Chapter #16

CONSTRUCT VALIDITY OF THE TCT- DP IN DIFFERENT SCHOOL LEVELS

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ABSTRACT
The Test for Creative Thinking-Drawing Production (TCT-DP, Urban & Jellen, 1986) is one of the most used instruments for the assessment of creative potential. A previous study with undergraduate and postgraduate Portuguese students presented a two-factor model with good and acceptable indices of fit, suggesting the importance of both conventional and non-conventional thinking for the creative process. This study aims to test the factor structure of the TCT-DP in a sample of younger Portuguese students. The sample has 2263 students, mostly female (51.5%) and upper middle class (25,7%), from different school levels. A one-factor and two-factor models were tested for each school level. The results of the CFA analysis indicate a marginal fit for the two-factor solution. Indices of RMSEA and GFI are above the cut-off recommended in literature, although CFI is below the recommended values. However, the two-factor model has better fit-indices compared with the one-factor solution. The comparison of the models with one and two factors through $\Delta\chi^2$ index indicates significant differences between the two models. Although these results are contrasting, it suggests that the TCT-DP, for the first 12 school years, can be best represented by a two-factor structure.

Keywords: TCT-DP, factorial structure, school levels.

1. INTRODUCTION

Creativity can be considered the most valuable resource for the 21st century's economy, communities and companies (Florida, 2012). At the individual level, the sense of happiness and self-actualization can have significant psychological and physical health benefits (Runco, 2007). Therefore, the studying and fostering of creativity throughout children's education path and into adulthood can be highly advantageous.

The longitudinal studies of Torrance (1988), conducted since the 1950s, as well as the review studies on the predictive validity between the divergent thinking tests results and the creative performance at different levels of education (Barron & Harrington, 1981; Harrington, Block, & Block, 1983) or professional settings (Althuisen, Wierenga, & Rossiter, 2010), are quite encouraging. Some of the more ambitious review studies were those of Cramond, Matthews-Morgan, Bandalos, and Zuo (2005) and Runco, Millar, Acar, and Cramond (2014), respectively, with follow-up studies of 40 years and 50 years of participants in the Torrance study.

However, some reflections are needed. First, it is widely recognized that no measure of creative thinking can fully operationalize the whole construct of creativity (e.g. Runco, 2007). Second, we cannot ignore the discussion about the predictive power of creative thinking measures in adult creative performance. Torrance (1975) warns that high scores obtained through his tests cannot guarantee that a subject behaves creatively. According to

Baer (2011), the diversity of assessment measures, evaluation criteria, and scoring methods (namely global creativity score vs. multiple specific scores) should lead to caution. Most likely there is no single creativity score that can predict all types of creative performance in adult life. Furthermore, as Charles and Runco (2001) stated, we should look beyond cognitive ability to predict creative behaviour, looking into preferences, judgments and motivation.

From a developmental point of view, according to Piaget (1962), formal and abstract thinking leads to a more creative way of thinking through the access to combinatorial reasoning, the use of symbols and propositions, and the imagination of the possible beyond the observable. Some studies based on Piagetian theory, reveal that the reaching of the stages of concrete operations and formal operations each lead to higher levels of creative thinking (Katz & Thompson, 1993; Noppe, 1985); others show the importance of attending university (Kleibeuker, De Dreu, & Crone, 2013; Nakano & Wechsler, 2006). However, the decrease in creativity levels in the first year and fourth year of schooling (Runco & Charles, 1995) or adolescence (Bahia & Ibérico Nogueira, 2006; Lowenfeld & Brittan, 1987) may be related to school requirements, the appeal to conformism and the need for integration in the peer group, all of which can inhibit creative expression.

In this context, schools can play a central role in promoting creativity development within their students in many ways, with the teachers playing a central part in this process.

Sali and Akyol (2015) show that teachers with higher levels of creativity use more flexible and elaborate styles of teaching, giving space for abstract thinking and fostering higher creativity levels in their students. With more developed competences, such as critical and divergent thinking skills, students seem to be better prepared for the job market and more able to adapt with flexibility to unexpected situations (Pishghadam, Nejad, & Shayesteh, 2012).

