Construct validity and factorial invariance across sex of the Torrance Test of Creative Thinking – Figural Form A in Spanish-speaking children

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ABSTRACT

The aim of this work was to study the construct validity of the Torrance Test of Creative Thinking (TTCT) by means of Confirmatory Factor Analysis (CFA). Based on previous litera-ture, four theoretical models were compared to explain the creativity construct as measured by the TTCT Figural, Form A, in a sample of Argentine children. This work also examined whether the structure found through the CFA was invariant across sex. A sample of 381 Spanish-speaking children and adolescents aged 9–12 years was studied. The CFA identi-fied two correlated factors: Innovative and Adaptive. The best-fit model indicated that the TTCT-Figural Form A is composed of two factors: innovative and adaptive ($\chi2$ = 3.88; df = 4; p = 0.423; GFI = 1.00, NFI = 0.99; CFI = 1.00, and RMSEA = 0.000). These factors included the skills proposed by Torrance et al. (1992). It was also found that the two-factor model was invariant (i.e., configural, metric, scalar, and structural) across sex. Finally, MANOVAs results revealed that there are no differences in each subscale of the factors found according to sex. The results are discussed in view of the psychometric implications and their significance in the educational and psychological spheres.

1. Introduction

Over the last few decades, many scientific and technological changes and innovations have demonstrated the importance of creativity in people's lives. Not only does creativity have a major impact on art, science, and education, as is typically thought, but it also affects aspects and issues of everyday life (Corbalán Berná et al., 2003; Richards, 2007; Runco, 2004; Schmidt, 2005). Creativity is a human behavior that is difficult to study, it is part of everyone and, to a greater or lesser degree, it involves virtually all psychological functions, from the most basic processes, such as perception, to the most complex functions such as analogical thinking and problem solving, and also functions ranging from cognitive processes to those that are affective-motivational in nature (Beghetto & Kaufman, 2007; Kaufman & Beghetto, 2009; Romo, 1998).

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Torrance (1974) considered creativity as a process that involves (a) sensitivity to problems, identifying difficulties, and/or gaps in knowledge; (b) searching for solutions; (c) asking questions and formulating hypotheses; and (d) testing these hypotheses and, if necessary, modifying them to be able to solve the problem. Therefore, creativity concerns people's ability to adapt to changes and generate solutions to problems that arise, which entails being able to be flexible and to think of different alternatives for solving problems. Furthermore, creativity also relates to the ability to search for new questions, leading to the creation of new types of problems. Hence, Runco (2004) notes that two aspects can be distinguished in the definition of creativity: (a) one aspect related to proactivity, which concerns searching for questions and exploration; and (b) another aspect related to reactivity, which concerns finding solutions to the problems that are encountered.

For decades, creativity assessment has been a problem for researchers within this area because it is aimed to observe and measure ideas, products, or people that are innovative, original, or atypical (Silvia, Wigert, Reiter-Palmon, & Kaufman, 2012). Creativity assessment has focused on creative products, creative cognition, creative traits, and creative achievements. To date, the most widely used tests for measuring creativity are divergent thinking tasks (Kaufman, Plucker, & Baer, 2008; Kaufman et al., 2011) and particularly those that generate creative ideas (Silvia et al., 2008).

The Torrance Test of Creative Thinking (TTCT, Torrance, 1966, 1974) is based, in part, on Guilford's concept of divergent production (Kaufman et al., 2011; Kaufman, Plucker, & Russell, 2012) and it is currently the most popular instrument in creativity assessment (Cropley, 2000; Davis, 1997; De la Torre, 2006; Kaufman et al., 2008). Its use has been extended to brain neuroimaging studies (Chávez, Graff-Guerrero, García Reyna, Vaugier, & Cruz Fuentes, 2004) and to the assessment of subjects with high intellectual abilities (Ferrando et al., 2007). The TTCT consists of two subtests, one that is Verbal and another that is Figural. Each test has two parallel forms, A and B (Torrance, 1990a; Torrance, 1990b; Torrance, Ball, & Safter, 1992), that can be administered in groups or individually (Torrance, 1990a).

2. Evidence for TTCT construct validity

Given its popularity, various investigations have studied this test's factorial structure (Primi, Nakano, Morais, Almeida, & David, 2013). The scientific literature presents different results regarding Torrance's theoretical proposal in relation to the skills assessed by the TTCT, for both verbal (Dixon, 1979; Hocevar, 1979; Krumm & Lemos, 2010; Krumm, Aranguren, Arán Filippetti, & Lemos, 2014) and figural tests (Almeida, Prieto, Ferrando, Oliveira, & Ferrándiz, 2008; Aranguren, 2014; Heausler & Thompson, 1988; Kim, 2006; Kim, Cramond, & Bandalos, 2006; Krumm, Lemos et al., 2014). In this regard, some research has suggested that TTCT would measure a general factor (Clapham, 1998; Hocevar, 1979) due to the high correlations between some of the skills that measure both the Figural (Clapham, 1998; Heausler & Thompson, 1988; Kim, 2006) and Verbal tests (Dixon, 1979; Hocevar, 1979).

