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METACOGNITIVE KNOWLEDGE AND MONITORING IN CREATIVITY TESTS

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ABSTRACT. Metacognitive knowledge, one of the dimensions of metacognition, can be understood as understanding one's own cognitive skills. Monitoring corresponds to the ability to observe, reflect and experience the progress of cognitive processes and tends to be evaluated through judgments about performance. From a cognitive point of view, creativity is the name given to a group of processes that tend to facilitate the development of new and unprecedented forms of grouping. The present study aimed to investigate the metacognitive knowledge and monitoring of 171 university students during the Torrance Creative Thinking Tests – Figural and Verbal Versions. They collectively performed the creativity tests and were asked to issue estimates of their knowledge and performance. The results indicated that the relationship between metacognitive knowledge and participants' performance on creativity tests was weak and not significant. Correlations between metacognitive monitoring and test performance followed the same trend. In this way, it was possible to verify the difficulties of university students in knowing their creative abilities and accurately evaluating them.

Keywords: Metacognition; meta-creativity; university students.

CONHECIMENTO E MONITORAMENTO METACOGNITIVOS EM TESTES DE CRIATIVIDADE

RESUMO. O conhecimento metacognitivo, uma das dimensões da metacognição, pode ser entendido como a compreensão das próprias competências cognitivas. O monitoramento corresponde à capacidade de observar, refletir e experienciar o andamento dos processos cognitivos e tende a ser avaliado por meio da emissão de julgamentos sobre o desempenho. Sob o ponto de vista cognitivo, a criatividade é o nome dado a um grupo de processos que tendem a facilitar a elaboração de novas e inéditas formas de agrupamento. O presente estudo objetivou investigar o conhecimento e o monitoramento metacognitivos de 171 estudantes universitários durante a realização dos *Testes de Pensamento Criativo de Torrance – Versões Figural e Verbal*. Eles realizaram, coletivamente, os testes de criatividade e foram solicitados a emitir estimativas sobre o seu conhecimento e sobre o seu desempenho. Os resultados indicaram que a relação entre o conhecimento

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metacognitivo e o desempenho dos participantes nos testes de criatividade foi fraca e não significativa. As correlações entre o monitoramento metacognitivo e o desempenho nos testes seguiram a mesma tendência. Dessa forma, foi possível constatar dificuldades dos universitários em conhecer suas habilidades criativas e avaliá-las de forma precisa.

Palavras-chave: Metacognição; metacriatividade; estudantes universitários.

CONOCIMIENTO METACOGNITIVO Y SEGUIMIENTO EN PRUEBAS DE CREATIVIDAD

RESUMEN. El conocimiento metacognitivo, una de las dimensiones de la metacognición, puede entenderse como la comprensión de las propias habilidades cognitivas. El seguimiento corresponde a la capacidad de observar, reflexionar y experimentar el progreso de los procesos cognitivos y tiende a ser evaluado a través de juicios sobre el desempeño. Desde un punto de vista cognitivo, la creatividad es el nombre que se le da a un conjunto de procesos que tienden a facilitar el desarrollo de nuevas e inéditas formas de agrupación. El presente estudio tuvo como objetivo investigar el conocimiento metacognitivo y el seguimiento de 171 estudiantes universitarios durante las Pruebas de Pensamiento Creativo de Torrance - Versiones Figurativa y Verbal. Ellos realizaron colectivamente las pruebas de creatividad y se les pidió que emitieran estimaciones de su conocimiento y desempeño. Los resultados indicaron que la relación entre el conocimiento metacognitivo y el desempeño de los participantes en las pruebas de creatividad fue débil y no significativa. Las correlaciones entre el seguimiento metacognitivo y el rendimiento de la prueba siguieron la misma tendencia. De esta forma, fue posible constatar las dificultades de los universitarios para conocer sus habilidades creativas y evaluarlas con precisión.

Palabras clave: Metacognición; meta-creatividad; estudiantes universitarios.

