

Figural Creativity Test: Initial Investigation for Use in Adolescents and Adults

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Abstract: As part of an investigation into the psychometric qualities of the Children's Figural Creativity Test (TCFI) for adolescents and adults, the research examined factor analysis, precision, and influence of gender and educational level variables. The sample consisted of 309 individuals ($M = 33.35$ years; $SD = 22.04$), 166 females and three levels of education, who filled out the aforementioned instrument. During the exploratory factor analysis, four factors were identified: the elaboration factor (F1), the external aspects factor (F2), cognitive aspects factor (F3), and emotional aspects factor (F4). Precision of the instrument was $\omega = 0.776$. We found differences in F1 and total score favoring females, in all factors and in total creativity, favoring the group with the highest education. Prior to using the instrument with individuals older than those considered in the children's version of the test, studies investigating other psychometric characteristics are advised.

Keywords: test validity, test reliability, psychological assessment

Teste de Criatividade Figural: Investigação Inicial para Uso em Adolescentes e Adultos

Resumo: Buscando investigar as qualidades psicométricas do Teste de Criatividade Figural Infantil para uso em adolescentes e adultos, o presente estudo apresenta os resultados da análise fatorial, precisão e influência das variáveis gênero e nível de escolaridade nos resultados. A amostra foi composta por 309 participantes ($M = 33,35$ anos; $DP = 22,04$), 166 do sexo feminino e diferentes níveis de escolaridade. A análise fatorial exploratória indicou a existência de quatro fatores: elaboração (F1), aspectos externos (F2), aspectos cognitivos (F3) e aspectos emocionais (F4). A precisão do instrumento foi $\omega = 0,776$. Diferenças foram encontradas no F1 e na pontuação total, a favor do sexo feminino; e em todos os fatores e na criatividade total, a favor do grupo com maior nível de escolaridade. Estudos voltados à investigação de outras qualidades psicométricas são recomendados antes do uso do instrumento em participantes com maior idade do que a contemplada na versão infantil do teste.

Palavras-chave: validade do teste, precisão do teste, avaliação psicológica

Prueba de Creatividad Figural: Investigación Inicial para su Uso en Adolescentes y Adultos

Resumen: Buscando investigar las cualidades psicométricas del Test de Creatividad Figurativa Infantil (TCFI) para uso en adolescentes y adultos, el presente estudio presenta los resultados del análisis factorial, precisión e influencia de las variables género y nivel educativo. La muestra estuvo conformada por 309 participantes ($M = 33,35$ años; $DT = 22,04$), 166 del sexo femenino y tres niveles de instrucción, que respondieron al mencionado instrumento. El análisis factorial exploratorio indicó cuatro factores: elaboración (F1), aspectos externos (F2), aspectos cognitivos (F3) y aspectos emocionales (F4). La precisión del instrumento fue $\omega = 0,776$. Se encontraron diferencias en F1 y puntuación total a favor del sexo femenino y en todos los factores y en creatividad total, a favor del grupo con mayor nivel educativo. Se recomiendan estudios dirigidos a investigar otras cualidades psicométricas antes de utilizar el instrumento en participantes de mayor edad que la contemplada en la versión infantil del test.

Palabras clave: validación de test, precisión de test, evaluación psicológica

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Along with other constructs, creativity has been highlighted in the national and international scientific literature as one of the main skills to be valued in the 21st century (Kupers, Lehmann-Wermser, McPherson, & van Geert, 2019), thus becoming a topic of interest among researchers, educators, and policymakers. As defined by Torrance (1966, p. 8), this skill has been valued in different

contexts based on its ability to detect deficiencies in information, formulate hypotheses or guesses concerning such deficiencies, test and revise hypotheses, and then communicate the results found.