Among the studies that show evidence in favor of a unidimensional structure is that of Heausler and Thompson (1988) who evaluated creativity through TTCT- Figural, Form A in a sample of 132 children with an average of 6.5 years old (the context is not mentioned). While the Exploratory Factor Analysis (EFA) with Varimax rotation showed a two-factor structure, the authors reached the conclusion that the test is unidimesional. Clapham (1998), also conducted an EFA with the TTCT-Figural, Forms A and B in a sample of 344 American students aged 17–45 years. The results showed that each skill (i.e., fluency, originality, elaboration, resistance to premature closure and abstractness of titles) of both Forms (A and B), loaded on one factor; on the one hand, the activities of Form A accounted for 55.89% of the variance, and on the other hand, the ones of Form B explained 50.27% of the variance. Data demonstrated that the tests were equivalent and measure a general factor. It is worth mentioning that the aforementioned study used the total score of each dimension.

Following Aranguren (2014), the contributions that revealed the multidimensional nature of the TTCT could be classified into three groups: (1) works with EFA and Confirmatory Factor Analysis (CFA) with the TTCT-Figural using the first criterion of correction of the test, in which fluency, flexibility, originality and elaboration are measured, (2) works with EFA and CFA with TTCT-Figural adding the error correction system proposed by Torrance and Ball (1984) in which flexibility is removed and fluency, originality, abstractness of titles, resistance to premature closure, elaboration and creative strength are measured, and (3) finally, works done with the TTCT Figural and Verbal jointly implemented, using EFA and CFA and conducted in different contexts and at distinct ages (Clapham, 2004; Oliveira et al., 2009; Plass, Michael, & Michael, 1974; Primi et al., 2013; Rudowicz, Lok, & Kitto, 1995). Considering that this work used only the TTCT- Figural, Form A, the third classification is not discussed.

Among the first group, Ferrando's work (2006) should be emphasized for through the use of TTCT-Figural, Form A in Spanish children aged 5 to 12 years, a three component structure was found by means of EFA. In a later study, conducted in a sample of 649 Spanish children of the same age, Ferrando et al. (2007) replicate the structure found above. Specifically, the components were set as follows: (a) the first factor found consisted of the activity 3 of the TTCT, except for the elaboration variable; (b) the second factor was represented by the activity 2, except for the elaboration variable; and (c) the third component groups the variables related to the elaboration of the three activities and the originality of activity 1.

Within the second group of works, Azevedo and Morais (2012) examined the Figural test in 348 pre-adolescents and adolescents from Portugal and found two factors by means of EFA; the first consists of fluency, originality and resistance to premature closure, and the second one of abstractness of titles, elaboration and creative strength. Meanwhile, Kim (2006) analyzed through CFA the data obtained from the TTCT- figural, Form A in 500 children from 6th grade, between 10 and 12 years of age (data from Scholastic Testing Service), considering the theoretical proposal of Kirton (1976, 1987), in which creativity could be made up of the two factors innovation and adaptation. The model with best fit was made up of the

innovation factor that included the dimensions fluency, originality and resistance to premature closure, and the adaptive factor, which included elaboration and abstractness of titles. This model does not include creative strength. In another analysis, conducted with a sample of 3000 children aged 5 to 13 years, Kim et al. (2006) found that the two-factor theoretical model was invariant as regards sex, but not in terms of grade level. Besides, the one-factor model did not properly fit in any of the analysis performed. In line with this study, Krumm, Lemos et al. (2014) also found a structure of two factors using the TTCT-Figural, Form B. The work performed with 577 Argentine children and adolescents tested four theoretical models; the best-fit model comprised the innovation factor, which included fluency and originality, and the adaptive factor, which involved elaboration, resistance to premature closure and abstractness of titles. Aranguren (2014) also used the TTCT-Figural, Form B to test six theoretical models in a sample of 465 Argentine students between 18 and 35 years of age. The results indicated that the best-fit model is composed of two factors, (a) Innovation that comprises fluency, originality and resistance to premature closure, and (b) The adaptive factor, which includes resistance to premature closure, abstractness of titles and elaboration. It is noteworthy that this model does not present the creative strength, as the adjustment including this dimension was lower. Moreover, in a recent study with the TTCT-Figural (the form is not mentioned) in 278 gifted students in primary education in Istanbul, a two-factor model was also found through CFA. However, in this case, the innovation factor consisted of fluency, originality and elaboration, and the adaptive factor of abstractness of titles and resistance to premature closure (Şahin, 2015). Interestingly, in this case elaboration loaded on the innovation factor.

