotted line shows score 2

5.3. Summary

A short version of the TCIA: TCIA-S is characterized by appropriate psychometric scores that make it useful as an instrument to be applied in all studies where creative imagery is not a central construct the researchers focus on. Both confirmatory factor analyses and IRT analyses provided comparable scores as observed in the case of the full version of the TCIA. Some scales' reliability may be slightly compromised due to a low number of items (4); therefore, using an overall score of creative imagination (sum of vividness, originality, and transformation) may work better than a separate scale.

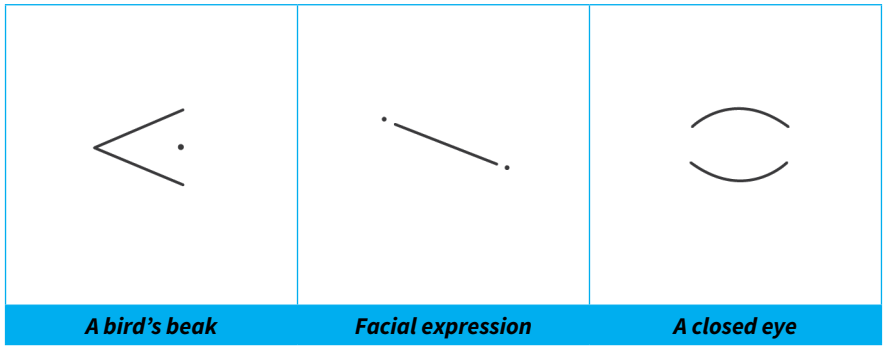
Additional interpretative information

This scoring guide with examples of responses has been designed to help users of the TCIA obtain measures of creative imagery abilities that are as objective and as meaningful as possible. It is recommended that with a basic understanding of the test task's rationales and the scoring concepts, the scorer should read this additional interpretative information.

6.1. Examples of scoring for imagery vividness

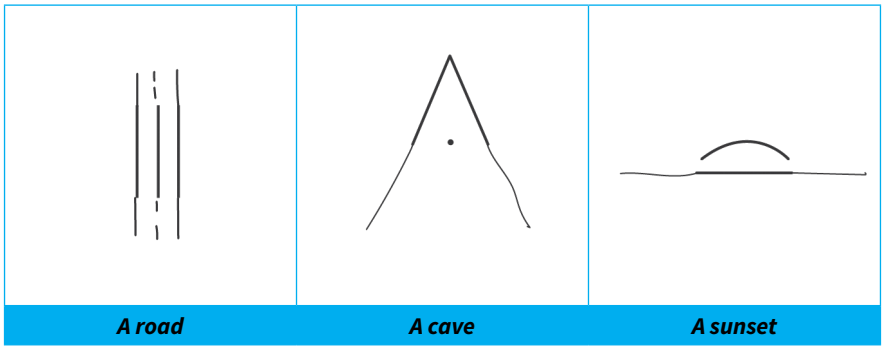
Low level (0 points)

- **The initial figure was not completed, but it was interpreted, namely, it was titled.**



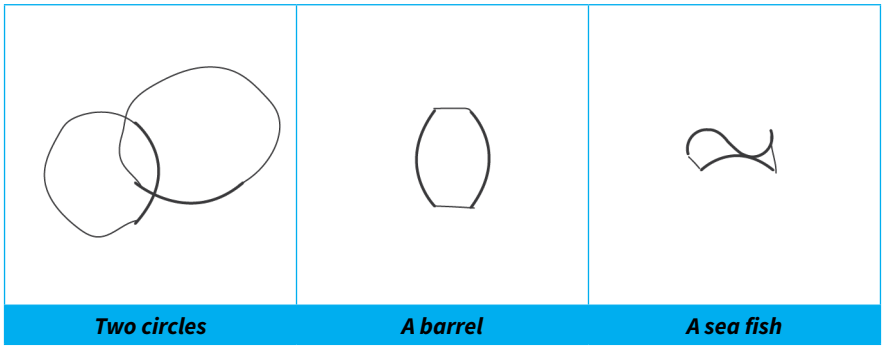
A bird's beak	*Facial expression*	*A closed eye*

- **Continuation, an extension of the lines of the initial figure with a continuous or dotted/dashed line.**



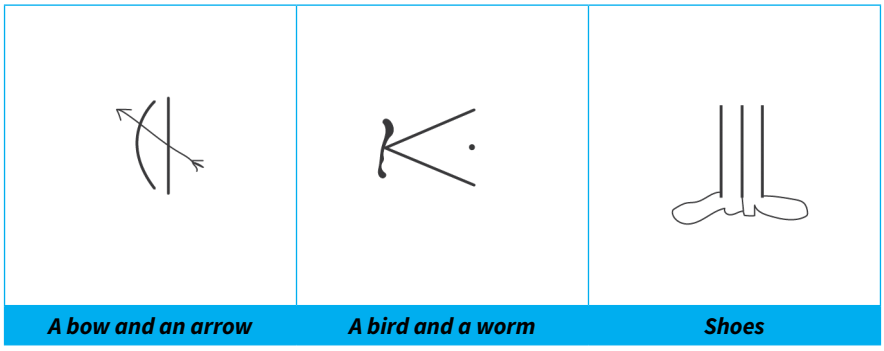
A road | *A cave* | *A sunset*

- **Simple closing of the initial figure.**



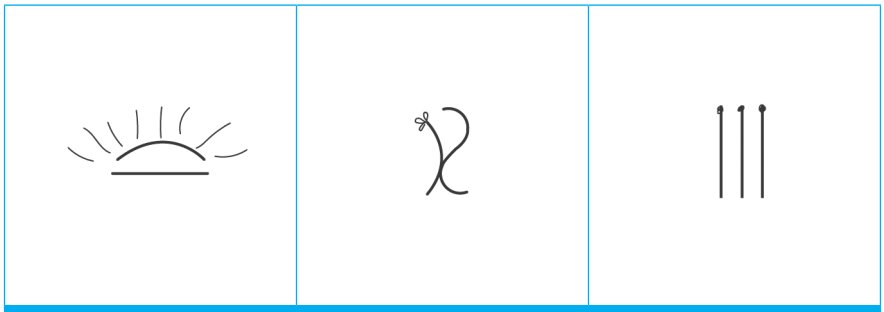
Two circles | *A barrel* | *A sea fish*

- **Adding to the unchanged, but interpreted initial figure; the small drawing element has a new quality.**



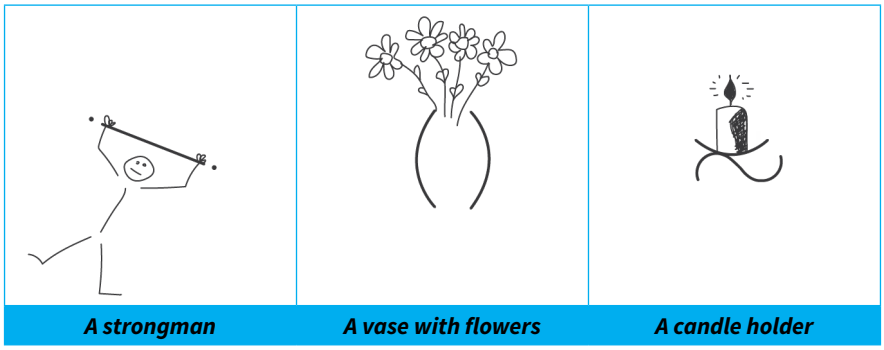
A bow and an arrow | *A bird and a worm* | *Shoes*

- **Slight completion of the initial figure – adding an individual line, point, or simple graphic element.**

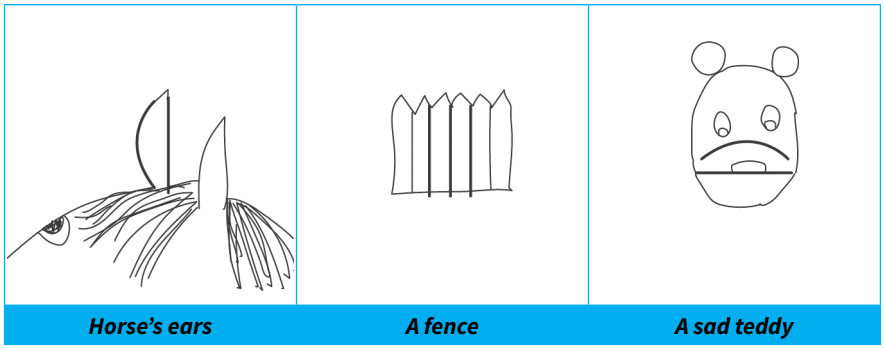


Moderate level (1 point)

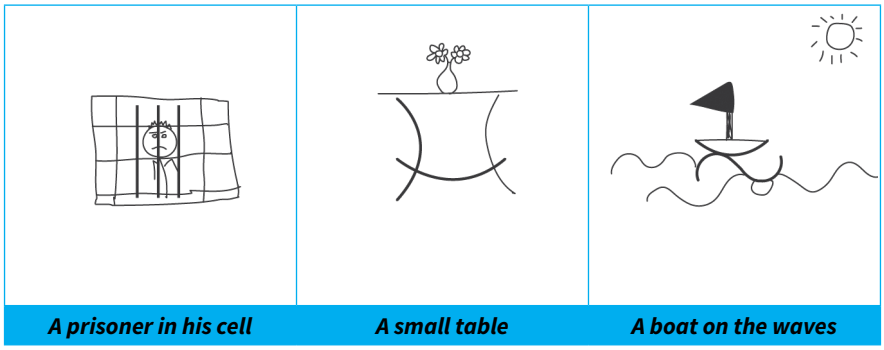
- **Adding to the unchanged but interpreted initial figure; the larger drawing element/drawing elements have the new quality to it/them.**