In light of the fact that creativity plays a crucial role in achieving success in personal, social, academic, and professional spheres, efforts have been made to develop it (Zhu, Shang, Jiang, Pei, & Su, 2019). Especially in today's environment of complexity and uncertainty (Lassig, 2019), creativity has become an essential economic resource (Organisation for Economic Co-operation and Development [OECD], 2019).

Among the major benefits associated with creativity, Yahn and Kaufman (2016) emphasize different levels: at a global level, it can facilitate the economic success of countries; at work, it can improve employee satisfaction; at an individual level, it can improve physical health conditions and positive moods, as well as facilitate coping with trauma. Plucker, Guo and Makel (2018) also highlight that creativity can be a driver for economic development, and a predictor of success in life, in addition to helping maintain positive mental health. Thus, different researchers have underscored such a construct as a positive and relevant characteristic for human development given its influence on positive emotional states (Vincent-Lancrin et al., 2020).

Its assessment began in the 20th century. Since then, many methods, instruments, and techniques have been proposed for the analysis of creativity. Although evaluating it is important, Brazil still lacks the instruments for this purpose in spite of the importance of evaluating it. At the present time, the country does not have any instruments available for the quantitative assessment of adolescents' and adults' creative potential, despite its previously cited benefits. It is noteworthy that a very different scenario is found in the international arena, where considerable attention has been given to the development of instruments that assess different aspects of this construct in order to account for its complexity and diversity (Said-Metwaly, Kyndt, & Van den Noortgate, 2017).

One of these instruments, the Torrance Tests, has been identified as the divergent-thinking test most widely used and cited in creativity research, having been translated into over 35 languages (Humble, Dixon, & Mpofu, 2018). In its original version (Torrance, 1966), the instrument assesses 13 creative characteristics in the figural version and eight creative characteristics in the verbal version, and in both cases, it consists of two factors (the first comprising four characteristics regarded as cognitive, and the second comprising those regarded as cognitive and emotional). Since its publication, however, several questions have arisen regarding its factor structure (Said-Metwaly, Fernández-Castilla, Kyndt, & Van den Noortgate, 2018).

Because there is no consensus regarding the number of factors, the literature has recommended studying the factor structure of creativity tests when they are intended for use in new groups not previously investigated, because previous results may not be applicable to new samples (Bart, Hokanson, & Can, 2017). It is evident from the historical interest in examining Torrance tests' factor structure that this trend has continued,

and it is evident from more recent research aimed at examining and reviewing the factor structure of these tests across various samples (Said-Metwaly et al., 2020; Said-Metwaly, Van den Noortgate, & Barbot, 2021).

This concern over the factor structure underlies the present study, since the Children's Figural Creativity Test - CFCT (Nakano, Wechsler, & Primi, 2011), which is the focus of the current study, was derived from Torrance's figural test. During psychometric studies conducted using CFCT, four factors have been identified in samples of 7 to 15-year-old children (enrichment of ideas, cognitive aspects, creative preparation, and emotional aspects). Because there are no creativity assessment instruments for adolescents, adults, and the elderly approved for use in Brazil by the System for Evaluation of Psychological Tests (SATEPSI), it is being investigated whether this instrument should be expanded to include a wider age range.

Additionally, researchers have also been interested in the influence of sociodemographic variables on creativity, in order to understand the extent to which these variables affect creative performance. The influence of gender, for example, has been explored quite extensively in recent decades, although the results are inconsistent (Prado, Alencar, & Fleith, 2016). In general, there are four strands of argument, namely female superiority, male superiority, the absence of differences, and oscillating differences, depending on the content assessed (Nakano, Oliveira, & Zaia, 2021). This study aims to determine if such a problem exists, and it should be noted that no significant differences were observed in the instrument for children.

Regarding education, most studies have reported that higher education levels are associated with greater creativity (Lemos, Gomes, & Gouveia, 2018). A significant difference between grades was found in studies using the CFCT, so normative tables were developed incorporating that variable into its manual (Nakano et al., 2011).