Only recently has creativity started to be valued in the training of teachers. Traditionally, teachers were not encouraged to be creative, sometimes not even being given opportunities to be so (Turner, 2013). Consequently, a strong focus on quantitative metrics (school performance measured in terms of grades) and the repression of students' creativity could be observed (Lee & Kemple, 2014). According to Sali and Akyol (2015), teachers directly and indirectly discriminated students for creative behaviour, on the grounds that they distracted and interrupted classrooms and classmates, and since creativity was not valued, teachers did not bother to learn methods to encourage creativity.

To be able to adequately promote creativity in schools, an assessment of students' creativity is a necessary step for which it is fundamental to have appropriate instruments. In this sense, the present study aims to contribute with the validity studies for the TCT- DP in different school levels in Portugal.

2. BACKGROUND

In this paper, creativity is conceptualized by the comprehensive model of Jellen and Urban (1986). This model draws attention to six components (three cognitive, three personal) that influence each other and are responsible for creative performance. The cognitive-type components are Divergent Thinking (elaboration, originality, flexibility, fluency, problem sensitivity), General Knowledge Base (evaluation, reasoning and logical thinking, analyzing and synthesizing thinking, memory network, broad perception), and Specific Knowledge Base and Specific Skills (acquisition and mastery of specific knowledge and skills for specific areas of creative thinking and acting). The personal-type components are Focusing/Task Commitment (topic/object/product focusing, selectivity,

steadfastness and persistence, concentration), Motives (need for novelty, playfulness, curiosity, drive for knowledge, communication, self-actualization, devotion, need for control), and Openness/Tolerance of Ambiguity (openness for experiences, readiness to take risks, adaptation and resistance, non-conformism, relaxation, humour).

The TCT-DP aims to assess divergent thinking, as well as more personal aspects. According to Urban and Jellen (1996), the definition of creativity implies the emergence of an original product/idea that is a response to a problem to which the individual is sensitive. This process involves exploration and extended perception of the information, an association and unusual combination of the information given and imagined, a synthesis, a global composition or holistic solution, which is presented and communicated to other individuals.

Guilford (1956) and Torrance (1988) characterized divergent thinking as multidimensional, whereas other authors suggest its unidimensionality (e.g. Clapham, 1998). In turn, Kim (2006) supported the two-dimensionality of divergent thinking based on the structural analysis of the Torrance Tests of Creative Thinking (TTCT) with Innovative and Adaptive factors. Guilford (1950, 1956) pointed out the creative thinking results as flowing from the interaction between divergent and convergent production, with particular relevance to the former. While the divergent production enables the development and production of new ideas, the convergent production is mostly useful to evaluate and select the most appropriate ideas, assuming a problem-solving logic type. It is assumed by several authors (e.g., Finke, Ward, & Smith, 1992; Guilford, 1950, 1956; Halpern, 2003; Jaarsveld, Lachmann, & Leeuwen, 2012; Shavinina, 2001) that divergent thinking leads to a functional and effective product if the convergent thinking pursues its function of analysis, evaluation, the appropriate selection of ideas and planning. Runco (2007) defines this dichotomy of divergent thinking/convergent thinking as a false one.

Urban and Jellen (1996) have referred several psychometric studies conducted by themselves or in collaboration with other authors who identified good internal consistency levels for the TCT-DP (Cronbach's alpha values greater than .87), high levels of interrater reliability (.95, on average, between trained raters), and parallel forms reliability (between .64 and .77). Other authors have found good internal consistency levels (.85, .75 and .74) in studies with adult Portuguese workers (Almeida & Ibérico Nogueira, 2009; Ibérico Nogueira & Almeida, 2010; Ibérico Nogueira, Almeida, & Rocha, 2012). In terms of discriminant validity, one can note the recent study of Karwowski and Gralewski (2013) that used the TCT-DP to evaluate creative abilities and the Raven's Progressive Matrices (RPM) to measure intelligence in a sample of 921 middle and high-school students, indicating a positive correlation (.24) in which creative abilities were predicted by the RPM score. Ibérico Nogueira, Almeida, and Ribeiro (2011) identified a moderate correlation (.56) between the results of the TCT-DP and the Raven's Coloured Progressive Matrices in a sample of 287 children with a mean age of 8 years.