Introduction

The understanding that people have of their cognitive abilities and processes is called metacognition by cognitive psychology. Flavell (1970) was the first to refer to metacognition as the knowledge an individual has about his or her own knowledge. He coined the term as the “cognition of cognition”, i.e., the knowledge of one’s own cognitive processes and products.

The Cognitive Monitoring Model was proposed by Flavell (1979) to specify the domains of metacognition. In this model, the author suggests that monitoring cognitive processes occurs through actions and interactions between four classes of phenomena: metacognitive knowledge, metacognitive experiences, cognitive objectives, and cognitive actions or strategies. According to the author, metacognitive knowledge is the belief an individual has about him/herself, including three variables (the person, the task, and the strategy) and the way they act in the course and product of cognitive processes. The person variable is divided into three more subcategories of knowledge: intraindividual, interindividual, and universal. The intraindividual subcategory relates to knowledge of one's own skills and abilities or cognitive difficulties. Interindividual refers to knowing the differences between oneself and others. Finally, the universal subcategory concerns the dominant knowledge about cognition disseminated in a given culture, such as that memory has limited capacity (Boruchovitch, Schelini & Santos, 2010). The task variable concerns

knowledge of the task to be faced, such as knowing whether it is familiar or not. Regarding the strategy variable, it refers to the most efficient ways, actions, or processes the individual knows to achieve some objectives. In this way, an individual can know how information is processed (person variable), a specific cognitive task (task variable), and the effectiveness of strategies - strategy variable (Boruchovitch et al., 2010). Thus, metacognitive knowledge can be understood as an individual's declarative knowledge and beliefs about their abilities and the factors influencing a cognitive task (Rhodes, 2019).

For Nelson and Narens (1990, 1996), two concepts are fundamental to understanding the metacognitive system: monitoring and control. Monitoring corresponds to several abilities, such as observing, reflecting, and experiencing the movement of cognitive processes, which allows a judgment and/or characterization of cognitive functioning (Nelson & Narens, 1996). Control can interrupt a cognitive activity, continue it, or modify it. Garrison and Akyol (2015) call control "metacognitive management," relating it to the term "action." In fact, in this case, the subject is acting on the cognitive process.

Metacognitive monitoring allows the individual to estimate their cognitive performance and the adaptation of this performance to the demand presented by the tasks. The information obtained through metacognitive monitoring will guide the choice and the need (if any) to change strategies, which can be understood as metacognitive control (Son & Schwartz, 2002). Monitoring is measured through the issuance of judgments (Morphew, 2020; Son & Schwartz, 2002), which can be given before, during, or after a cognitive task. Judgments made before or after carrying out a task correspond to estimates about the performance of that task, while those made during the performance of an activity can contribute to checking how favorable and adequate performance is in the pursuit of previously defined objectives.

Metacognition seems to help direct and redirect cognitive strategies. Diverse cognitive tasks, such as those covering attention, memory, perception, logical reasoning, and problem-solving, can also be enhanced by metacognitive performance (Zampieri & Schelini, 2013). Therefore, it seems plausible to consider that metacognitive processes would also be related to performance in tasks involving creativity.

Main concepts about creativity

In 1956 and 1957, Guilford developed a factor theory of intelligence according to which cognitive operations, such as memory, convergent thinking, divergent thinking, and evaluation of cognition, if applied to different information, could result in different types of productions. According to this view, creativity is based on different mental operations and particularly on divergent thinking, understood as the ability to develop a large number of ideas based on a stimulus (Plucker, 2018).

Based on Guilford's divergent thinking tasks, Torrance (1972) suggested that creativity was associated with problem-solving based on the raising of hypotheses and their investigation, which characterizes a creative process with a cognitive function. The author expanded the concept of creativity, emphasizing fluency, flexibility, originality, elaboration, expression of feelings, fantasy, unusual perspective, movements, use of contexts, expressive titles, and extension of limits (Oliveira & Wechsler, 2016). This approach points to the interaction of several elements: cognitive skills, socio-emotional aspects, and personality traits (Wechsler, 2018).