In light of the above, this study examined the factor structure, the accuracy, and the influence of variables "gender and education level" of the Children's Figural Creativity Test for use with adolescents and adults.

Method

Participants

A total of 309 participants, aged 14 to 84 years ($M = 33.35$ years; $SD = 22.04$), were included in the study, of whom 167 were females (54.04%). In terms of education level, 31.7% of participants had graduated from elementary school, 51.1% from high school, and 16.8% from college.

Instrument

Children's Figural Creativity Test (Nakano et al., 2011)

It consists of three activities, each requiring the response of a drawing to incomplete stimuli. First, participants are

asked to respond to a single poorly defined stimulus using a single response; second, they are asked to complete ten stimuli; and third, they are asked to illustrate as many pictures as possible in response to the same stimulus (repeated 30 times).

The instrument allows for evaluating figural creativity by scoring 12 creative characteristics: fluency (number of ideas), flexibility (diversity of types or categories of ideas), elaboration (adding details to the drawing), originality (unusual ideas), expression of emotion (expression of feelings), fantasy (presence of imaginary beings, from fairy tales or science fiction), movement (expression of movement), unusual perspective (unusual angles), internal perspective (internal view of objects), use of context (creating an environment for drawing), extending limits (extending the stimuli before concluding the drawings), and expressive titles (going beyond the obvious description of the drawing, abstracting it). The presence of each characteristic was assessed in each response provided by the participant, and the raw score for each feature was used in the analyses presented here.

The children's version proposes four factors: Factor 1 - Enrichment of Ideas (capacity to examine the situation in greater detail and from a different perspective), Factor 2 - Emotivity (use of creative resources associated with a more emotional perception), Factor 3 - Creative Preparation (characteristics evaluated in the first activity of the test that serve as a warm-up for the remaining activities) and Factor 4 - Cognitive aspects (use of cognitive resources to seek out differentiated, original solutions that go beyond the established boundaries). As a result of these factors, we can determine the areas in which an individual's creative potential is strongest and weakest. A total score is also provided by the test.

Procedures

Data collection. There was a part of the collection during the Coronavirus pandemic period; thus, the sample used was a convenience sample. A snowball method was used to select participants based on the researchers' personal contacts and through referrals. Additionally, a part of the collection was conducted after the reopening of schools, so it included students from a private university in the state of Sao Paulo.

Those who accepted the invitation answered the instrument individually in the presence of one of the researchers, taking all the necessary precautions. It was applied in a single session lasting approximately 30 minutes. In the case of minors, all applications were completed after their parents or guardians had signed the Informed Consent Form (ICF) and the participants had signed the Informed Agreement Form (IAF).

Data analysis. A confirmatory factor analysis was performed using the JASP statistical software to determine if the four-factor model found in the children's sample was also applicable to the adolescents and adults' sample.

During the analysis, an important decision was made to remove activity 1 from the analysis. Due to the difference

in the proposal, which involved the production of a single drawing, whereas the others allowed for a greater number of answers, the characteristics of the activity were grouped into a separate factor. Consequently, a shorter version of the instrument was also considered.

As a first step, the descriptive statistics of each characteristic were estimated. Following guidelines presented in the specialized literature (Muthén & Muthén, 2012), the following indexes were evaluated: chi-square (χ^2), degrees of freedom (gl), Comparative Fit Index (CFI), Tucker Lewis Index (TLI) and Root Mean Square Error of Approximation (RMSEA). CFI and TLI values should be between 0.90 and 0.95 to be understood as indicators of sufficient adjustment, with values higher than 0.95 being recommended. In terms of the RMSEA values, the aforementioned authors state that a value of less than 0.08 indicates that the model is adequate.

For accuracy analysis, McDonald's omega coefficient analysis was used, with orientation used as an interpretation parameter, according to which values between 0.60 and 0.70 are acceptable, values between 0.70 and 0.90 are good, and values above 0.90 are excellent. An analysis of means was performed using the Mann-Whitney test for gender variables, and the Kruskal-Wallis test for level of education variables. Additionally, the effect size was estimated in the analysis.