In summary, the studies performed with the TTCT Figural, Form A and B (Aranguren, 2014; Kim, 2006; Kim et al., 2006; Krumm, Lemos et al., 2014; Şahin, 2015) have generally and consistently shown that the creativity construct could comprise two factors: an innovative style and an adaptive one. The skills proposed by Torrance et al. (1992) would be within these factors. This two-factor model is similar to the description provided by Kirton (1976, 1978, 1994) in which the Innovative factor would be composed of Fluency, Originality, and Resistance to Premature Closure and the Adaptive factor would be composed of Resistance to Premature Closure, Elaboration, and the Abstractness of Titles.

3. The current study

On the basis of the previous study by Krumm, Lemos et al. (2014), which tested four theoretical models through CFA to explain the children's creativity construct by TTCT-Figural, Form B, this study aimed to test the same stated assumptions listed below, with a similar age group and context, but with TTCT-Figural, Form A, to assess the equivalence of its functioning and the pertinence to be considered parallel forms in evaluating creativity. This analysis is relevant, as to use both forms as equivalent for instance in studies with pre-test and post-test designs, it is necessary to know whether they do value the same underlying construct. This work also adds the study of factorial invariance in terms of sex by CFA. This latest analysis enables to verify whether the content of the items of an instrument and the underlying construct that it values is equivalent in different samples (Byrne, 2008).

The hypotheses used were:

Hypothesis 1. The latent innovative factor would be composed of fluency and originality, and the latent adaptive factor would be represented by skills including elaboration, the abstractness of titles, and creative strength. Resistance to premature closure would belong to both factors (Aranguren, 2014; Kim, 2006). This model is called "creativity construct with *resistance to premature closure* as part of the latent innovative and adaptive factors" (Krumm, Lemos et al., 2014, p. 74).

Hypothesis 2. The latent innovative factor is composed of fluency, originality, and resistance to premature closure, and the latent adaptive factor is composed of skills such as elaboration, the abstractness of titles, and creative strength (Kim, 2006). This model was named by Krumm, Lemos et al. (2014, p. 75) "creativity construct with *resistance to premature closure* as part of the latent innovative factor".

Hypothesis 3. The latent innovative factor would comprise fluency and originality, and the latent adaptive factor would consist of resistance to premature closure, elaboration, and the abstractness of titles. This model was hypothesized in accordance with the results obtained in the EFA on the Form B test published by Krumm and Lemos (2011). This model was called "creativity construct with *resistance to premature closure* as part of the latent adaptive factor" (Krumm, Lemos et al., 2014, p. 75).

Hypothesis 4. This hypothesis would be similar to Model three but it does not include creative strength in the latent adaptive factor (Kim et al., 2006). This model is called "creativity construct without *creative strength*" (Krumm, Lemos et al., 2014, p. 75). The four models are shown in Fig. 1.