With the objective of testing the factorial structure of the TCT-DP, Ibérico Nogueira, Almeida, and Lima (2017), through a confirmatory factor analysis, obtained a two-factor structure that showed the best suitability indices compared with an alternative model. This two-factor structure suggests the representativeness of two ways of thinking, i.e., conventional thinking and non-conventional thinking. The correlation between them suggests the need for both ways of thinking in the process of creative production. These two forms of thought seem to be inseparable and complementary, although they occur in different stages of the creative process (Finke, Ward, & Smith, 1992; Runco, 2007). This study, based on an adult sample, was the first to analyze the latent structure of the TCT-DP using a confirmatory factor analysis, strengthening its construct validity.

It was then of the utmost importance to do the factorial and construct validity analyses of the TCT-DP for different school levels. This study presents the first results of these analyses.

3. METHOD

3.1. Sample

This study considered a sample of 2263 students, mostly female (51.5%), belonging to upper class (15,6), upper middle class (25,7%), lower middle class (20,1) and worker and rural class (19,8), from different school levels: 1st level - 1st and 2nd grades (N=331; M=6.82; SD=0.57); 2nd level - 3rd and 4th grades (N=472; M=8.85; SD=0.71); 3rd level – 5th and 6th grades (N=454; M=11.02 SD=1.04); 4th level – 7th, 8th and 9th grades (N=550; M=13.4; SD=1.18); 5th level – 10th, 11th and 12th grades (N=456; M=16.7; DP=1.27).

3.2. Instruments

The participants were recruited according to a convenience method. The school directors and parents were contacted and signed informed consent forms. The instruments were a) a brief socio-demographic questionnaire about gender, age and school year; and b) the Test for Creative Thinking - Drawing Production (TCT-DP) of Urban and Jellen (1996), theoretically supported by the componential model of creativity (Urban, 2004). This instrument asks for an elaboration of a drawing from six fragments, and Cropley (2000) refers to it as one of the best tools for the assessment of the creative potential because it is based on a general theory of creativity, which surpasses the models exclusively based on divergent thinking or divergent production and takes into account personality variables.

The TCT-DP is widely regarded as being culture-fair and has a broad spectrum of potential applications while allowing the assessment of different age, gender, social and economic groups. Its authors present 14 key criteria for the TCT-DP: 1- Continuations (Cn), 2- Completions (Cm), 3- New Elements (Ne), 4- Connections with lines (Cl), 5- Connections that contribute to a theme (Cth), 6- Boundary-breaking being Fragment-dependent (Bfd), 7- Boundary-breaking being Fragment-independent (Bfi), 8- Perspective (Pe), 9- Humour, affectivity/emotionality/expressive power of the drawing (Hu), 10- Unconventionality A (Ua), 11- Unconventionality B (Ub), 12- Unconventionality C (Uc), 13- Unconventionality D (Ud), 14- Speed (Sp). In the present study, the criterion Speed (Sp) was not used because of the difficulty to systematically control this variable, as Sayed and Mohamed (2013) pointed out.

Furthermore, despite the existence of two Forms (Form A and B) for TCT-DP, this study opted for the exclusive use of Form A after some previous research suggesting there are no significant differences between the results of Forms A and B (Almeida, Ibérico Nogueira, Bahia, & Urban, 2007).