Many researchers have turned their attention to the characteristics of creative people. The line of research that highlights the “creative person” focuses on the study of personal characteristics observable in the individual and addresses cognitive abilities, personality traits, thinking styles, creativity and motivation styles, as well as values, habits, emotions, mental processes, temperament, and physiology (Nakano, Zaia & Oliveira, 2016). Wechsler (2018) best explored the characteristics of creative people, emphasizing: a) fluency, which concerns the ability to generate a large number of solutions or ideas in the face of a specific situation; b) flexibility, understood as the change of perspective when looking at a problem; c) original and innovative thinking that breaks with habitual patterns of thinking; d) high external and internal sensitivity, which is characterized by the perception of flaws in the information given or acquired, and the perception of feelings of internal discomfort; e) fantasy and imagination, which is an internalized game that can be used to solve problems and conflicts; f) nonconformity, independence of judgment and openness to new experiences, which make it possible to believe in one's own ideas for creative production, despite others; g) the use of analogies and unusual combinations, which can be described as playing with ideas, colors, shapes and concepts to achieve unlikely juxtapositions; h) elaborated and enriched ideas that mean the detailing of the final forms of the idea.

To the extent that human beings have a “self-correction system” to know what they have learned and what they should learn, the hypothesis is raised that metacognition operates on creativity. This is because creative thinking uses cognitive components, such as fluency, flexibility, and elaboration, to expand the range of possible solutions to a problem that does not have a simple and direct answer, that is, to express one’s own creativity. Therefore, it is possible to assume that knowing these components and monitoring and controlling them through metacognitive skills because of an objective would make performance more satisfactory.

Metacognition and creativity

Metacognitive knowledge and monitoring guide individuals to select, evaluate, and utilize cognitive strategies that are valuable for creativity. Empirically, international studies indicate that metacognitive knowledge contributes to creativity (Jia, Li & Cao, 2019). For example, Erbas and Bas (2015) found a moderate correlation between metacognitive knowledge and creativity; Puente-Diaz and Cavazos-Arroyo (2018) reported that metacognitive experiences had a positive influence on originality scores regarding a divergent thinking task; Pesout and Nietfeld (2021) asked 350 university students to judge their performance on the Torrance Tests of Creative Thinking, in which participants were overconfident in their judgments of creative performance.

In the Brazilian context, studies that propose the relationship between the constructs of metacognition and creativity are lacking. Most of the research analyzes some metacognitive skills in artists, gifted people, and inventors when performing tasks that involve creativity and in elementary school students and teachers in the teaching-learning process without addressing the relationship between knowledge and metacognitive monitoring and creativity.

To produce knowledge about the relationship between metacognition and creativity, Deffendi and Schelini (2017) investigated the metacognitive monitoring of university students through judgment (estimation) about performance in tasks involving verbal creative processes. The authors found that the study population seemed to have few metacognitive monitoring skills

in tasks involving creativity, as the relationships between actual and estimated performance tended to be weak and non-significant. They also emphasized that the technique adopted to evaluate the metacognitive monitoring of the participants, the Creativity Monitoring Technique (CMT, previously called the Metacognitive Monitoring Scale), needed to be improved to more adequately access the notions of creativity assessed by the Torrance Test of Creative Thinking – Verbal, since this may have presented broad concepts in the description of the characteristics that make up the verbal creative index 1 (fluency, flexibility, elaboration, and originality), and this may have partially caused the low correlations found between the actual performance in the creativity test and estimated performance in the technique. The authors also suggested that figural creativity be considered on another occasion so that creative metacognitive monitoring addresses the cognitive components of this capacity globally and not just in its verbal dimension. They also highlighted the importance of evaluating metacognitive knowledge in the future and its implications for monitoring, considering that knowledge is important in identifying and representing situations that facilitate access to the strategies available in the individual's conscious decision-making, as well as how it allows the evaluation of final or intermediate results.