- **Simple, often schematic completion of the initial figure.**

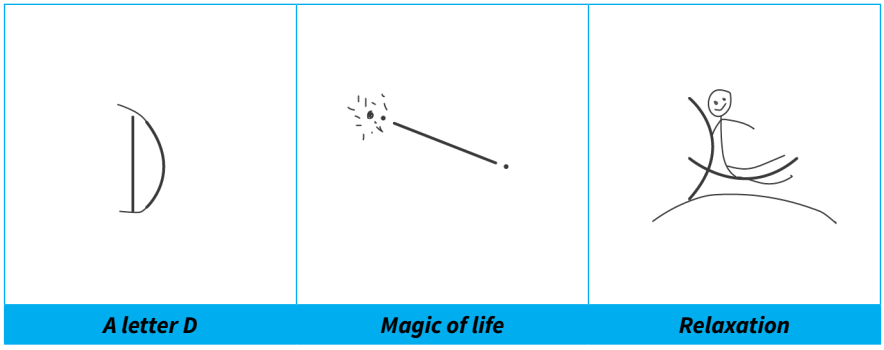


- **Simple, often schematic completion of the initial figure with and added relatively independent object/objects.**



A prisoner in his cell | *A small table* | *A boat on the waves*

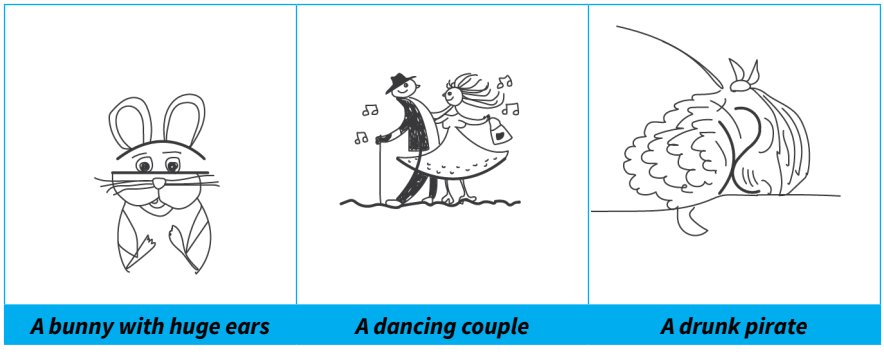
- **Simple, often schematic presentation of abstract content (e.g., definitions), symbolic content (e.g., letters, mathematical symbols), metaphorical, or philosophical content (e.g., poetic comparisons).**



A letter D | *Magic of life* | *Relaxation*

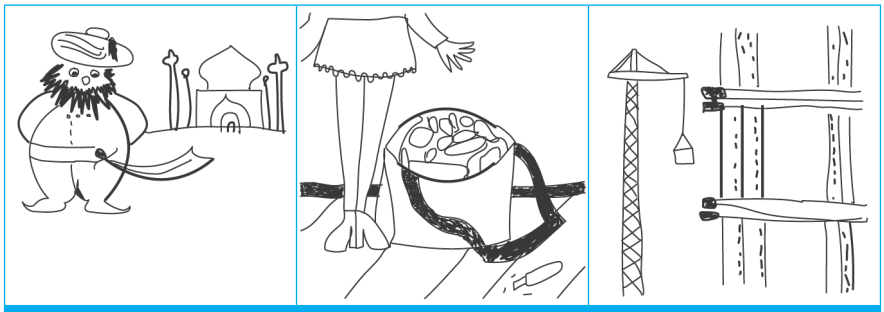
High level (2 points)

- **Sophisticated completion of the initial figure, rich in detail.**



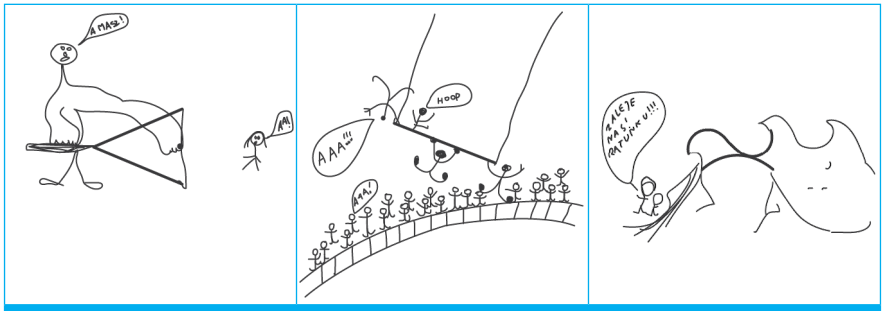
A bunny with huge ears | *A dancing couple* | *A drunk pirate*

- **Sophisticated completion of the initial figure, rich in detail, with an added relatively independent object/objects.**



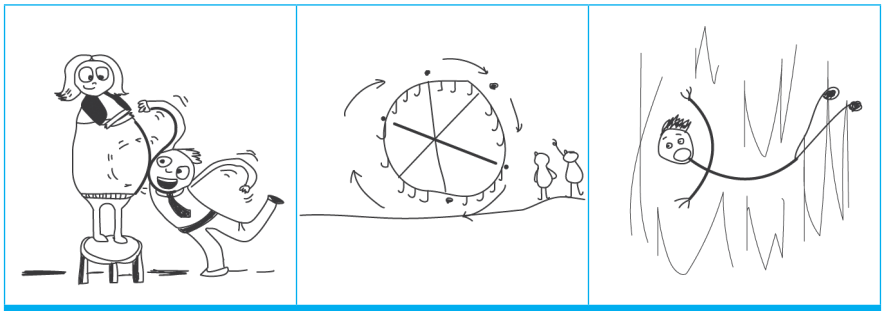
A sultan | *OMG! Where is my lipstick?* | *A construction site*

- **Presentation of a short dialogue story, a drawn story, or an action paused "in a frame."**



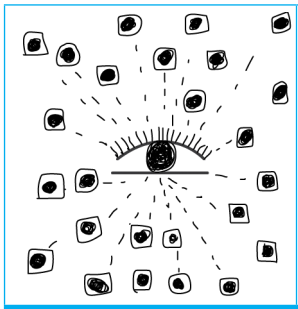
Fighting | *Circus performers* | *To the rescue!*

- **Evident animation of the drawing, portrayal of dynamics, motion.**

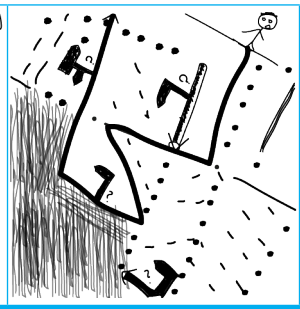


Happy daddy | *London Eye* | *A person falling*

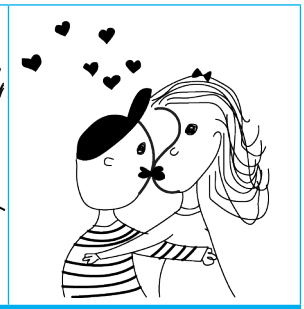
- **Complex, rich in detail presentation of abstract content (e.g., definitions), symbolic content (e.g., letters, mathematical symbols), metaphorical, or philosophical content (e.g., poetic comparisons).**



Different points of view

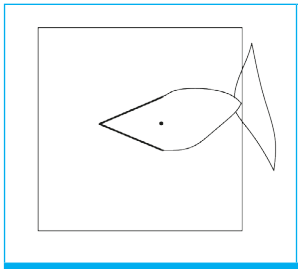


The course of life

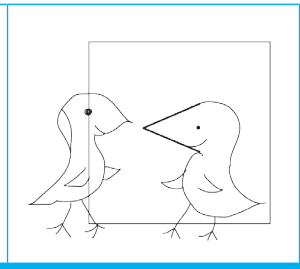


Love

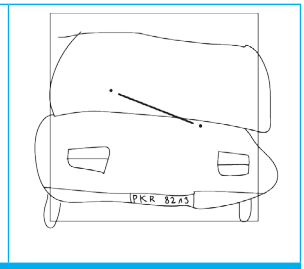
Note. Drawings that scored 0 or 1 point but moved outside of the frame obtain an extra point on this scale.