3.3. Statistical analysis

AMOS 18 software was used to perform confirmatory factor analyses aiming to test the construct validity of the scale. The estimation method used was the Maximum Likelihood Estimation (MLE) using the variance-covariance matrix, and the missing cases were replaced by the mean. First, we test a two-factor solution identified in previous study. Additionally, the fit of a one-factor solution was also tested. The following indices were used to test the general fit of the models. The ratio of chi-square to degrees of freedom (χ^2/df), with values between 2 and 3 indicating indicates an acceptable fit, the goodness of

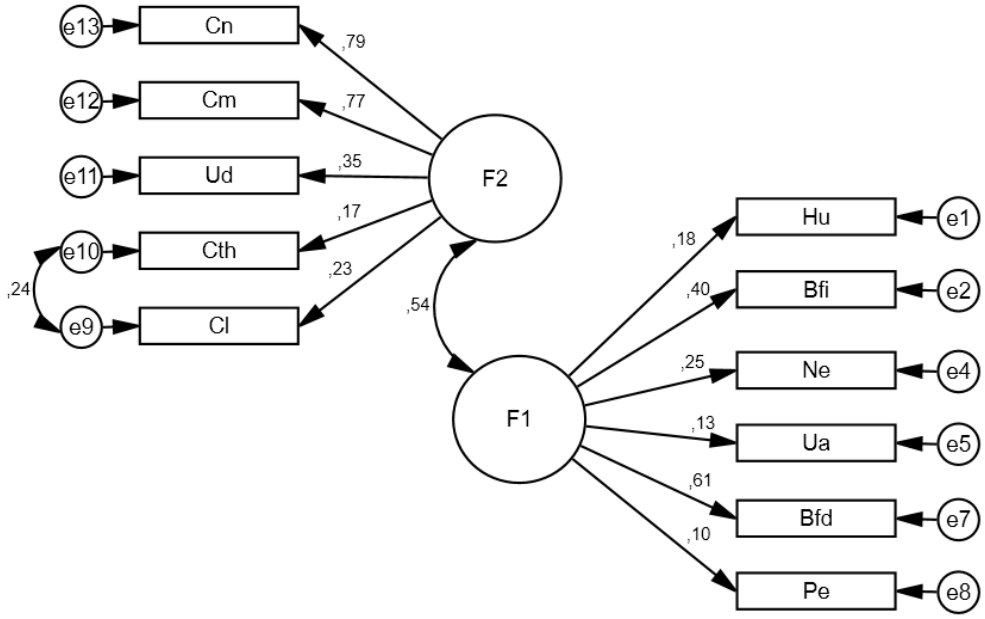
fit index (GFI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA), with values approximately .95, .95 and .06 or better, respectively, indicates a good fit (Byrne, 2010; Garson, 2013). Values greater than .90 for the GFI and CFI and lower than .08 for the RMSEA also indicate an acceptable fit. Additionally, the χ^2 difference ($\Delta\chi^2$) between the models and the expected cross-validation index (ECVI) were employed to assess significant improvement over competing models. Significant values of $\Delta\chi^2$ and lower ECVI values reflect the model with a better fit (Brown, 2006).

4. RESULTS

First, an initial analysis with the total sample was conducted, the fit indices for the two-factor solution were as follows: χ^2 (64) = 1438.2, $p < .001$, χ^2 /*df* = 22.4, *GFI* = .90, *CFI* = .58, RMSEA [CI 95%] = .097 [.093 - .102], ECVI = 0.66. However, two items (Uc and Ub) with non-significant regression weights in Factor 1 were excluded from the analysis. A second analysis was conducted with only 11 items. The fit indices for the two-factor solution were as follows: χ^2 (43) = 1,119.7, $p < .001$, χ^2 /*df* = 26.04, *GFI* = .90, *CFI* = .64, RMSEA [CI 95%] = .105 [.100 - .111], ECVI = 0.51. The model was re-specified after examining the modification indices, correlated errors between items 10 and 9 are added to the fit model. The fit indices were as follows: χ^2 (42) = 992.8, $p < .001$, χ^2 /*df* = 23.6, *GFI* = .92, *CFI* = .68, RMSEA [CI 95%] = .100 [.095 - .105], ECVI = 0.46. Fit indices showed that the re-specified model resulted in a significant improvement of fit, compared to the originally unmodified model, $\Delta\chi^2$ (1) = 126.9, $p < .001$, and the EVCI is smaller in the re-specified model. All factor loadings were statistically significant ($p < .001$). The factorial structure and the regression weights can be observed in Figure 1. The first factor includes the items related to the unconventional way of thinking, breaking of limits, new elements, perspective and humor (Ua, Bfi, Bfd, Ne, Pe, Hu) whereas the second factor includes more conventional items (Cn, Cm, Cl, Cth and Ud).