After defining which model best fit the data, it was assessed whether the model was invariable across sex.
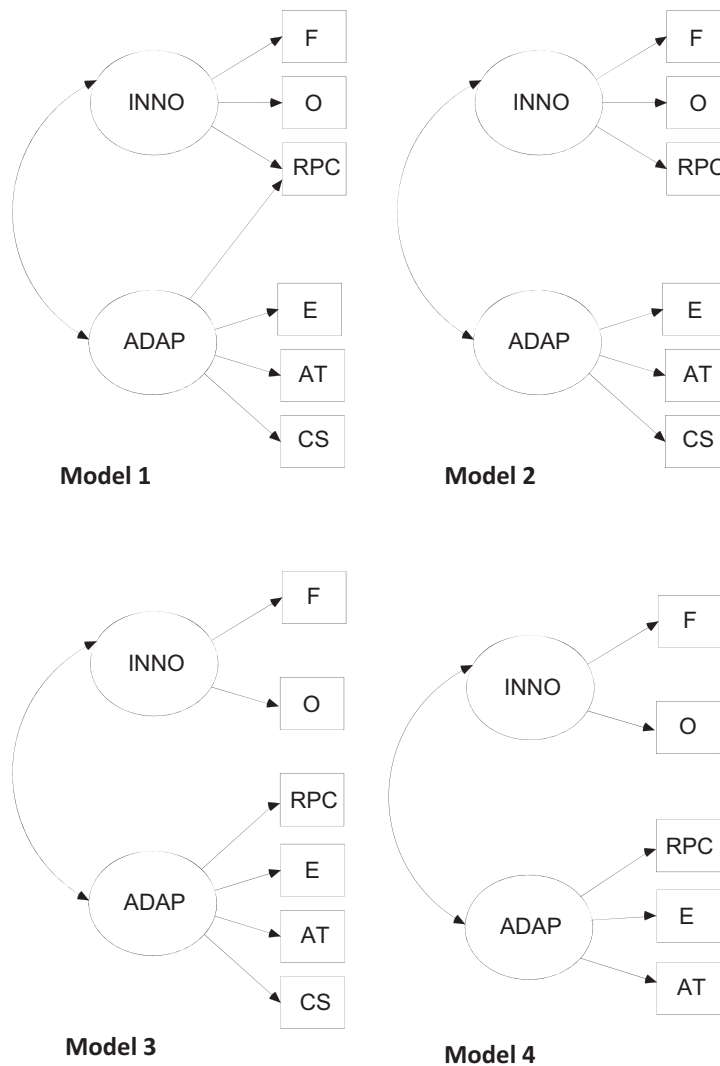
Fig. 1. Hypothesized models of the creativity construct.
Note: INNO = Innovative; ADAP = Adaptive; F = Fluency; O = Originality; RPC = Resistance to Premature Closure; E = Elaboration; AT = Abstractness of Titles; CS = Creative Strengths. Extracted from Krumm, Lemos et al. (2014, p. 75).

4. Method

4.1. Participants

The sample consisted of 381 children 9 to 12 years of age (*M* = 10.88; *SD* = 1.08) among whom 219 (57.5%) were female and 162 (42.5%) were male. The students attended the fourth, fifth, and sixth year of primary school and the first year of secondary education in schools in the provinces of Buenos Aires and Entre Rios in the Argentine Republic.

The research project was approved by the Ethics Committee of the Interdisciplinary Center for Research in Mathematics and Experimental Psychology (Comité de Ética del Centro Interdisciplinario de Investigaciones en Psicología Matemática y Experimental – CIIPME), the Executing Unit of the National Scientific and Technical Research Council (CONICET), and the Universidad Adventista del Plata (UAP). First, the characteristics of the research were explained to the school principals, to whom authorization to work with the participants was requested. Then, a sealed manila envelope with the informed consent, which explained the study objectives and the tasks that would be developed during the class schedule, was sent to the parents or legal guardians, via the children. The letter emphasized that collaboration was voluntary and anonymous. Finally, after the consent forms were signed by the parents or guardians, the test was administered. The criteria for participants to take part in the study were: (a) authorization from the school principals, (b) informed consent by the parents or legal guardians, and (c) free and voluntary participation on the part of the students.

Table 1
Fit indices of models.

Models	Chi-Square test			Fit Indices			
	χ^2	df	p	GFI	NFI	CFI	RMSEA
Model 1	12.70	7	0.080	0.99	0.98	0.99	0.05
Model 2	42.64	8	0.000	0.97	0.93	0.95	0.11
Model 3	15.08	8	0.058	0.99	0.98	0.99	0.05
Model 4	**3.88**	**4**	**0.423**	**1.00**	**0.99**	**1.00**	**0.000**

Note: The "best-fit model" values are presented in bold type.

4.2. Measures

The TTCT Figural Form A, which can be administered to all education levels, comprises three activities, with each lasting 10 min. Each task poses a different assignment related to drawing or completing figures. As a whole, the activities assess Fluency (the ability to create drawings and ideas), Originality (the ability to produce responses that are out of the ordinary or unusual), Elaboration (the ability to improve and develop the idea), Abstractness of Titles (the capacity to give good titles to the drawings), and Resistance to Premature Closure (the ability to not close the figures, making room for original ideas) (Torrance et al., 1992). The first activity stimulates the creation of a drawing or scene based on a particular form. This activity evaluates originality, the abstractness of titles, and elaboration. The second activity consists of creating interesting and original drawings, using 10 incomplete figures; it assesses fluency, originality, the abstractness of titles, elaboration, and resistance to premature closure. Finally, the third activity consists of three pages with parallel lines that must be used in the drawings. In this case, the activity evaluates fluency, originality, and elaboration (Torrance et al., 1992).