A fish



A meeting

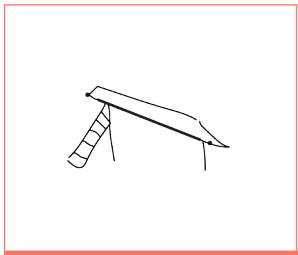


An innovative windshield wiper

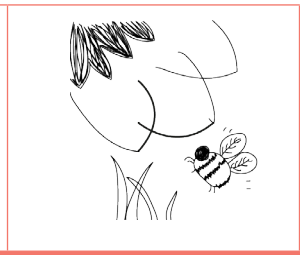
6.2. Examples of scoring for originality of images

Low level (0 ponts)

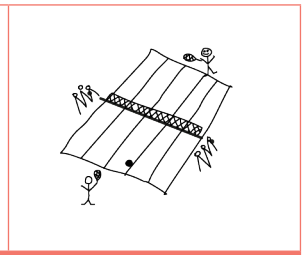
- **Presentation of generally known objects (things, plants, animals, people, places) with unaltered structure, functions, and properties as well as typical activities, processes, states, and events.**



A playground



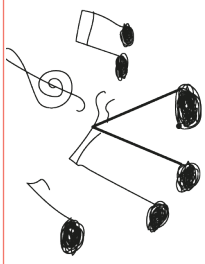
A bumblebee



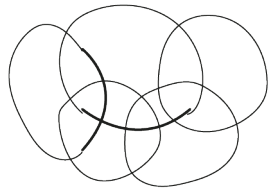
A game of tennis

- **Presentation of known symbolic content (e.g., letters, mathematical symbols).**

A prohibition road sign



Musical notes



Olympics

- **Presentation of known literary, film, computer-game characters, or public persons.**

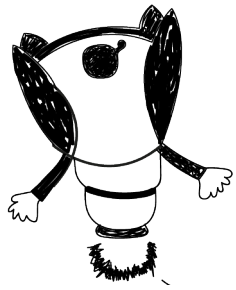
Elvis Presley

Ninja

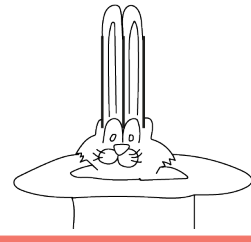
The Wizard of Oz

- **Presentation of objects and activities, processes, states, and events that are generally considered nonexistent.**

UFO



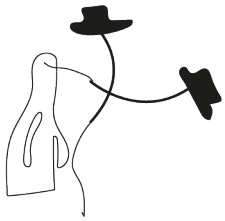
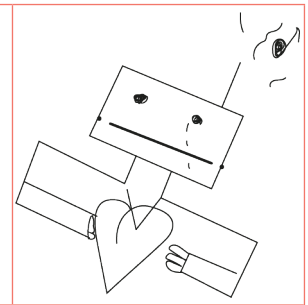
A time machine



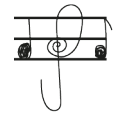
Magic

Moderate level (1 point)

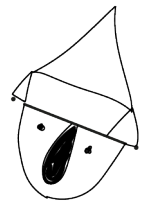
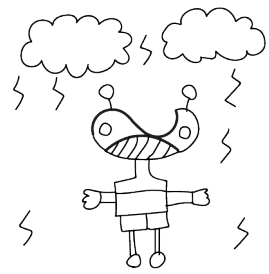
- **Individual, simple modifications of structure, functions, and properties of generally known objects (things, plants, animals, people, places) and typical activities, processes, states, and events.**

		
A living clothes hanger	*The eighth color of the rainbow*	*A machine - unhappily in love*

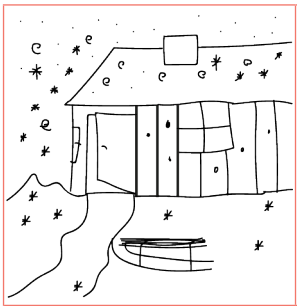
- **Modification of known symbolic content (e.g., letters, mathematical symbols).**

		
A double four	*Letter A - right-sided and left-sided*	*A three-line*

- **Modification of an image, character traits, and/or way of being of known literary, film, computer-game characters, or public persons.**

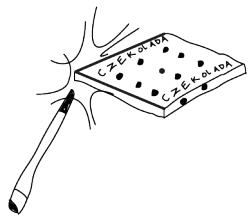
		
A disenchanted pencil	*Pinocchio with an automatically growing nose*	*A new (dangerous) version of E.T.*

- **Modifications of objects as well as activities, processes, states, and events that are generally considered nonexistent or visualization of an oxymoron.**



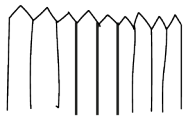
Warm snow

A cap of invisibility with a teleport

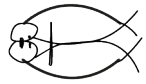


A magic wand that turns everything into sweets

- **Presentation of abstract content (e.g., general ideas or definitions) and metaphoric and philosophical content (e.g., poetic comparisons) with the use of close associations.**



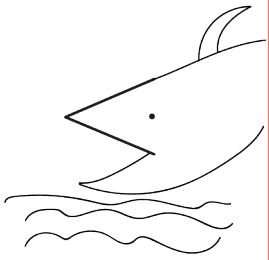
Barriers



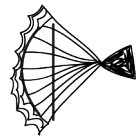
Forever love

Comfort

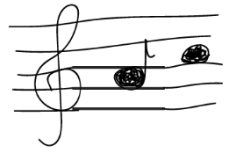
- **Presentation of the products of culture (titles and content of literary works, newspapers and periodicals, musical tunes, games, works of art), historical events, and geographical names with the use of close associations.**



Jaws III

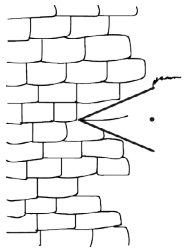
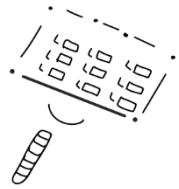
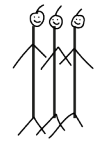


Japan



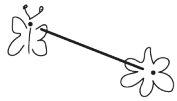
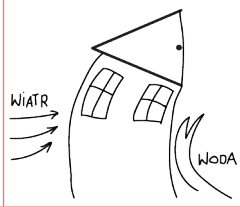
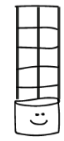
The Song of Roland

- **Presentation of known sayings, advertising slogans, and multi-word expressions with the use of close associations.**

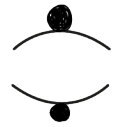
		
Banging your head against a brick wall (tough stuff)	*Practice makes perfect*	*One for all and all for one*

High level (2 points)

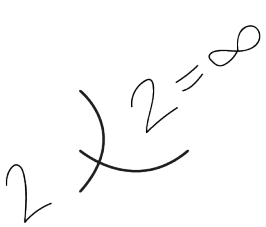
- **Complex modification of structure, functions, and properties of generally known objects (things, plants, animals, people, places) and typical activities, processes, states, and events that significantly depart from reality.**

		
A new species of butterfly that collects nectar with a laser beam	*A flexible house – it will always turn away from natural disasters*	*A happiness bar*

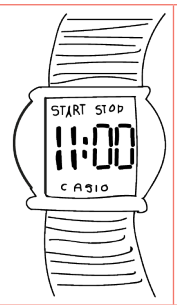
- **Presentation of new objects (things, plants, animals, people, places) and untypical activities, processes, states, and events.**

		
A container with this special powder that lets you be in two places at the same time	*A tool that brings back the balance of mind*	*Family vacation of the future*

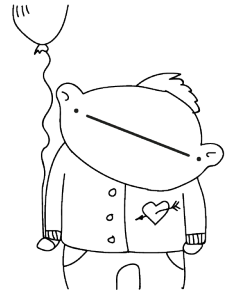
- **Presentation of new symbols and surprising and untypical presentation of abstract content (e.g., general ideas), metaphoric and philosophical content (e.g., poetic comparisons) using remote associations.**



The queen of the sciences can be whimsical sometimes

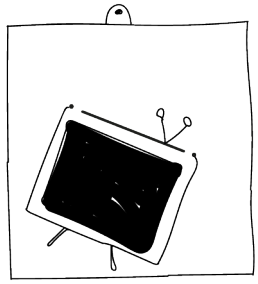


Nothing happens twice (...)

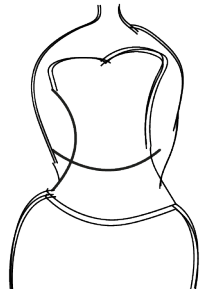


Sunday afternoon

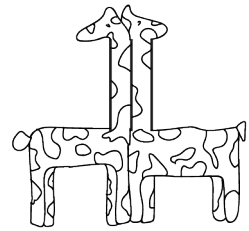
- **Surprising and untypical presentation of the products of culture (e.g., titles and content of literary works, newspapers and periodicals, musical tunes, games, works of art), historical events, and geographical names with the use of distant associations.**



A black square against white background - a new version

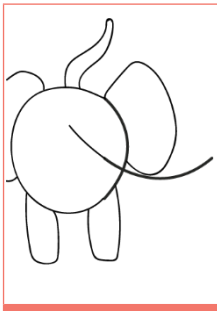


Lady without an ermine



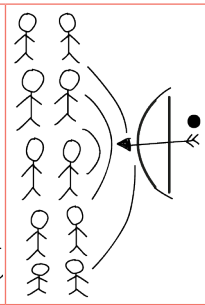
A Siamese (hahaha) giraffe by Salvadore Dali

- **Surprising and untypical presentation of known sayings, advertising slogans, and multi-word expressions using distant associations.**



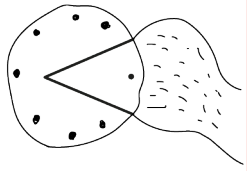
At the very tail end

Parenthetically speaking… vacation

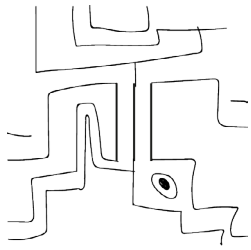


Hitting bull's eye (10 out of 10)

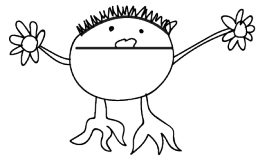
- **Presentation of new sayings, comparisons, and neologisms.**



Pecking time

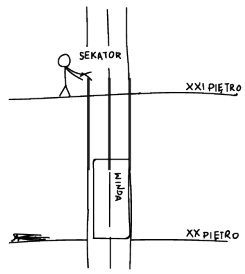


"Thinkability" (in the labyrinth of your thoughts)

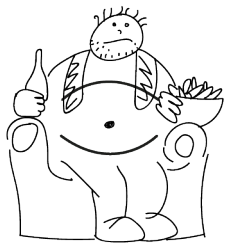


Hugging life

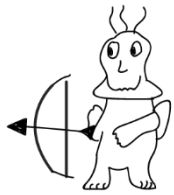
- **Witty and comic presentation of content that indicates high level of a sense of humor.**



Revenge of the elevator operator

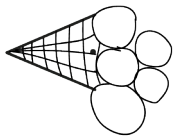
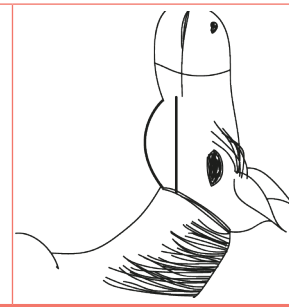


A friendly match



"Nuptials", or Amore Mio

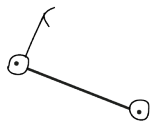
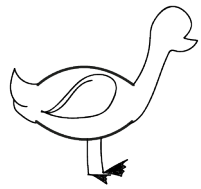
Note. Drawings that scored 0 or 1 point but were created using sheet modification of at least 45 degrees obtain an extra point on this scale.