Ethical Considerations

The study was approved by the Research Ethics Committee of Pontifícia Universidade Católica de Campinas, Report No. 3.646.180, CAAE No. 21488419.1.0000.5481.

Results

An initial Confirmatory Factor Analysis (CFA) was conducted to determine whether the factor structure of the children's version was maintained in the older sample. Results revealed that the data analyzed did not support the four-factor model of the Children's Figural Creativity Test, as the chi-square value (764.92), Comparative Fit Index (0.698), and Tucker Lewis Index (0.668) were not adequate. Alternative to this, Exploratory Factor Analysis (EFA) was performed to identify the number of factors that cluster creative characteristics in the older-age group. It was estimated using maximum likelihood and varimax rotation.

Based on the KMO results of 0.761 and Bartlett's test of sphericity ($\chi^2 = 1730.42$; gl = 465.00; $p < 0.001$), the data were suitable for factor analysis. Through parallel analysis, the factor solution recommended a structure consisting of four factors. Consequently, the researchers conducted an EFA to estimate, a priori, a four-factor factor solution. In order for the factor load to be maintained, it must be at least 0.30. Table 1 shows the structure of the factor, the item loadings, and the singularity of the factors.

Table 1
Factor structure

	Enrichment of ideas	External aspects	Cognitive aspects	Emotional aspects	Uniqueness
Elab2	0.721				0.422
Ucont2	0.747				0.421
Pint2					
Mov2	0.707				0.489
Pinc2		0.414			0.715
Elab3	0.780				0.317
Pint3	0.423				0.719
Mov3	0.612				0.603
Pinc3		0.660			0.556
Ucont3	0.556				0.631
Tit2	0.664				0.453
Emo2				0.700	0.429
Fant2		0.352			0.692
Tit3	0.642				0.519
Emo3				0.688	0.509
Fant3		0.597			0.578
Flu2			0.824		0.245
Flex2			0.759		0.377
Orig2			0.639		0.548
Flu3			0.366		0.203
Flex3			0.399		0.262
Orig3			0.348		0.402
Extlim3		0.676			0.440

Note. Flu = fluency; Flex = flexibility; Fant = fantasy; Orig = originality; Extlim = extension of limits; Emo = emotion; Tit - expressive titles; Ucont = use of context; Pinc = uncommon perspective; Elab = elaboration; Mov = movement.

The first factor includes elaboration characteristics (activities 2 and 3), use of context (activities 2 and 3), movement (activities 2 and 3), internal perspective (activity 3), and expressive titles (activities 2 and 3). In the second factor, the characteristics related to unusual perspectives (activities 2 and 3), fantasy (activities 2 and 3), and extending boundaries (activity 3) were grouped. In the third factor, there were characteristics of fluency (activities 2 and 3), flexibility

(activities 2 and 3), and originality (activities 2 and 3). Finally, the fourth factor grouped the characteristic of expression of emotion in activities 2 and 3.

The correlations between factors were estimated (Table 2) and ranged from $r=0.275$ to $r=0.541$, indicating the existence of a common construct, creativity, as well as specific aspects to each factor. Additionally, the factors were significantly correlated with the total score.

Table 2
Factor's Correlations

	Ideas Enrichment	External Aspects	Cognitive Aspects	Emotional Aspects	Total score
Enrichment Ideas	1,000	0,541*	0,353*	0,402*	0,798*
External Aspects		1,000	0,608*	0,275*	0,820*
Cognite Aspects			1,000	0,198*	0,795*
Emotional Aspects				1,000	0,389*
Total score					1,000

Note. * $p < 0,001$.