In relation to scoring, the score of fluency is assigned in activities 2 and 3 when the answer is relevant to the stimulus. Responses that do not receive a score in fluency are not considered in the other skills. Originality and elaboration are assessed in all three activities. In the case of originality, 1 point is given when the drawing is original and 0 when it is not. Elaboration is scored on a scale ranging from 1 to 6, depending on the amount of detail that the subject has included in the drawing. The amount of detail is specified in the correction manual (Torrance et al., 1992). The abstractness of titles is scored in activities 1 and 2 on a scale ranging from 0 to 3. Finally, resistance to closure is evaluated only in activity 2; each response is scored on a scale ranging from 0 to 2. In addition, the Figural tests, in both Forms A and B, measure the following 13 criteria, which are called Creative Strengths (Torrance et al., 1992): Emotional Expressiveness, Storytelling Articulateness, Movement or Action, Expressiveness of Titles, Synthesis of Incomplete Figures, Synthesis of Lines or Circles, Unusual Visualization, Internal Visualization, Extending or Breaking Boundaries, Humor, wealth of Imagery, Colorfulness of Imagery, and Fantasy.

4.3. Data analysis

CFA was conducted by means of the AMOS *Graphics* 20.0 program (Arbuckle, 2007) to test different models of the creativity construct. To determine which model provided the best fit, the χ^2 test and the following fit indices were taken into account: GFI (Goodness of Fit Index), NFI (Bentler–Bonett Normed Fit Index), CFI (Comparative Fit Index), and IFI (Incremental Fit Index). In addition, the Root Mean Square Error of Approximation (RMSEA) index was calculated for each model to estimate the degree of error. Besides, Multigroup CFA (MGCFA) was used to test factorial invariance across sex. With respect to the sample size required to perform the structural models, it has been indicated that 5 to 10 participants are necessary per estimated parameter (Floyd & Widaman, 1995).

Like in other CFA studies (Aranguren, 2014; Kim et al., 2006; Kim, 2006; Krumm, Lemos et al., 2014; Şahin, 2015) the composite score of TTCT-Figural, Form A was used, as each item consists of different activities and each activity do not measure all the skills alike.

5. Results

5.1. Confirmatory factor analyses (CFA)

CFA was used to study the structure of the latent creativity construct. To that end, the different models were tested: Model 1 – "creativity construct with *resistance to premature closure* as part of the latent innovative and adaptive factors"; (b) Model 2 – "creativity construct with *resistance to premature closure* as part of the latent innovative factor"; (c) Model 3 – "creativity construct with *resistance to premature closure* as part of the latent adaptive factor"; and (d) Model 4 – "creativity construct without *creative strength*" (see Fig. 1). As shown in Table 1, the fit indices of Models 1, 3, and 4 were very good because the GFI, NFI, and CFI indices had values above 0.95 and the RMSEA index was lower than 0.06. However, Model 4 demonstrated the best fit to data (see Table 1 and Fig. 2).

After determining that Model 4 best explains the creativity construct, different models were compared to observe whether their structure was better explained by a unidimensional construct or by a construct of non-correlated factors. To test the one-factor model (unidimensional construct), the correlation between the latent variables was set to 1. As Table 2 shows, no
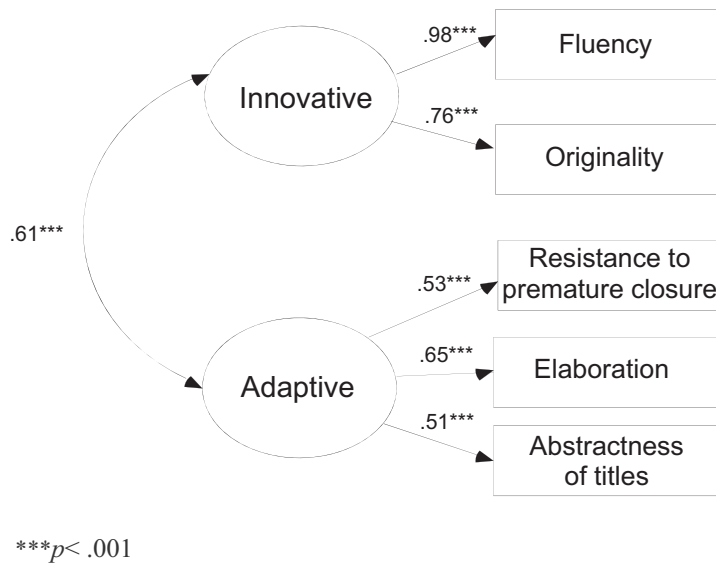
Fig. 2. Form A creativity construct in Spanish-speaking children.

Table 2

Fit indices for the two-factor CFA model and reduced models.