		
Ice cream	***A boat on the lake***	***A horse's head***

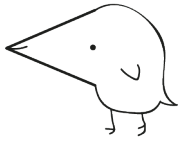
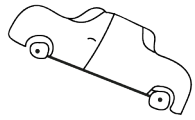
6.3. Examples of scoring for imagery transformation

Low level (0 points)

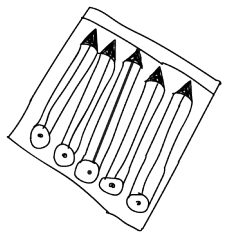
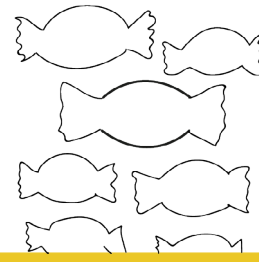
- **Precise reproduction of the initial object.**

		
Selected mental image: ***A scooter*** My mental image: ***A scooter***	Selected mental image: ***A goose*** My mental image: ***A goose***	Selected mental image: ***A hairdressing comb*** My mental image: ***A hairdressing comb***

- **Simple completion of the initial object or its simplification.**

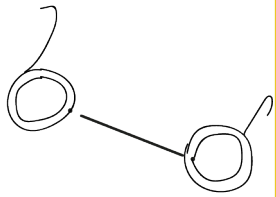
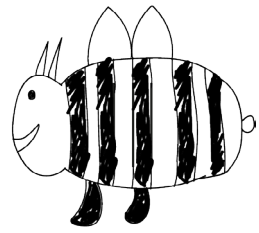
		
Selected mental image: ***A bird's beak*** My mental image: ***A bird***	Selected mental image: ***Car chassis*** My mental image: ***A car***	Selected mental image: ***Little flower stalks*** My mental image: ***Three little flowers***

- **Multiplication of the initial object.**

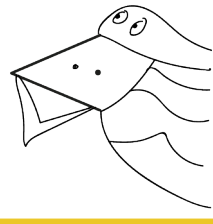
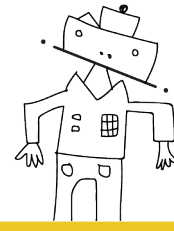
		
Selected mental image: ***A crayon*** My mental image: ***A set of crayons***	Selected mental image: ***Two flower pots*** My mental image: ***A collection of flower pots***	Selected mental image: ***Candy*** My mental image: ***A fistful of candy***

Moderate level (1 point)

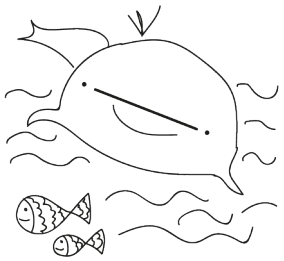
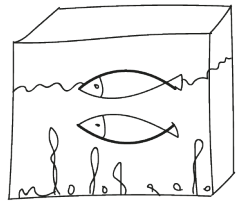
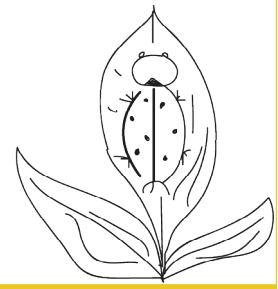
- **Simple modification of the initial object—adding detail to its single and simple aspect, most often its structure and appearance.**

		
Selected mental image: ***Glasses*** My mental image: ***Rose-tinted spectacles***	Selected mental image: ***Legs*** My mental image: ***A woman's legs***	Selected mental image: ***A bee*** My mental image: ***An obese bee***

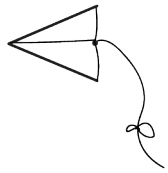
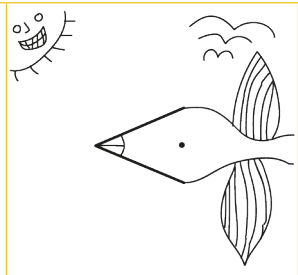
- **Completion of the initial object (reintegration) and its simple modification (e.g., enriching, detailing the image).**

		
Selected mental image: ***A bird's beak*** My mental image: ***A pelican's head***	Selected mental image: ***A stem*** My mental image: ***A fern flower***	Selected mental image: ***Facial expression*** My mental image: ***A robo-human***

- **Reproduction, completion, or multiplication of the initial object, and adding to it a relatively independent object/objects.**

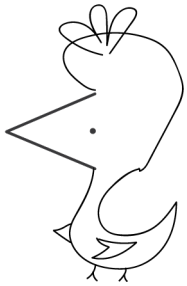
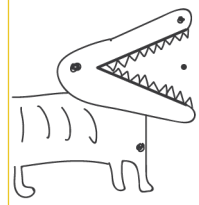
		
Selected mental image: ***Whale's eyes*** My mental image: ***A whale and food***	Selected mental image: ***A tiny fish*** My mental image: ***Tiny fish in the aquarium***	Selected mental image: ***A part of a ladybird*** My mental image: ***A ladybird on the leaf***

- **Simple metamorphosis (transformation into something completely different) of the initial object (e.g. a change of one thing into a different thing, a change of a living organism into another living organism).**

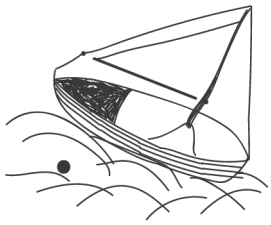
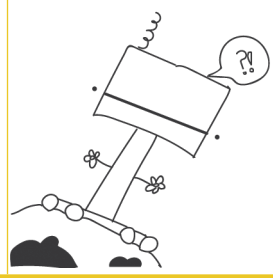
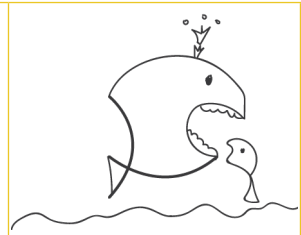
		
Selected mental image: ***A bird's beak*** My mental image: ***A kite***	Selected mental image: ***A fish*** My mental image: ***A flying bird***	Selected mental image: ***A letter R*** My mental image: ***An octopus***

High level (2 points)

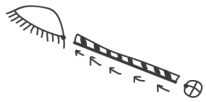
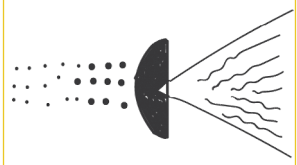
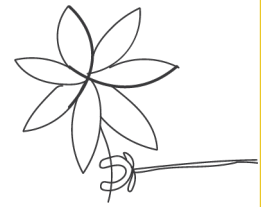
- **Complex modification of the initial object – adding detail to many of its aspects.**

		
Selected mental image: ***A bird's beak*** My mental image: ***A dressed-up Easter chicken***	Selected mental image: ***Gunsight*** My mental image: ***A sniper's rifle (final seconds)***	Selected mental image: ***A maw*** My mental image: ***A maw of an amusing crocodile from a kids' story***

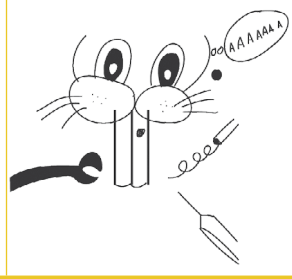
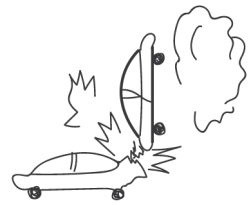
- **Modification of the initial object (simple or complex) and adding to it a relatively independent object/objects.**

		
Selected mental image: ***A sail*** My mental image: ***A boat drifting on calm seas***	Selected mental image: ***An alien*** My mental image: ***A Martian on planet Earth***	Selected mental image: ***A whale*** My mental image: ***A baby whale called Irritabe is eating Ed the Flatfoot***

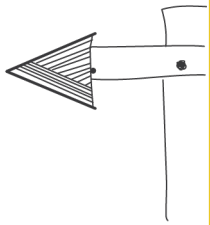
- **Modification indicating a surprising combination of 2 or more initial objects belonging to different domains.**

		
Selected mental image: ***Eyes, an applicator*** My mental image: ***Universal medicine for sleeplessness***	Selected mental image: ***A mountain, a road, an open mouth*** My mental image: **A *fatigue absorber***	Selected mental image: ***Flower petals, outstretched hands*** My mental image: ***An automatic flower collector***