Reflecting, planning, organizing strategies, using crystallized knowledge, and paying attention to relevant information facilitate the creative process. In the expression of creativity, not only the act of thinking is important, but also the self-reflection of individuals on the way they do it and how they could do it "better," that is, their metacognitive evaluation of the creative process (Defendi & Schelini, 2017).

The general objective of this study was to investigate the metacognitive knowledge and monitoring of university students in tasks involving verbal and figural creativity. The specific objectives were 1) to analyze the relationships between the participants' metacognitive knowledge about their own creativity and their actual performance in figural and verbal creativity tests; 2) to check the relationships between actual performance in figural and verbal creativity tests and the estimated performance (metacognitive judgment) by participants in these tests; and 3) to investigate the relationships between actual performance in the creative characteristics of fluency, flexibility, elaboration, and originality.

Method

Participants

Participants were 171 university students, 103 males (M) and 68 females (F), aged between 17 and 51 years (mean=22.44; SD= 5.91), from public (47) and private institutions (124). The courses covered were Occupational Therapy (M=1; F=33), Accounting Sciences (M=7; F=12), Computer Science (M=34; F=2), Biology (M=5; F=6), Graphic Design (M=17; F=8), Digital Games (M=25; F=5), Systems Analysis and Development (M=12; F=2), Chemical Engineering (F=1), and Electrical Engineering (M=1).

Material

Creativity was assessed using the Torrance Tests of Creative Thinking– Figural and Verbal, adapted by Wechsler (2004). The Torrance Test of Creative Thinking, in its figural version, consists of three activities with traits to be completed. The verbal version contains six activities for which questions, causes, consequences, or ideas that can improve a

product are requested. Participants' responses are evaluated according to cognitive and emotional characteristics or indicators related to creativity (Wechsler, 2004).

In his creativity tests, which were adapted and validated for the Brazilian population (Wechsler, 2004), Torrance sought to evaluate the creative person through eight characteristics present in the verbal creativity test and 13 characteristics present in the figural creativity test. Among the 13 creative characteristics evaluated by the figural creativity test are: a) fluency, b) flexibility, c) elaboration, d) originality, e) expression of emotion, f) fantasy, g) movement, h) unusual perspective, i) internal perspective, j) use of context, k) combination of ideas, l) extension of limits, and m) expressive titles. The analysis of responses to the Figural Creativity Test allows us to obtain the figural creativity index 1 (FCI1) and the figural creativity index 2 (FCI2). The first is the set of characteristics of fluency, flexibility, originality, and elaboration. These four characteristics are considered to indicate divergent thinking. The figural creativity index 2 is the set of 13 figural creative characteristics, adding the four characteristics present in the figural creativity index 1 with the rest of the characteristics considered as the affective aspects of the creative personality.

Among the eight creativity characteristics assessed by the verbal creativity test are a) fluency, b) flexibility, c) elaboration, d) originality, e) expression of emotion, f) fantasy, g) unusual perspective, and h) use of analogies and metaphors. The analysis of responses to the Verbal Creativity Test also allows obtaining the verbal creativity index 1 (VCI1) and the verbal creativity index 2 (VCI2). The first is based on the scores for the set of characteristics of fluency, flexibility, originality, and elaboration. These four characteristics are considered to indicate divergent thinking. The verbal creativity index 2 (VCI2) is the sum of the scores for the set of eight verbal creativity characteristics, adding the four characteristics present in the verbal creativity index 1 (VCI1) with the rest of the characteristics that consider the affective aspects of the creative personality.

The Figural Creativity Monitoring Technique (FCMT – Deffendi & Schelini, 2017) and the Verbal Creativity Monitoring Technique (VCMT – Deffendi & Schelini, 2017) were used to verify the metacognitive judgment of performances in the creativity tests. The idea was that participants, after carrying out the Torrance tests, would estimate their performance according to each of the four characteristics of the Figural 1 and Verbal 1 creativity indices and answer whether they were able to propose, in general, creative solutions to problems proposed by the test activities.