Following this, McDonald’s Omega coefficient was used to estimate accuracy by means of internal consistency. Among the factors evaluated, factor 1 ($\omega = 0.846$), factor 3 ($\omega = 0.887$), and factor 4 ($\omega = 0.845$) were adequate. Among the factors, only factor 2 had a slightly lower accuracy than expected ($\omega = 0.585$). A total accuracy of 0.776 was obtained for the test.

In addition, non-parametric analysis was used to determine whether there were significant differences

between the factors and the total score according to gender and educational level. A summary of the descriptive statistics and significant results can be found in Table 3.

According to the Mann-Whitney test, there are significant differences between genders in F1 and in total creativity. In contrast, the Kruskal-Wallis test indicates significant differences with regard to education in all factors and in total creativity. There was a small effect size.

Table 3
Descriptive Statistic According to Gender and Level of Education

Variable	Gender		Mann-Whitney	Level of Education			Kruskall-Wallis	
	F (n=167)	M (n=142)		ES (n=98)	HS (n=158)	C (n=52)		
F1	M	26,19	17,1	$\omega = 4,872^{**}$	11,37	26,00	30,36	71,861 ^{**}
	SD	17,7	14,1	$d = 0,327$	9,27	15,58	21,22	$\eta^2=0,199$
F2	M	8,77	9,60	$\omega = -0,970$	6,60	9,93	11,75	17,125 ^{**}
	SD	7,74	7,13	$d = -0,094$	5,88	7,04	9,80	$\eta^2=0,063$
F3	M	42,89	42,95	$\omega = -0,035$	38,32	44,22	47,88	15,390 ^{**}
	SD	14,35	15,16	$d = 0,011$	15,31	13,83	14,05	$\eta^2=0,054$
F4	M	0,65	0,46	$\omega = 1,517$	0,24	0,67	0,86	14,123 ^{**}
	SD	1,20	1,01	$d = 0,098$	0,65	1,16	1,49	$\eta^2=0,043$
Total	M	78,52	70,20	$\omega = 2,268^*$	56,55	80,84	90,86	48,942 ^{**}
	SD	33,09	30,94	$d = 0,162$	24,38	28,60	40,36	$\eta^2=0,161$

Note. * $p < 0,05$; ** $p < 0,001$; F = female; M = male; ES = elementary school; HS = high school; C = college; F1 = ideias enrichment; F2 = external aspects; F3 = cognitive aspects; F4 = emotional aspects.

Discussion

As in the children’s version of the creativity test, the factor structure of four factors was replicated in the sample studied. In spite of this, some differences were found regarding the characteristics comprising the factors when the instrument was applied to older samples and when activity 1 was excluded.

The first factor, Enrichment of Ideas, is equivalent to the same factor in the children’s version of the instrument, which refers to the ability to perceive a situation more clearly from a different perspective (Nakano et al., 2011). It is very important for individuals to develop the ability to develop ideas by providing more details, as, often, individuals have an excellent idea, but ultimately present it in a crude, incomplete manner, which ultimately leads to rejection or difficulty in acceptance (Wechsler, 2008). By adding details to a new idea, it is possible to reduce resistance to its implementation. It was composed of characteristics such as elaboration (activities 2 and 3), context use (activities 2 and 3), movement (activities 2 and 3), internal perspective (activity 3), and expressive titles (activities 2 and 3). The difference between this factor and the comparable one in the children’s version of CFCT stems from the absence of characteristics such as “unusual perspectives and movement” as well as scores for “elaboration and unusual perspectives” in activity 1 (removed from the analysis).

Factor 2 represents the External Aspects factor. It grouped the characteristics of unusual perspective

(activities 2 and 3), fantasy (activities 2 and 3), and extending limits (activity 3), which involved considering external aspects of the drawing, especially environmental elements, namely the ability to see from an unusual angle, inserting elements involving fantasy, science fiction and fairy tales as well as reaching beyond the confines of the stimuli available. The children’s test manual does not contain any factors similar to this one.