- **Clear dynamization of the initial object, its completion, or modification.**

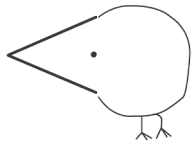
		
Selected mental image: ***A figure*** My mental image: ***Praying to a puppet***	Selected mental image: ***Bunny's teeth*** My mental image: ***A bunny at a dentist's***	Selected mental image: ***A car*** My mental image: ***An action movie***

- **Complex metamorphosis (transformation into something completely different) of the initial object often with philosophical, metaphorical, abstract dimension (e.g., a change of a thing into a general concept).**

		
Selected mental image: ***An indicator*** My mental image: ***A machine that shows happy solutions in life***	Selected mental image: ***A clover*** My mental image: ***A happy life is a choice, not a coincidence***	Selected mental image: ***Letters*** My mental image: ***An automatic leaf collector***

The scoring of image transformation criteria refers to basic operations of transforming visual imagery, such as:

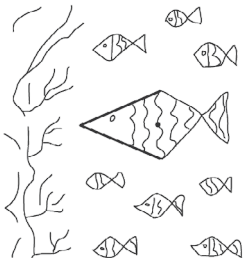
- **reintegration or renewed image integration; for instance, based on noticing one of its fragments;**

	Selected mental image: ***A beak*** My mental image: ***A bird***

- **bisociation, or combination of two distant images;**

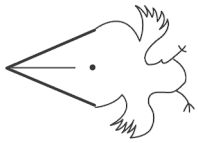
	Selected mental image: ***Cosmic radiation, a way*** My mental image: ***Wandering in the skies***

- **multiplication, or redoubling of any element of an image;**



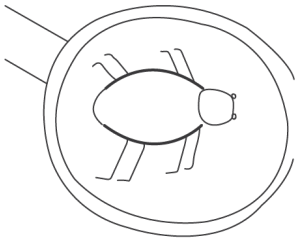
Selected mental image: ***A fish***
My mental image: ***A school of fish***

- **hyperbolization, or exaggerated distortion of proportions, exposing an element of an image;**



Selected mental image: ***A beak***
My mental image: ***A beaker – a new species of birds with enormous beaks***

- **majorization, or relatively uniform image enlargement;**



Selected mental image: ***A maggot***
My mental image: ***An enlarged ant***

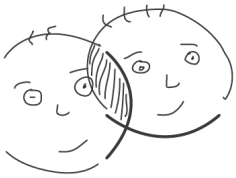
- **schematization, or image simplification;**

Selected mental image: ***A map***
My mental image: ***A ride from point A to point B***

- **amplification, or enrichment of an image with detail;**

Selected mental image: ***A piece of watermelon***
My mental image: ***A girl is eating a sweet watermelon on the beach***

- **metaphorization, or expressing an image or a term with the use of symbols;**

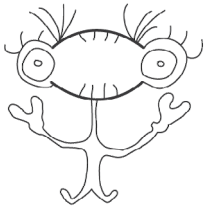


Selected mental image: ***Faces***
My mental image: ***Friendship***

- **animization, or ascribing to certain inanimate objects or plants the manifestations of life and abilities to feel, which are characteristic of human beings;**

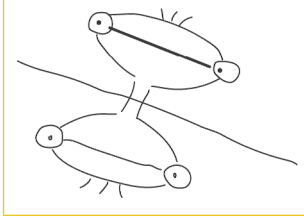
Selected mental image: ***A tree***
My mental image: ***A smiling tree***

- **conversion, or reversing the direction of the course of action or activity, color inversion of the object;**



Selected mental image: ***An alien***
My mental image: ***A blue alien***

- **rotation or spatial inversion, turning an image around a particular axis;**



Selected mental image: ***A frog***
My mental image: ***A frog in a mirror reflection***

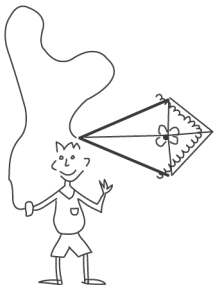
- **time manipulation, or imagining a slower or faster course or change of time;**

Selected mental image: ***A snowman***
My mental image: ***A snowman in the summertime***

- **animation, or visual ascription of some dynamic properties to inanimate elements of an image in relation to the remaining elements of the image;**

Selected mental image: ***Letters***
My mental image: ***Learning to read***

- **metamorphosis, or evolutionary and purposeful change of an initial object in order to create a new and autonomous object (Młodkowski, 1998).**



Selected mental image: ***Part of a geometric figure***
My mental image: ***Flying a kite***

Chapter 7

Norms

This chapter provides norms for the full version of the TCIA as well as normative values for the TCIA-S. All norms are provided as an equivalent of a standardized IQ scale (i.e., a scale with $M = 100$ and $SD = 15$ points). Given that in the case of the TCIA we have also identified gender differences and the links with participants' age, we provide separate norms for women and men as well as regression-based obtained scores for individuals, aged 10, 15, 20, 25, and 30 years. In the case of the TCIA-S, we add norms for the overall (summative) score. We emphasize that all studies the norms are based on were conducted in Poland, and the TCIA-S was standardized on a homogenous sample of Polish students from elementary and middle schools. Therefore, especially in the case of TCIA-S, norms should be used with caution.

7.1. TCIA (STANDARD VERSION) NORMS

Figure 17. IQ-Equivalent Norms for the Raw Scores of the TCIA

Table 13

IQ-Equivalent Norms and Percentiles for Each TCIA Scale

	Vividness		Originality		Transformation	
Raw Score	**IQ Scale**	**Percentile**	**IQ Scale**	**Percentile**	**IQ Scale**	**Percentile**
0	56	0,17	83	13	76	5,5
1	61	0,43	95	37	86	16,6
2	66	1,1	104	60	91	26,6
3	71	2,7	110	74	95	36,7
4	77	6,42	114	82	99	46,7
5	84	14,12	118	88	102	56
6	91	27,5	121	92	106	65
7	98	45,5	124	94	109	73
8	105	63,8	127	96	113	80
9	112	78	129	98	116	86
10	118	88	132	98,4	120	91
11	123	94	135	99	124	94
12	128	97	138	99,4	128	97
13	132	98	141	99,7	133	99
14	136	99	144	99,9	140	99,6

Table 14

IQ-Equivalent Norms for Men and Women

	Vividness		Originality		Transformation	
	Men	**Women**	**Men**	**Women**	**Man**	**Woman**
Raw Score	**IQ Scale**	**IQ Scale**	**IQ Scale**	**IQ Scale**	**IQ Scale**	**IQ Scale**
0	55	55	86	82	78	69
1	62	59	99	93	88	84
2	69	64	109	102	94	89
3	75	69	115	107	98	93
4	82	74	120	112	102	97
5	89	81	124	116	106	101
6	96	89	127	119	110	104
7	103	96	130	122	113	108
8	110	104	133	125	117	111
9	117	110	136	128	121	115
10	124	116	139	130	125	118
11	130	121	141	133	129	122
12	135	126	144	136	133	127
13	139	130	145	139	137	132
14	143	135	146	143	138	138

Table 15

IQ-Equivalent Norms for Raw Scores Obtained in the Imagery Vividness Scale

	Vividness				
Raw Score	**10 y.o.**	**15 y.o.**	**20 y.o.**	**25 y.o.**	**30 y.o.**
0	56	55	55	55	55
1	62	58	55	55	55
2	69	64	61	58	56
3	76	71	67	63	61
4	82	78	73	69	67
5	89	85	80	76	73
6	97	92	87	83	80
7	104	99	95	91	88
8	110	106	102	99	96
9	117	113	109	106	103
10	123	119	115	112	110
11	128	124	121	118	116
12	133	129	126	123	121
13	138	134	130	128	125
14	142	138	134	131	129

Table 16

IQ-Equivalent Norms for Raw Scores Obtained in the Imagery Originality Scale

Raw Score	**Originality**				
	10 y.o.	**15 y.o.**	**20 y.o.**	**25 y.o.**	**30 y.o.**
0	73	82	80	79	76
1	103	96	92	90	88
2	111	103	99	97	96
3	118	109	105	103	102
4	123	114	110	108	107
5	127	118	114	112	112
6	132	122	118	116	116
7	135	125	121	119	120
8	139	129	124	123	124
9	142	132	127	126	128
10	145	135	130	129	132
11	145	137	133	132	136
12	145	140	135	135	139
13	145	142	138	137	143
14	145	145	140	140	145

Table 17

IQ-Equivalent Norms for Raw Scores Obtained in the Imagery Transformation Scale

Raw Score	Transformation				
	10 y.o.	15 y.o.	20 y.o.	25 y.o.	30 y.o.
0	84	76	73	74	75
1	91	84	80	79	80
2	97	90	85	84	83
3	101	95	90	88	87
4	106	99	94	91	90
5	110	103	98	95	94
6	114	107	102	99	97
7	117	111	106	102	100
8	121	115	110	106	104
9	125	119	113	109	107
10	128	123	117	113	110
11	132	127	122	117	114
12	135	131	126	122	119
13	139	136	132	128	125
14	143	142	144	137	133