The FCMT and VCMT are techniques composed of three and six questions, respectively, relating to each of the creativity test activities, and the participant must mark between 0 and 10 in the answer to each item in the question. The value 0 is representative of the lowest estimated performance (the participant does not consider that they have presented good ideas in the creativity tests), and the value 10 is indicative of the best-estimated performance. There was also a final question about performance on the test in general so that the participant could indicate values between 0 and 10.

The questions that make up the techniques were created based on the material proposed by Deffendi and Schelini (2017) to access metacognitive monitoring in tasks involving creativity and the description of the creative characteristics comprising the figural and verbal creativity indices 1 (fluency, flexibility, elaboration, and originality) presented by Wechsler (2004) in the manual for the Assessment of Creativity through Pictures and Words tests. The techniques were constructed so that the participant can judge their performance according to their ability to generate a large number of ideas when faced with the task (fluency), change perspective when looking at the problem (flexibility), detail the ideas proposed to solve the problem (elaboration), propose innovative solutions to the problem,

breaking with habitual thought patterns (originality), and generally propose creative solutions. These characteristics were chosen among all, as they are those that refer to the cognitive aspects of creativity.

To assess the participants' metacognitive knowledge, the Metacognitive Knowledge of Creativity Technique (MKCT) was developed based on the same precepts used in the elaboration and reformulation of the CMT (Defendi & Schelini, 2017). However, this technique did not aim to access the estimated performance (understood as a measure of metacognitive monitoring) of participants in tasks involving creativity, but the knowledge they have about their own creative abilities.

Procedure

The study proposal was sent for analysis by the Human Research Ethics Committee, and after its approval (CAAE: 56249016.0.0000.5504), the coordinators of several undergraduate programs in two municipalities in the interior of the state of São Paulo were contacted to check the availability of students and recruit them to participate in the proposed procedure. Afterward, groups of participants were formed, divided by course, to apply the procedure so that each subject went through a single collective session lasting approximately 1h40 min.

Participants received the Informed Consent and upon agreeing to participate in the research, first responded to the Metacognitive Knowledge of Creativity Technique (MKCT) and the Torrance Tests of Creative Thinking – Figural and Verbal. Next, some concepts related to creativity and the creative person were explained to the participants, specifically those about the cognitive characteristics of creativity, which were those addressed in the study so that they could respond to the Creativity Monitoring Techniques (FCMT and VCMT). These concepts were presented following the theoretical foundation used to construct the techniques and to minimize the effects of a possible lack of understanding of the terms when filling out the instrument. The aim of this explanation was not to name the characteristics because participants were not expected to relate their names to their descriptions. Below is the description given orally to the participants before the application of metacognitive monitoring techniques (based on the definitions pointed out by Wechsler, 2004):

"Creativity is the process of becoming sensitive to problems and/or gaps in the environment, identifying difficulties or missing elements in the information, formulating hypotheses, testing and retesting these hypotheses, modifying them and retesting them again, and, finally, communicating the results found." Some characteristics of creative people already identified in previous studies are a) the ability to generate a large number of solutions or ideas in the face of a specific situation, b) the ability to change perspective when looking at a problem, c) the ability to break with habitual patterns of thinking, and d) the ability to elaborate and enrich ideas, to detail them and transform them into products."

Results

First, participants' responses were evaluated in each of the three activities of the Torrance Test of Creative Thinking– Figural and the six activities of the Torrance Test of Creative Thinking– Verbal. Among the characteristics assessed by the figural and verbal creativity tests, the four that make up the figural and verbal creativity indices 1 were emphasized in the data analysis, as they represent only cognitive indicators, while the other

characteristics are also influenced by emotional indicators. Next, the distribution of participants' responses in the creativity tests, the Metacognitive Knowledge of Creativity Technique, and the Figural and Verbal Creativity Monitoring Techniques were verified so that the most appropriate statistical test was selected for the subsequent correlational analysis. As the data were not normal, Spearman Correlation was applied. The results referring to the Torrance Tests of Creative Thinking– Figural and Verbal were correlated to the results of the Metacognitive Knowledge of Creativity Technique (MKCT) and the results of the Figural and Verbal Creativity Monitoring Techniques (FCMT and VCMT), also considering each one of the four characteristics that make up the figural and verbal creativity indices 1 (fluency, flexibility, elaboration, and originality).