Models	χ^2	df	p	CFI	IFI	AIC	RMSEA	$\Delta\chi^{2a}$	Δdf	p
1. 2-factor model	3.88	4	**0.423**	**1.00**	**1.00**	**25.88**	**0.000**			
2. 1-factor model	78.06	5	0.000	0.85	0.85	98.06	0.19	74.18	1	<0.001

Notes:

[a] Indicates that comparisons are with the two-factor model.

Values higher than 0.95 for the CFI and IFI, lower values for the AIC, and a RMSEA below 0.06 indicate good fit.

χ^2 difference tests indicated that the reduced model provided a significantly worse fit than the two-factor model.

The non-correlated-factor model could not be identified.

The best fit model is in bold.

Table 3

Measurement invariance across Sex.

	χ^2	df	p	IFI	CFI	RMSEA	$\Delta\chi^{2a}$	Δdf	p	CFI[a]
Models (M) across sex										
Female	3.32	4	0.505	1.00	1.00	0.00				
Male	1.50	4	0.826	1.01	1.00	0.00				
Factorial invariance										
M1. Configural invariance	4.82	8	0.776	1.01	1.00	0.00				
M2. Metric invariance	7.11	11	0.790	1.01	1.00	0.00	2.29	3	0.516	0.00
M3. Scalar invariance	10.63	16	0.832	1.01	1.00	0.00	3.52	5	0.621	0.00
M4. Structural invariance	13.96	19	0.786	1.01	1.00	0.00	3.33	3	0.343	0.00
M5. Residual invariance	25.81	24	0.363	1.00	1.00	0.01	11.85	5	0.037	0.00

[a]Comparisons are made in relation to the previous model, M2 to M1, M3 to M2, and so on.

significant improvement of fit was found in the unidimensional model over the two-factor model. Therefore, the two-factor model was retained as the best fit. Finally, a model with non-correlated factors, in which the correlation between the latent variables was set to 0, was tested. This model could not be identified. These data suggest that a model with two correlated factors best explains the creativity construct (see Table 2).

5.2. Multigroup CFA across sex

To test the factorial invariance across groups, it is necessary to first identify the construct base model to be studied (i.e., best-fitting model) and estimate it for each group separately (Dimitrov, 2010). As model 4 showed a good fit for both men and women (see Table 3), the MGCFA was conducted to test the factorial invariance across sex. The initial step to establish equivalence between groups requires proving configural invariance. When this model has an acceptable fit, it indicates that the structure is similar between samples of interest (Byrne, 2008). In the second model the metric invariance is tested, which enables to confirm whether the content of each item is interpreted in the same way in each group (Byrne, 2008).

Table 4
Means and deviations in the subscale of the Creativity Construct as measured by the TTCT Figural Form A according to sex.

Factor	Subscale	Female		Male	
		M	(SD)	M	(SD)
Innovative	Fluency	22.69	8.83	21.70	8.85
	Originality	14.05	7.81	13.34	6.65
Adaptive	Elaboration	5.77	2.58	5.40	2.53
	Abstractness of titles	6.70	4.93	5.94	4.63
	Resistance to premature closure	9.53	3.98	9.17	3.89

The third model allows to verify the scalar invariance, and indicates whether the observed scores are equally related to the latent scores in the same way in each group (Milfont & Fischer, 2010). The fourth model of structural invariance focuses on the study of latent variables (i.e., factor variances and covariances), and enables to confirm whether the underlying construct is equivalent across groups (Byrne, 2008). Finally, the residual invariance (i.e., Model 5) allows checking if the measurement error of each item is equivalent between groups (Milfont & Fischer, 2010). The MGCFA is performed through a sequence of hierarchically nested models. Non significant differences between the nested models mean that the invariance can be assumed through groups. In turn, as an indicator that the restricted parameters were invariant, the change in CFI was considered to be equal or less than 0.01 between the successive levels of invariance (Cheung & Rensvold, 2002). In model 1 (M1 base model) that enables to check the configural invariance, all parameters vary independently between the groups. As this model showed acceptable fit indices, it is possible to assume configural invariance between groups. This means that the creativity construct can be conceptualized in the same way in both boys and girls. In subsequent analyzes, equality constraints on different parameters between the groups are imposed. Specifically in Model 2 (M2), the factor loadings are restricted to be equal in both groups. As shown in Table 3, the increase in the χ^2 was not significant, the model fit indices were adequate, and the difference of the CFI was equal to 0. Therefore, the criterion of metric invariance across sex could be assumed. The implication is that the relationship between the indicators for each variable with its respective latent factor was equivalent among groups. In Model 3 (M3), the intercepts were constrained to being equal between groups. Due to a non-significant increase in χ^2, adequate fit indices for the model, and a CFI difference equal to 0, it was possible to assume the criterion of scalar invariance across sex. In Model 4 (M4), the variances and covariances of the factors were restricted to being equal between groups. Given that the increase in χ^2 was not significant, the model's fit indices were adequate, and the CFI difference was equal to 0, the criterion of structural invariance was assumed. Finally, in Model 5 (M5), error variances and covariances were restricted to being equal between groups. Because the increase in χ^2 was significant, it was not possible to assume invariance in the residues. However, it should be noted that the model had satisfactory fit indices.