7.2. TCIA-S (SHORT VERSION) NORMS

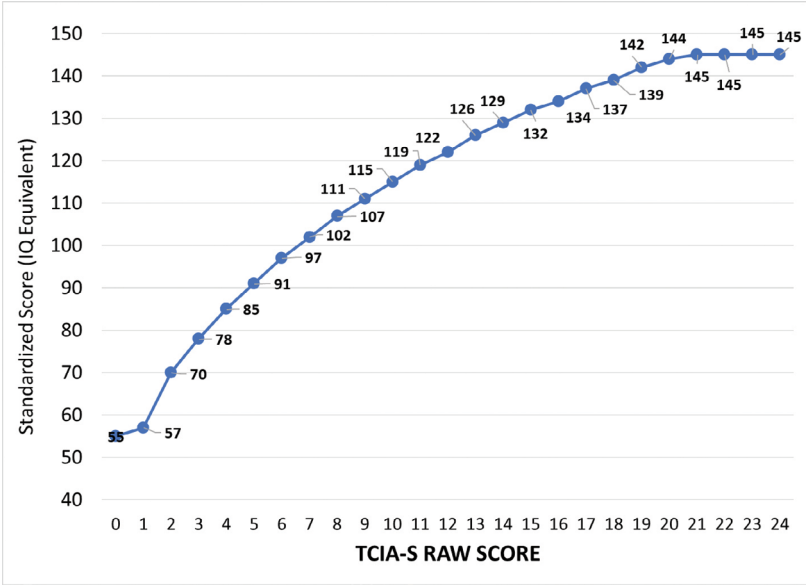


Figure 18. IQ-Equivalent Norms for the Raw Total Score of the TCIA-S

Table 18

IQ-Equivalent Norms and Percentiles for Raw Scores Obtained in TCIA-S Scales

	Vividness		Originality		Transformation	
Raw Score	**IQ Scale**	**Percentile**	**IQ Scale**	**Percentile**	**IQ Scale**	**Percentile**
0	61	0,48	93	32	82	11
1	68	1,6	110	75	93	31
2	76	5	121	92	99	48
3	86	18	129	97	105	64
4	100	51	135	99	111	76
5	114	82	139	99	116	86
6	124	94	143	99	122	93
7	131	98	147	99	128	97
8	137	99	152	99	136	99

References

Anastasi, A., & Schaefer, C. E. (1971). The Franck Drawing Completion Test as a measure of creativity. *The Journal of Genetic Psychology: Research and Theory on Human Development, 119*, 3-12. https://doi.org/10.1080/00221325.1971.10532620

Artola, T., Ancillo, I., Mosteiro, P. Y., & Barraca, J. (2004). *PIC-N: Prueba de Imaginación Creativa: Test Psicométrico*. Madrid, TEA Ediciones.

Artola, T., Barraca, J., Mosteiro, P., Martín, C., Ancillo, I., & Poveda, B. (2008). *PIC-J: Prueba de Imaginación Creativa para adolescentes y jóvenes: Test Psicométrico*. Madrid, TEA Ediciones.

Ball, O. E., & Torrance, E. P. (1984). *Torrance Tests of Creative Thinking: Streamlined scoring guide Figural A and B.* Bensenville, IL: Scholastic Testing Service.

Barraca, J., Poveda, B., Artola, T., Mosteiro, P., Sanchez, N., & Ancillo, I. (2010). Three version of a new test for assessing creativity in Spanish population (PIC-N, PIC-J, PIC-A). ECHA Conference, Paris, July 7-9.

Barron, F. (1958). The psychology of imagination. *Scientific American, 199*(3), 150–170. https://doi.org/10.1038/scientificamerican0958-150

Beghetto, R. A. (2016). Creative learning: A fresh look. *Journal of Cognitive Education and Psychology, 15*(1), 6–23. https://doi.org/10.1891/1945-8959.15.1.6

Beghetto, R. A., & Karwowski, M. (2017). Toward untangling creative self-beliefs. In M. Karwowski & J. C. Kaufman (Eds.), *The creative self: Effects of self- efficacy, mindset and identity* (pp. 4–24). Academic Press.

Betts, G. H. (1909). The distribution and functions of mental imagery. *Teachers' College Columbia University Contributions to Education, 26*, 1-99.

Blackwell, S. E., Rius-Ottenheim, N., Schulte-van Maaren, Y. W. M., Carlier, I. V. E., Middelkoop, V. D., Zitman, F. G., Spinhoven, P., Holmes, E. A., & Giltay, E. J. (2013). Optimism and mental imagery: A possible cognitive marker to promote well-being? *Psychiatry Research, 206*(1), 56–61. https://doi.org/10.1016/j.psychres.2012.09.047

Blajenkova, O., Kozhevnikov, M., & Motes, M. A. (2006). Object-spatial imagery: A new self-report imagery questionnaire. *Applied Cognitive Psychology, 20*, 239-263. https://doi.org/10.1002/acp.1182

Borst, G., & Kosslyn, S. M. (2008). Visual mental imagery and visual perception: Structural equivalence revealed by scanning processes. *Memory & Cognition, 36*(4), 849-862. https://doi.org/10.3758/MC.36.4.849

Brogaard, B., & Gatzia, D. E. (2017). Unconscious imagination and the mental imagery debate. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.00799

Chalmers, R. P. (2012). mirt: A multidimensional item response theory package for the R environment. *Journal of Statistical Software, 48*(6), 1-29. doi:10.18637/jss.v048.i06

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling, 14,* 464-504. http://dx.doi.org/10.1080/10705510701301834.

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling, 9,* 233-255. http://dx.doi.org/10.1207/s15328007sem0902_5

Cheung, M.W-L. (2014). Modeling dependent effect sizes with three-level meta-analyses: A structura2l equation modeling approach. *Psychological Methods, 2,* 211-29. https://doi.org/10.1037/a0032968

D'Angiulli, A., & Reeves, A. (2007). The relationship between self-reported vividness and latency during mental size scaling of everyday items: Phenomenological evidence of different types of imagery. *The American Journal of Psychology, 120*(4), 521. https://doi.org/10.2307/20445424

Dean, G. M., & Morris, P. E. (2003). The relationship between self-reports of imagery and spatial ability. *British Journal of Psychology, 94*(2), 245-273. https://doi.org/10.1348/000712603321661912

D'Esposito, M., Detre, J., Aguirre, G., Stallcup, M., Alsop, D., Tippet, L., & Farah, M. (1997). A functional MRI study of mental image generation. *Neuropsychologia, 35*(5), 725-730. https://doi.org/10.1016/S0028-3932(96)00121-2

Dziedziewicz, D., Gajda, A., & Karwowski, M. (2014). Developing children's intercultural competence and creativity. *Thinking Skills and Creativity, 13*, 32–42. http://dx.doi.org/10.1016/j.tsc.2014.02.006

Dziedziewicz, D., & Karwowski, M. (2015). Development of children's creative visual imagination: A theoretical model and enhancement programmes. *Education 3-13: International Journal of Primary, Elementary and Early Years Education, 43*(4), 23-33. http://dx.doi.org/10.1080/03004279.2015.1020646

Dziedziewicz, D., Olędzka, D., & Karwowski, M. (2013). Developing 4- to 6-year-old children's figural creativity using a doodle-book program. *Thinking Skills and Creativity, 9*, 85–95. http://dx.doi.org/10.1016/j.tsc.2012.09.004

Faw, B. (2009). Conflicting intuitions may be based on differing abilities – evidence from mental imaging research. *Journal of Consciousness Studies, 16*, 45-68.

Finke, R. A. (1990). *Creative imagery: Discoveries and inventions in visualization.* Lawrence Erlbaum Associates, Inc.

Finke, R. A., Pinker, S., & Farah, M. J. (1989). Reinterpreting visual patterns in mental imagery. *Cognitive Science, 13*(1), 51-78. https://doi.org/10.1207/s15516709cog1301_2

Finke, R. A., & Slayton, K. (1988). Explorations of creative visual synthesis in mental imagery. *Memory & Cognition, 16*(3), 252-257. https://doi.org/10.3758/BF03197758

Finke, R. A., Ward, T. B., & Smith, S. M. (1992). *Creative cognition: Theory, research, and applications.* The MIT Press.

Franck, K., & Rosen, E. (1949). A projective test of masculinity-femininity. *Journal of Consulting Psychology, 13*(4), 247–256. https://doi.org/10.1037/h0057315

Gajda, A., Karwowski, M., & Beghetto, R. A. (2017). Creativity and academic achievement: A meta-analysis. *Journal of Educational Psychology, 109*(2), 269–299. https://doi.org/10.1037/edu0000133

Galton, F. (1880). Statistics of mental imagery. *Mind, 5*, 301– 318.

Garaigordobil, M., & Pérez, J. I. (2002). Análisis predictivo y correlacional de la creatividad gráfica y verbal con otros rasgos de la personalidad infantil. *Revista de Psicología General y Aplicada, 55*, 373-390.

Gerwig, A., Miroshnik, K., Forthmann, B., Benedek, M., Karwowski, M., & Holling, H. (2021). The relationship of intelligence and divergent thinking: A meta-analytic update. *Journal of Intelligence.*

Gralewski, J., & Karwowski, M. (2012). Creativity and school grades: A case from Poland. *Thinking Skills and Creativity, 7*, 198–208. http://dx.doi.org/10.1016/j.tsc.2012.03.002

Guarnera, M., Pellerone, M., Commodari, E., Valenti, G. D., & Buccheri, S. L. (2019). Mental images and school learning: A longitudinal study on children. *Frontiers in Psychology, 10*. https://doi.org/10.3389/fpsyg.2019.02034

Guilford, J. P. (1956). The structure of intellect. *Psychological Bulletin, 53*(4), 267–293. https://doi.org/10.1037/h0040755

Hancock, G. R., & Mueller, R. O. (2001). Rethinking construct reliability within latent variable systems. In R. Cudeck, S. du Toit, D. Sörbom (Eds.), *Structural equation modeling: Present and future – A festschrift in honor of Karl Jöreskog* (pp. 195–216). . Lincolnwood, IL: Scientific Software International, Inc.