Table 1 lists the descriptive statistics of the 171 participants in the three activities comprising the Torrance Test of Creative Thinking - Figural, in the six activities comprising the Torrance Test of Creative Thinking - Verbal, in the Figural and Verbal Creativity Monitoring Techniques (FCMT and VCMT) and the Metacognitive Knowledge of Creativity Technique (MKCT). For a proper understanding of the table, it is worth noting that, according to the test manual, the characteristics "fluency" and "flexibility" are not assessed in activity 1 of the figural test, and the characteristic "flexibility" is not assessed in activity 6 of the verbal test.

Table 1. Descriptive statistics of participants' performance in the Creativity Tests, MKCT, FCMT, and VCMT (N=171).

	Minimum	**Maximum**	**M**	**SD**
Fluency	0	20	12.51	4.21
Flexibility	3	145	14.22	10.25
Elaboration	2	225	21.69	23.38
Originality	0	185	19.94	13.68
Total Figural Creativity Test Score (FCI 1)	33	207	85.81	32.40
Total Verbal Creativity Test Score (VCI 1)	20	191	70.78	28.99
MKCT	2	10	6.66	1.43
Overall FCMT	0	10	6.77	1.98
Overall VCMT	1	10	6.60	1.58

Note: MKCT = Metacognitive Knowledge of Creativity Technique; Overall FCMT = Figural Creativity Monitoring Technique; Overall VCMT = Verbal Creativity Monitoring Technique.

Regarding performance in the creativity tests, using the Kolmogorov-Smirnov test, the responses of the 171 participants presented a non-normal distribution for both Figural (M = 85.81 and SD = 32.40) and Verbal (M = 70.78 and SD= 28.99) tests. Data referring to knowledge techniques (M = 6.66; SD= 1.43) and figural (M = 6.77; SD= 1.98) and verbal (M = 6.60; SD= 1.58) metacognitive monitoring followed the same trend and, for this reason, non-parametric statistical tests were used in subsequent (correlational) analyses that included measures of creativity in the total sample and measures of metacognitive knowledge and monitoring. The interpretation of the magnitude of the correlations was based on Dancey and Reidy (2018), in which a correlation can be considered high with r >=0.7, moderate with 0.4 >r<0.6, and weak with r ≤ 0.3, and normality tests were expressed in significance levels.

Firstly, and in the form of text, because the table generated is a single line, the results referring to the correlations between the figural creativity test and the metacognition assessment techniques are presented, followed by data referring to the relationship between the latter and scores on verbal creativity tests. The results indicated no significant correlation between the total scores on the figural creativity test (referring to the score on the figural creativity index 1) and the Metacognitive Knowledge of Creativity Technique (MKCT) (rho=-0.003). The correlations between MKCT scores and individual scores for the creative characteristics of fluency (*rho*=-0.037) and flexibility (*rho*=-0.042) were also weak, negative, and non-significant. Between the MKCT scores and the elaboration (*rho*=0.025) and originality (*rho*=0.069) characteristics, the correlations were also weak, non-significant, but positive.

The correlation between total scores on the creativity test (FCI 1) and the Figural Creativity Monitoring Technique (FCMT) was non-significant but was positive and weak (*rho*=0.217). The correlations between FCMT scores and individual scores for the creative characteristics of fluency (*rho*=0.231), flexibility (*rho*=0.197), elaboration (*rho*=0.141), and originality (*rho*=0.247) followed the same trend (*p*= 0.01).

The correlation data obtained between the scores on the verbal creativity test (expressed by the verbal creativity index 1) and the techniques that measure metacognition (MKCT and VCMT), as well as between these techniques and each cognitive characteristic of creativity that make up the VCI 1 are presented below.