In function of the correlation between Factors 1 and 2 ($r = 0.54$), a one-factor solution was tested. The one-factor model had poor fit indices compared with the two factors solution: χ^2 (44) = 1265,7, $p < .001$, χ^2 /*df* = 28.7, *GFI* = .89, *CFI* = .59, RMSEA [CI 95%] = .111 [.106 - .116], ECVI = 0.58. Moreover, the comparison of the models with one and two factors thru $\Delta\chi^2$ index indicated that the two-factor model had a better fit, $\Delta\chi^2$ (1) = 272.9, $p < .001$.

Figure 1.
Factorial structure of the TCT-DP.



5. FUTURE RESEARCH DIRECTIONS

The factorial structure observed in a previous study with a sample of young adults (Ibérico Nogueira, Almeida, & Lima, 2017) does not seem to fit adequately to the sample of the present study. Therefore, a more detailed investigation should be carried out in future studies, testing for a more adequate factorial structure for this sample and assessing whether this structure is invariant throughout the different school levels.

Furthermore, future studies should analyse the factorial structure of the TCT-DP for each school year independently. More specifically, the importance of the items Unconventional b (Ub) and Unconventional c (Uc) (excluded from the present confirmatory factorial study) should be analysed, since they respectively represent the use of abstract, surrealistic or symbolic themes and the use of symbols, signs, words, numbers and cartoon-like elements. Like other abilities, these may follow a specific developmental path, having Piaget (1962) already highlighted the importance of imagination, use of symbols and abstract reasoning of the early adolescents.

The factorial structure of TCT-DP should also be analysed for each gender, considering the possible differential influence of skills and motivation (Baer & Kaufman, 2008) and of socio-cultural factors (Simonton, 2000) in creative, school and professional performances.

It would also be interesting to look into the relationship between creativity (conventional and unconventional thinking dimensions) and creative styles (innovation and adaption styles) in the Portuguese population, similarly to what other authors (Houtz et al., 2003; Kirton, 1976) have already started doing.

Regarding concurrent validity, it will be relevant to assess the relationship between the TCT-DP and other instruments to assess creative thinking. In what concerns the discriminant validity, there is an ongoing study about the relation between the TCT-DP and Wechsler Intelligence Scale for Children (WISC-III).

6. CONCLUSION/DISCUSSION

As initially stated, only a reliable instrument to assess creativity will allow for the understanding of the creativity levels and challenges in schools. The conclusions of such analyses would in turn become a good base where to start building creativity-fostering approaches and planning precise interventions.

After a previous study analysed the latent structure of the TCT-DP using a confirmatory factor analysis and strengthening its construct validity within undergraduate and postgraduate Portuguese students (Ibérico Nogueira et al., 2017), the current study now fills a considerable gap by encompassing every pre-university school level in a similar way.

The present results of the single-group CFA analysis suggest an acceptable fit for the two-factor solution. RMSEA and GFI are above the cut-off recommended in literature, although CFI is below the recommended values. Although these results are contrasting, they can indicate that the TCT-DP is best represented in this sample by a two-factor structure. Therefore, the TCT-DP enables both a global index of creativity and the two dimensions: conventional and unconventional thinking.

This conclusion is supported by Jaarsveld, Lachmann, and Leeuwen (2012), Kaufman (2003) and Mumford (2003), who have defended the importance of both convergent and divergent thinking, considering the effectiveness of a new idea beyond its originality.

However, the fact that the invariance between school levels was not tested constitutes a limitation of this study. It is possible that the lack of invariance may decrease the fit of the model to the data and does not allow the use of the TCT-DP to compare the groups studied here. In this scenario, one could consider that children and adolescents, along their development path, can develop some of the dimensions that are contemplated by TCT-DP. This would mean that this instrument cannot be expected to present the same factor structure throughout the 12 years of schooling.

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