Helstrup, T., & Anderson, R. E. (1991). Imagery in mental construction and decomposition tasks. In R. H. Logie & M. Denis (Eds.), *Mental images in human cognition* (pp. 229-240). Amsterdam: Elsevier.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6,* 1–55. http://dx.doi.org/10.1080/10705519909540118

Intons-Peterson, M. J. (1993). Imagery's role in creativity and discovery. In B. Roskos-Ewoldsen, M. J. Intons-Peterson and R. E. Anderson (Eds.), *Imagery, creativity, and discovery: A cognitive perspective* (pp. 1-37). North Holland.

Jankowska, D. M., Czerwonka, M., Lebuda, I., & Karwowski, M. (2018). Exploring the creative process: Integrating psychometric and eye-tracking approaches. *Frontiers in Psychology, 9*. https://doi.org/10.3389/fpsyg.2018.01931

Jankowska, D. M., & Gralewski, J. (2020). The familial context of children's creativity: parenting styles and the climate for creativity in parent-child relationship. *Creativity Studies. https://psyarxiv.com/2b35p/*

Jankowska, D. M., & Karwowski, M. (2015). Measuring creative imagery abilities. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2015.01591

Jankowska, D. M., & Karwowski, M. (2020). Visual imagery and creativity: The Polish version of Vividness of Visual Imagery Questionnaire and its links with creativity. https://psyarxiv.com/eyfxr

Jasińska, A., & Modzelewski, M. (2012). Można inaczej. *Wykorzystanie IRT do konstrukcji testów osiągnięć szkolnych* [It could be done differently. Application of the IRT to construction of the school achievement tests] (pp. 157-168). In B. Niemierko, K. Szmigel (Eds.), Regionalne i lokalne diagnozy edukacyjne, Wrocław: PTDE.

Kālis, E., Roke, L., & Krumina, I. (2014). Investigation of psychometric properties of the Test for Creative Thinking-Drawing Production: Evidence from study in Latvia. *Journal of Creative Behavior, 50*(1), 47-63. https://doi.org/10.1002/jocb.68

Karwowski, M. (2008). Measuring creativity using the Test of Creative Imagination (TCI). Part 1. Presentation of a new instrument to measure creative potential. *New Educational Review, 1*, 44-54.

Karwowski, M. (2009). *Zgłębianie kreatywności. Studia nad pomiarem poziomu i stylu twórczości* [Exploring creativity. Studies on measuring the level and style of creativity]. Wydawnictwo APS.

Karwowski, M., & Beghetto, R. A. (2019). Creative behavior as agentic action. *Psychology of Aesthetics, Creativity, and the Arts, 13*(4), 402–415. https://doi.org/10.1037/aca0000190

Karwowski, M., & Gralewski, J. (2013). Threshold hypothesis: Fact or Artifact? *Thinking Skills and Creativity, 8*, 25-33. http://dx.doi.org/10.1016/j.tsc.2012.05.003

Karwowski, M., & Jankowska, D. M. (2019). Sir Francis Galton and the statistics of mental imagery. In V. P. Glăveanu, (Ed)., *The Creativity Reader* (pp. 87-109). Oxford University Press.

Karwowski, M., Jankowska, D. M., Brzeski, A., Czerwonka, M., Gajda, A., Lebuda, I., & Beghetto, R. A. (2020). Delving into creativity and learning. *Creativity Research Journal*, *32*(1), 4–16. https://doi.org/10.1080/10400419.2020.1712165

Karwowski, M., & Lebuda, I. (2016). The big five, the huge two, and creative self-beliefs: A meta-analysis. *Psychology of Aesthetics, Creativity, and the Arts, 10*(2), 214–232. https://doi.org/10.1037/aca0000035

Kihlstrom, J. F., Glisky, M. L., Peterson, M. A., Harvey, E. M., & Rose, P. M. (1991). Vividness and control of mental imagery: A psychometric analysis. *Journal of Mental Imagery, 15*, 133–142.

Kim, K. H. (2005). Can only intelligent people be creative? A meta-analysis. *Journal of Secondary Gifted Education, 16*(2-3), 57–66. https://doi.org/10.4219/jsge-2005-473

Kim, K. H. (2017). The Torrance Tests of Creative Thinking - Figural or Verbal: Which one should we use? *Creativity. Theories-Research-Applications, 4*(2), 302-321. https://doi.org/10.1515/ctra-2017-0015

Kline, R. B. (2010). *Principles and practice of structural equation modeling*, 3rd Edn. Guilford Press.

Kosslyn, S. M. (1994). *Image and brain: The resolution of imagery debate.* MIT Press.

Kosslyn, S. M., Seger, C., Pani, J. R., & Hillger, L. A. (1990). When is imagery used in everyday life? A diary study. *Journal of Mental Imagery, 14*(3-4), 131–152.

Kosslyn, S. M., Thompson, W. L., & Ganis, G. (2010). *The case for mental imagery.* Oxford University Press.

Kozhevnikov, M., Hegarty, M., & Mayer, R. E. (2002). Revising the visualizer-verbalizer dimension: Evidence for two types of visualizers. *Cognition and Instruction, 20*(1), 47-77. https://doi.org/10.1207/S1532690XCI2001_3

LeBoutillier, N., & Marks, D. F. (2003). Mental imagery and creativity: A meta-analytic review study. *British Journal of Psychology, 94*, 29–44. https://doi.org/10.1348/000712603762842084

Markey, F. V. (1935). Imagination. *Psychological Bulletin, 32*(3), 212–236. https://doi.org/10.1037/h0058411

Marks, D. F. (1973). Visual imagery differences in the recall of pictures. *British Journal of Psychology, 64*, 17–24. https://doi.org/10.1111/j.2044-8295.1973.tb01322.x

Marks, D. F. (1995). New directions for mental imagery research. *Journal of Mental Imagery, 19*(3-4), 153–167.

Marks, D. F. (1999). Consciousness, mental imagery and action. *British Journal of Psychology, 90*, 567-585. https://doi.org/10.1348/000712699161639

Marks, D. F. (2019). I am conscious, therefore, I am: Imagery, affect, action, and a general theory of behavior. *Brain Sciences, 9*(5), 107. https://doi.org/10.3390/brainsci9050107

Martin, K. A., Moritz, S. E., & Hall, C. R. (1999). Imagery use in sport: A literature review and applied model. *The Sport Psychologist, 13*(3), 245-268. https://doi.org/10.1123/tsp.13.3.245

McAvinue, L. P., & Robertson, I. H. (2007). Measuring visual imagery ability: A review. *Imagination, Cognition and Personality, 26*(3), 191–211. https://doi.org/10.2190/3515-8169-24J8-7157

McHenry, R. E., & Shouksmith, G. A. (1970). Creativity, visual imagination and suggestibility: their relationship in a group of 10-year-old children. *British Journal of Educational Psychology, 40*(2), 154–160. https://doi.org/10.1111/j.2044-8279.1970.tb02115.x

McKelvie, S. J. (1995). The VVIQ and beyond: Vividness and its measurement. *Journal of Mental Imagery, 19*(3-4), 197–252.

Miller, A. I. (2000). *Insights of genius imagery and creativity in science and art.* MIT Press.

Młodkowski, J. (1998). *Aktywność wizualna człowieka* [Human visual activity]. Warszawa – Łódź: Wydawnictwo Naukowe PWN.

Moran, A. P. (1993). Conceptual and methodological issues in the measurement of mental imagery skills in athletes. *Journal of Sport Behavior, 16*(3), 156 - 170.

Moreau, D., Clerc, J., Mansy-Dannay, A., & Guerrien, A. (2010). Assessing movement imagery ability: self-report questionnaires vs. performance based tests. *Europe's Journal of Psychology, 4*(4), 93 - 109. https://doi.org/10.5964/ejop.v6i4.225

Muthén, L. K., & Muthén, B. O. (2015). *Mplus User's Guide. Seventh Edition*. Los Angeles, CA: Muthén & Muthén.

Nelis, S., Holmes, E. A., Griffith, J. W., & Raes, F. (2014). Mental imagery during daily life: Psychometric evaluation of the Spontaneous Use of Imagery Scale (SUIS). *Psychologica Belgica, 54*(1), 19-32. http://doi.org/10.5334/pb.ag

Paivio, A. (1978). The relationship between verbal and perceptual codes. In E. C. Caterette & M. P. Friedman, (Eds.), *Handbook of perception* (pp. 375-397). Vol. IX: Perceptual processing. Academic Press. https://doi.org/10.1016/B978-0-12-161908-4.50017-6

Palmiero, M., Piccardi, L., Giancola, M., Nori, R., D'Amico, S., & Belardinelli, M. O. (2019). The format of mental imagery: from a critical review to an integrated embodied representation approach. *Cognitive Processing, 20*, 277–289. https://doi.org/10.1007/s10339-019-00908-z Pearson, D. G. (2007). Mental imagery and creative thought. *Proceedings of the British Academy, 147*, 187–212. https://doi.org//10.5871/bacad/9780197264195.003.0009

Pearson, D. G., Deeprose, C., Wallace-Hadrill, S. M., Heyes, S. B., & Holmes, E. A. (2013). Assessing mental imagery in clinical psychology: A review of imagery measures and a guiding framework. *Clinical Psychology Review, 33*(1), 1-23. https://doi.org/10.1016/j.cpr.2012.09.001

Pearson, J., Naselaris, T., Holmes, E. A., & Kosslyn, S. M. (2015). Mental imagery: Functional mechanisms and clinical applications. *Trends in Cognitive Sciences, 19*(10), 590–602. https://doi.org/10.1016/j.tics.2015.08.003

Pérez-Fabello, M. J., Campos, A., & Gómez-Juncal, R. (2007). Visual imaging capacity and imagery control in fine arts students. *Perceptual and Motor Skills, 104*(3), 815–822. https://doi.org/10.2466/pms.104.3.815-822

Pylyshyn, Z. W. (1973). What the mind's eye tells the minds brain: A critique of mental imagery. *Psychological Bulletin, 80*, 1–24. https://doi.org/10.1037/h0034650

Pylyshyn, Z. W. (2003). Explaining mental imagery: now you see it, now you don't. Trends in *Cognitive Sciences, 7*, 111–112. https://doi.org/10.1016/S1364-6613(03)00004-4

Rasch, G. (1980). *Probabilistic models for some intelligence and attainment tests*, 2nd Edn. University of Chicago Press.