5.3. Differences between the factors according to sex

Once invariance (configural, metric, scalar, and structural) between the male and female participants was verified, multivariate analyses of variance (MANOVAs) were performed to test the differences in the scores in each factor, according to the sex of the child.

5.3.1. Innovative

A MANOVA indicated that there were no significant differences in the innovative factor according to gender (*F* Hotelling's $(2, 378) = 0.601$; $p = 0.549$, *partial* $\eta^2 = 0.003$). The univariate results showed that there were no significant differences in the fluency subscale ($F_{1, 379)} = 1.172$; $p = 0.280$, *partial* $\eta^2 = 0.041$) or in the originality subscale ($F_{1, 379)} = 0.857$; $p = 0.355$, *partial* $\eta^2 = 0.002$).

5.3.2. Adaptive

A MANOVA analysis indicated that there were no significant differences in the adaptive factor according to gender (*F* Hotelling's $(3, 377) = 1.094$; $p = 0.351$, *partial* $\eta^2 = 0.009$). The univariate results also showed that there are no significant differences in the elaboration subscale ($F(1, 379) = 2.054$; $p = 0.153$, *partial* $\eta^2 = 0.005$), in the abstractness of titles subscale ($F(1, 379) = 2.289$; $p = 0.131$, *partial* $\eta^2 = 0.006$), or in resistance to premature closure subscale ($F(1, 379) = 0.788$; $p = 0.375$, *partial* $\eta^2 = 0.002$) (Table 4).

6. Discussion

The objective of this study was to examine the construct validity of the TTCT Figural, Form A, in Spanish-speaking children. To that end and on the basis of the study by Krumm, Lemos et al. (2014) with Form B, four theoretical models, which were each composed of two factors, Innovative and Adaptive, were tested. The results confirmed the two-correlated factor model: (1) the Innovative factor composed of fluency and originality, and (2) the Adaptive factor composed of resistance to premature closure, the abstractness of titles, and elaboration. The Innovative factor would be characterized by novelty, speed, rupture,

and different approaches based on the approach to the task, whereas the adaptive factor would correspond to more gradual changes, but with greater depth, within an established structure (Kim, 2006, 2008; Kirton, 1987).

In the present study, the model with best fits the data (i.e., model 4) included Resistance to Premature Closure in the adaptive factor and excluded Creative Strength from the model, which is in line with the previous study by Krumm, Lemos et al. (2014) in a similar context (province of Entre Ríos) and at an age range slightly broader (9–14 years), but with Form B (parallel to Form A) of the TTCT-Figural. This is significant for the assessment of the creativity construct by TTCT-Figural, since in this cultural context of assessment, both forms, A and B, would measure the creativity construct in the same way. Nevertheless, our results diverge from other studies regarding the skill related to resistance to premature closure. Specifically, the previous research with the TTCT-Figural in different contexts and ages showed a good model fit when the aforementioned skill (i.e., resistance to premature closure) was present in both factors or only in the innovative factor (i.e., Models 1 and 2) (Aranguren, 2014; Kim, 2006).

The differences with other studies that were found could be due to differences in the age ranges and different cultural contexts. For example, the study by Aranguren (2014), conducted in Argentinian young adults with Figural, Form B showed that resistance to closure was present in adaptive and innovative factors (i.e., Model 1). Kim's study (2006), that used the TTCT-Figural, Form A in children and adolescents aged 10 to 12 years, but in a different linguistic context of this work (i.e. English-speaking children) showed that the innovation factor would be composed of fluency, originality and resistance to premature closure, whereas the adaptive factor would consist of elaboration and abstractness of titles (see also Kim et al., 2006). Apparently, the children evaluated in our context would demonstrate a creative potential in which resistance to premature closure would be in the adaptive factor, together with elaboration and abstractness of titles. Following Torrance et al. (1992), resistance to closure means to "keep open and delay closure long enough to make the mental leap that make it possible original ideas" (Torrance et al., 1992; p. 40). Besides, as regards its scoring, this ability is assessed not only on the basis of the absence of closure of the figure or depending on closing irregular lines; those answers that present a quick and easy closure but add details and elaborations outside the closed figure are also positively punctuate. Given the latter, the structure found in this study, which groups the skills elaboration and resistance to closure on a single factor, is consistent with the way the resistance to closure is scored. As for the creative strengths, it can be verified in other studies (see e.g. Aranguren, 2014; Kim et al., 2006; Kim, 2006) that the models that include it get a worse fit.