The results showed no significant correlation between the total scores on the creativity test (VCI 1) and the Knowledge of Creativity Technique (MKCT) (*rho*=0.135). The correlations between MKCT scores and individual scores for the creative characteristics of fluency (*rho*=0.088), flexibility (*rho*=0.085), and elaboration (*rho*=0.109) were also weak, positive, and non-significant. Between the MKCT scores and the originality characteristic (*rho*=0.191), the relationship was also weak, positive, but significant (*p*= 0.05). The correlation between total scores on the creativity test (VCI 1) and the Verbal Creativity Monitoring Technique (VCMT) was also non-significant but was positive and weak (*rho*=0.234). The correlations between VCMT scores and individual scores for the creative characteristics of fluency (*rho*=0.197), flexibility (*rho*=0.218), elaboration (*rho*=0.121), and originality (*rho*=0.240) followed the same trend (*p*= 0.01).

Discussion

To produce data about metacognitive knowledge and monitoring of creativity in university students, this study was designed so that participants indicated their knowledge and estimated their performance in activities involving figural and verbal creativity processes. Analyzing prior knowledge and the relationships between actual performance on creativity measures and estimated performance (metacognitive judgment) by participants on these measures were the main objectives of this research.

The total scores on the figural and verbal creativity indices 1 and the Metacognitive Knowledge of Creativity Technique (MKCT were not significantly correlated, so there was no relationship between actual performance on the tests and participants' prior knowledge about their own creativity. The correlations between MKCT and the characteristics of figural creativity were also weak and non-significant, as well as between this technique and the verbal creativity characteristics of fluency, flexibility, and elaboration. Between originality (of the verbal test) and MKCT, there was statistical significance, but the relationship remained weak. Erbas and Bas (2015) found a moderate correlation between metacognitive

knowledge and creativity, so their results disagreed with our findings. This may suggest, hypothetically, that there is a lack of self-knowledge among the participants in this research about their own creative abilities. Although the correlations, in general, were weak, they had greater magnitude between the estimates in the technique and the results in the verbal creativity tests, perhaps because the population covered has greater knowledge about their productions that involve more objective stimuli, such as verbal language, to the detriment of those that only involve drawings/figures, which are even more subjective.

Regarding the relationship between the actual performance in the creativity tests and the scores obtained in the Creativity Monitoring Techniques, there were no significant correlations for both tests (figural and verbal). Such data also seem to suggest a difficulty in the metacognitive monitoring of participants. This result corroborates Pesout and Nietfeld (2021), which found that participating university students provided discordant estimates of actual creative performance.

One hypothesis that could explain the low correlations between actual performance in the creativity test and estimated performance in the technique evaluating metacognitive monitoring is the complexity of the activities proposed by the Torrance Tests of Creative Thinking. Pieschl (2009) argues that tasks can be classified according to the degree of complexity, that is, the level of knowledge and cognitive operations required by each activity. Information recall activities have a lower degree of complexity than tasks that require content understanding. These, in turn, are less complex than tasks that require the application of acquired knowledge.

Test activities can be considered complex in that, to achieve fluent, flexible, elaborate, and original solutions, many cognitive operations are required. Furthermore, the instructions that guide participants to solve the problems proposed by the test point there are no right or wrong answers, expanding the range of possible possibilities for this resolution and making it difficult to subsequently formulate estimates about actual performance (Defendi & Schelini, 2017).

In general, the tasks proposed by the creativity tests are unfamiliar to the participants, and this seems to confirm the explanation that mastery of the topic favors the accuracy of judgments, which, in this case, showed weak correlations with actual performance. Notably, the accuracy of judgments tends to increase as the individual acquires greater contact with the task they perform (Efklides, 2006). Thus, the low correlations between the FCMT and VCMT and the scores on the figural and verbal creativity tests, respectively, can be explained by the little exposure of university students to creative proposals (Alencar, Fleith & Pereira, 2017; Plucker, 2022), since low exposure can make training difficult to monitor the execution of tasks that involve creativity, as well as making self-knowledge about these abilities difficult.