Raven, J., Raven, J. C., & Court, J. H. (2003). *Manual for Raven's Progressive Matrices and Vocabulary Scales*. San Antonio, TX: Harcourt Assessment.

Rawolle, M., Schultheiss, O. C., Strasser, A., & Kehr, H. M. (2017). The motivating power of visionary images: Effects on motivation, affect, and behavior. *Journal of Personality, 85*(6), 769–781. https://doi.org/10.1111/jopy.12285

Ren, F., Li, X., Zhang, H., & Wang, L. (2012). Progression of Chinese students' creative imagination from elementary through high school. *International Journal of Science Education, 34*(13), 2043–2059. https://doi.org/10.1080/09500693.2012.709334

Renner, F., Murphy, F. C., Ji, J. L., Manly, T., & Holmes, E. A. (2019). Mental imagery as a "motivational amplifier" to promote activities. *Behaviour Research and Therapy, 114,* 51-59. https://doi.org/10.1016/j.brat.2019.02.002

Revelle, W. (2020) *psych: Procedures for Personality and Psychological Research*, Northwestern University, Evanston, Illinois, USA, https://CRAN.R-project.org/package=psych Version = 2.0.8,.

Richardson, A. (1969). *Mental imagery.* Springer.

Rizza, M. G., McIntosh, D. E., & McCunn, A. (2001). Profile analysis of the Woodcock-Johnson III Tests of Cognitive Abilities with gifted students. *Psychology in the Schools, 38*(5), 447–455. https://doi.org/10.1002/pits.1033

Sadoski, M., & Paivio, A. (2013). *Imagery and text: A dual coding theory of reading and writing.* Routledge.

Samejima, F. (1969). Estimation of a latent ability using a response pattern of graded scores. *Psychometrika Monographs, 34*(Suppl. 4).

Schaefer, C. (1970). Developmental of an originality scale for the Franck Drawing Completion Test. *Perceptual and Motor Skill, 31*(2), 402. https://doi.org/10.2466/pms.1970.31.2.402

Schifferstein, H. N. J. (2006). The relative importance of sensory modalities in product usage: a study of self-reports. *Acta Psychologica, 121*(1), 41-64. https://doi.org/10.1016/j.actpsy.2005.06.004

Schmeidler, G. (1965). Visual imagery correlated to a measure creativity. *Journal of Consulting Psychology, 29*, 78–80. https://doi.org/10.1037/h0021660

Schubert, D. S. P. (1973). Intelligence as necessary but not sufficient for creativity. *The Journal of Genetic Psychology, 122*(1), 45–47. https://doi.org/10.1080/00221325.1973.10533169

Shepard, R. N. (1978). Externalization of mental images and the act of creation. In B. S. Randhawa & W. E. Coffman (Eds.), *Visual learning, thinking, and communication* (pp. 133-189). New York: Academic Press.

Shepard, R. N., & Cooper, L. A. (1982). Mental images and their transformations. The MIT Press.

Shepard, R. N., & Metzler, J. (1971). Mental rotation of three-dimensional objects. *Science 171*, 701–703. https://doi.org/10.1126/science.171.3972.701

Silvia, P. J. (2015). Intelligence and creativity are pretty similar after all. *Educational Psychology Review, 27*, 599–606. https://doi.org/10.1007/s10648-015-9299-1

Silvia, P. J., Winterstein, B. P., Willse, J. T., Barona, C. M., Cram, J. T., Hess, K. I., Martinez, J. L., & Richard, C. A. (2008). Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity, and the Arts, 2*(2), 68–85. https://doi.org/10.1037/1931-3896.2.2.68

Simpson, R. M. (1922). Creative imagination. *The American Journal of Psychology, 33*(2), 234-243. https://doi.org/10.2307/1414133

Singh, T., & Pande, N. (2017). Empirical investigation of visual imagery: An overview. *International Journal of Social Science Review, 5*(3), 541-546.

Soszyńska, E., & Francuz, P. (2007). Wpływ aktywizacji wyobraźni na myślenie dywergencyjne oraz na odbiór wrażeń płynących z ciała. In P. Francuz (Ed.), *Obrazy w umyśle. Studia nad percepcją i wyobraźnią* (pp. 291-314). Wydawnictwo Naukowe Scholar. [*Mental images in the mind. Studies of perception and mental imagery*].

Standards for educational and psychological testing. (2014). Washington, DC: American Educational Research Association.

Thomas, N. J. (1999). Are theories of imagery theories of imagination? An active perception approach to conscious mental content. *Cognitive Science, 23*(2), 207-245. https://doi.org/10.1207/s15516709cog2302_3

Thompson, W. L., Hsiao, Y., & Kosslyn, S. M. (2011). Dissociation between visual attention and visual mental imagery. *Journal of Cognitive Psychology, 23*(2), 256-263. https://doi.org/10.1080/20445911.2011.477810

Tiggemann, M., & Kemps, E. (2005). The phenomenology of food cravings: The role of mental imagery. *Appetite, 45*(3), 305–313. doi:10.1016/j.appet.2005.06.004 https://doi.org/10.1016/j.appet.2005.06.004

Tomasino, B., & Gremese, M. (2016). Effects of stimulus type and strategy on mental rotation network: An activation likelihood estimation meta-analysis. *Frontiers in Human Neuroscience.* https://doi.org/10.3389/fnhum.2015.00693

Torrance, E. P. (1962). *Guiding creative talent. Englewood Cliffs.* New York: Prentice-Hall.

Torrance, E. P. (1974). *Torrance Tests of Creative Thinking: Norms-technical manual.* Scholastic Testing Service.

Torrance, E. P., Ball, O. E., & Safter, H. T. (1992). Torrance tests of creative thinking: Streamlined scoring guide. Figural A and B. Scholastic Testing Service.

Tye, M. (1991). *The imagery debate*. MIT Press.

Verstijnen, I. M., van Leeuwen, C., Goldschmidt, G., Hamel, R., & Hennessey, J. M. (1998). Creative discovery in imagery and perception: Combining is relatively easy, restructering takes a sketch. *Acta Psychologica, 99*(2), 177–200. https://doi.org/10.1016/S0001-6918(98)00010-9

Ward, T. B. (1994). Structured imagination: The role of category structure in exemplar generation. *Cognitive Psychology, 27*, 1–40. http://dx.doi.org/10.1006/cogp.1994.1010

Ward, T. B., & Sifonis, C. M. (1997). Task demands and generative thinking: What changes and what remains the same? *Journal of Creative Behavior, 31*, 245–259. http://dx.doi.org/10.1002/j.2162-6057.1997.tb00797.x

Ward, T. B., Wilkenfeld, M. J., Sifonis, C. M., Dodds, R. A., & Saunders, K. N. (2002). The role of graded category structure in imaginative thought. *Memory & Cognition, 30*, 199–216. http://dx.doi.org/10.3758/bf03195281

Wraga, M., & Kosslyn, S. M. (2002). Imagery. In L. Nadel (Ed.), *Encyclopedia of cognitive science*. Vol. 2 (pp.446-470). Nature Publishing Group.

The manual of the TCIA is highly usable for both researchers and practitioners. The required testing conditions are well described and clear with respect to many details. The scoring guide is outlined in a way that facilitates scoring even by novice users of the test (e.g., practitioners who want to measure creative imagery ability). […] The most important feature of the manual to make the scoring work is a chapter with worked examples on how to score TCIA responses of varying quality. Hence, the complete process from preparing the test administration to scoring of the responses is well documented by the authors. […] In a nutshell, the TCIA in its current form provides a theoretically and psychometrically sound measure of creative mental imagery abilities that comes along with a highly usable manual for researchers and measurement practitioners.

Dr. Boris Forthmann, Universität Münster

This is a very well researched, easy to read and understand manual. One might even call it a companion piece since the sections on visual imagery are very comprehensive and stand on their own as an excellent reframing of how to conceptualize and define how creative mental imagery should work. Within the first few pages, it is clear that a test like this, that doesn't rely solely on the kinds of verbal problems that other creativity tests have is an important contribution to research. Additionally, while some of the older creativity test batteries have imagery or "figural" components, this tool connects the tool with newer approaches to visual cognition which render the test scores more interpretable, and greatly enhance efforts to validate the instrument via construct validity.

Dr. Richard W. Hass, Thomas Jefferson University

ISBN: 978-83-63487-48-5