Up to date, in relation to the original proposal of Torrance et al. (1992), finding six factors that explain the creativity construct measured by the TTCT figural, with both EFA and CFA, has not been possible (see the studies cited in the intro-duction). However, it is also worth noting that the results show that there is not a general factor but that it is possible to explain creativity by means of two factors that include the skills proposed by Torrance et al. (1992). Therefore, the results found through CFA do not contradict the author's original proposal.

Measurement invariance consists of subjecting the assumption of equivalence to empirical evidence (Byrne & Watkins, 2003; Widaman, Ferrer, & Conger, 2010). It requires performing CFA first to separate the measurement error from the real score. Subsequently, a series of restrictions are generated to verify whether the construct is invariant in different groups or moments. The results obtained in relation to invariance across sex enable to confirm configural invariance. The implication is that both groups (i.e., boys and girls) conceptualize the construct in the same manner (Milfont & Fischer, 2010). Metric invariance, which assumes that factor loadings are equivalent for both boys and girls, was also verified. Thus, the strength of the relationship between each dimension and its construct is similar in each group. The implication is that the relationship between the latent construct and the indicators is interpreted in the same manner for the two groups (Coromina, 2015). In relation to scalar invariance, the results confirm that in boys and girls, the observed scores are equally related to the latent punctuations in the same way (Milfont & Fischer, 2010). When scalar invariance is maintained, the means of the latent factor can be compared between the different groups (Coromina, 2015). Structural invariance was also found. The implication is that variance, covariance, and the means of the variances are equivalent in the two groups (Milfont & Fischer, 2010). However, no residual invariance was found across sex; thus, the errors differ in each group. The results related to invariance are consistent with the study on the Form B test performed by Krumm, Lemos et al. (2014), who found configural, metric, and structural invariance but not residual invariance across sex. In relation to residual invariance, it has been suggested that it is very strict (Chan, 1998), which would make it less relevant to study factorial invariance than the previous analysis. Taken together, the measurement properties tested allow establishing that in both groups (i.e., boys and girls), the same factorial structure can be identified, the skills represent the construct in a similar way, and the response scale by ability is equivalent for boys and girls.

With regard to the comparison of the scores on the factors evaluated between boys and girls, there are no significant differences in the innovative and adaptive factors of the skills (i.e., fluency, originality, elaboration, the abstractness of titles and resistance to premature closure), showing a very homogeneous performance across sex. Although studies show contradictory results in relation to differences across sex (Baer & Kaufman, 2008; Kaufman, 2006), there is growing consensus among researchers with respect to the existence of an effect of sex on creativity (Kaufman, 2006). Krumm, Lemos et al. (2014) work serve as an example. These authors use Figural Form B in children aged 9 to 14 years and find differences in creativity according to sex in the innovative and adaptive factors, although the effect size was less than 0.05. The differences may be due to the age range, given that in the present study the age of the children ranges from 9 to 12 years, whereas in the study by Krumm, Lemos et al. (2014), the range is from 9 to 14 years of age.

In summary, the TTCT, Form A would present an appropriate validity to study creativity in Spanish-speaking children. Given that the study has been based on that of Krumm, Lemos et al. (2014) performed with Form B, and has proved the same

assumptions in a similar context and age range, Forms A and B could be considered as parallel, for they value creativity through two factors: Innovation and Adaptation. Regarding the psychometric implications, the study of an instrument's invariance is a necessary condition so that measurement does not produce distortion in the representation of the phenomenon of interest; in this case, testing invariance across sex would ensure a proper assessment of the construct between males and females.

The present work presents a limitation when generalizing the results beyond the sample used, so future studies would benefit from replicating these results in different age groups. Besides, the sample of school children was taken from only two regions, not in all of the different regions that comprise the country. In addition, socio-economic and socio-cultural differences were not considered in the total study sample. These aspects should be considered in future studies. Although different studies have shown that TTCT-Figural consists of two factors, the latter would not have the same configuration indicating, as Kim (2006) mentions, that creativity does not manifest itself in the same way in all groups; thus, prior to the study of creativity in any specific sample, it would be necessary the examination of its factorial invariance across different ages and cultures. In this sense, the results of this research are of great relevance for the study of creativity in Spanish-speaking children.

Acknowledgments

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