Aspect 3, also known as Cognitive Aspects, corresponds to the factor of the same name in the CFCT. This process involves creativity that uses cognitive resources to develop differentiated, original solutions that exceed established limits (Nakano et al., 2011). Numerous research studies have documented creativity as a cognitive skill (Benedek & Fink, 2019), which state that creativity involves the use of cognitive processes. In spite of this, it is important to note that creativity and intelligence are considered separate constructs, although they are related (Shi, Wang, Yang, Zhang, & Xu, 2017). This factor consisted of the characteristics “fluency (activities 2 and 3), flexibility (activities 2 and 3), and originality (activities 2 and 3). The absence of the characteristic “extending limits” in activity 3 supports the difference from the children’s model.

Lastly, the fourth factor, Emotional Aspects, grouped the characteristic of emotion-expression in activities 2 and 3. This factor corresponds to the Emotivity factor of CFCT and is based on the fact that emotions and feelings are essential for the creation process to occur, acting as a facilitator of creativity (Nakano et al., 2011). The absence

of characteristics such as expressive titles and fantasy supports the difference between the model found and the children's model. It is noteworthy that, due to the elimination of the first activity from the instrument, the factor entitled Creative Preparation in the children's manual no longer exists, essentially grouped some characteristics assessed in the first activity of the test, which served as a warm-up for the subsequent activities (Nakano et al., 2011).

Regarding the influence from the variables analyzed, the presence of significant gender-related differences was identified in F1 (enrichment of ideas) and in total creativity, in both cases, in favor of the female gender. Several studies conducted in the last two decades have also shown females' creative superiority, both internationally and nationally. Nakano et al. (2021) conducted a literature review of 133 national and international publications on this topic. A majority of these publications also confirmed the existence of a gender difference in creativity in favor of women. The authors note, however, that there is no consensus among researchers about this result, with reports of male superiority, the absence of differences, and performance oscillations depending on the type of creativity assessed.

The difference regarding education was significant in all four factors and in total creativity as well. Across all cases, an increased level of creativity was accompanied by increased education, which confirms previous research (Lemos et al., 2018), and echoes results from the children's version of the test (Nakano et al., 2011).

Since the instrument evaluates a large number of creative characteristics, identifying the way in which these characteristics are organized in terms of factor structure is an integral part of determining the psychometric quality of the instrument. This particular case takes into account the change in target audience. This type of study attempts to answer the following question: what is the factor structure that underlies these characteristics? Using two types of factor analysis, confirmatory and exploratory, the answer can be considered satisfactory.

It was found that a model consisting of four factors, as adopted in the children's version of the instrument, was also present in this older-age group, although there were some differences concerning the characteristics that make up each factor. A number of similarities can be observed between the factor structure of the test in the children's sample and the children's sample, particularly in regards to the presence of a cognitive factor, an emotional factor, and a factor related to the enrichment of ideas.

It should be noted, however, that the verification of differences between the characteristics that comprise each factor further emphasizes the importance of conducting studies on tests with samples taken from the population where the instrument will later be used. A study of all psychometric qualities for the new population is required in order to determine whether the instrument is appropriate for use by adolescents as well as adults. Consequently, this study represents the first study that examines psychometric qualities for an enlarged age range. After this study, the name of the test for use in adolescents and adults was changed to Creativity Figural Test.

The data were suitable for the type of analysis intended. Data collection, however, partly involved direct contact between researchers and a referral method (known as snowballing), which poses a limitation to the study. Because of this, it is prudent to exercise caution when interpreting and generalizing the data. We hope that future studies will include a more diverse and representative sample, including adults with poor educational backgrounds, women and men equally, and a greater number of participants from each age group. A subsequent study should investigate other sources of validity evidence, as well as other types of accuracy associated with the use of the test in samples other than those for which the instrument has already demonstrated its psychometric properties.

Although these limitations are present, the results obtained here are consistent with the continuity of the process of investigating the test's psychometric qualities in this adult population, providing evidence of its factor structure and differences between the versions.

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