Even though universities attach importance to creativity in professional training, many of them do not promote the expression of creative skills or original and divergent ideas (Alencar et al., 2017). Creativity is rarely a learning objective included in higher education curricula, with many professors not prepared or familiar with situations that enable creative expression (Alencar et al., 2017; Pereira-Guizzo et al., 2021). Beyond universities, creativity has been neglected throughout the Brazilian educational system, with exceptions (Alencar et al., 2017; Pereira-Guizzo et al., 2021).

Furthermore, metacognitive knowledge and monitoring of tasks that involve creativity can be more difficult because, in this type of task, there seem to be no right or wrong answers as in cognitive tasks that involve more objective answers, with a greater possibility of verifying mistakes and successes in issuing responses. This occurs because, for these

tasks, feedback and corrections are not provided to inform the individual about their performance (Defendi & Schelini, 2017).

Maki and McGuire (2002) emphasize that contact with performance information provides conditions for the individual to compare their metacognitive experiences and estimates with their actual performance. In other words, the less exposure to creative tasks, the less likely individuals are to receive feedback from the environment, which could lead to less accurate judgments and difficulty in understanding their own creativity (metacognitive knowledge).

Final considerations

A contribution of the present study to be highlighted is the production of data still poorly explored in Brazil on the relationship between metacognition and the cognitive dimension of creativity. Based on the information that adequate metacognitive monitoring accompanies good cognitive performance, it becomes interesting to consider the possibility of stimulating metacognitive skills as a strategy for optimizing individuals' performance in tasks with cognitive demand, including in this demand the tasks that involve creativity.

Promoting favorable conditions for the development of metacognitive abilities, such as knowledge and monitoring, for example, can assist in the autonomy of individuals in their creation process. Some authors agree that most people have a creative potential to be developed (Wechsler, 2018; Plucker, 2022), so creativity is present in a large portion of the population, at least latently, and could emerge spontaneously as long as it is not inhibited. Thus, favorable conditions would act as a "fertile soil" for creative skill to emerge from creative potential (Spadari, Nakano & Peixoto, 2017).

One limitation of the study is the homogeneity of the sample, which, although significant, only included university students, a very common population in this type of research due to its ease of access. For future investigations, heterogeneity in the variable "participants" is suggested concerning years of study, age, types of schools (and teaching) attended, and even parental style.

Another aspect that should be considered in future investigations is the applicability of the Metacognitive Knowledge of Creativity Technique (MKCT), which needs to be improved to more adequately access the notions of creativity assessed by the Torrance Tests of Creative Thinking. Because it only has one item, the technique may have had a limited scope of participants' knowledge about their own creativity, which may be related to the low correlations found between actual performance in creativity tests and metacognitive knowledge measured in the technique. Developing items to measure knowledge of creative cognitive characteristics individually, as is done in creativity monitoring techniques (FCMT and VCMT), can be a way to solve this problem.

Furthermore, creativity was assessed using two versions of a test (Torrance Tests of Creative Thinking), and new research with different assessments of the cognitive dimension of creativity can be a means of reusing and improving the techniques developed in this study to evaluate metacognition as well as to investigate the possible relationship between the two constructs. In addition to assessing creativity through other techniques, metacognitive knowledge, and monitoring are suggested to be evaluated using other instruments and at other times for higher coverage and control of the variables involved in metacognitive phenomena that involve creative performance.

This study provided the observation that the population covered seems to have little metacognitive knowledge and monitoring skills in tasks that involve creativity since the relationships between actual performance, knowledge, and estimated performance tended

to be weak and non-significant. The body of knowledge produced by this study is expected to motivate the continuation of research in this field so that investigative studies produce the benefits of formulating new hypotheses and eliminating possible biases caused by methodological limitations encountered during the application of the proposed procedure.

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