

## Psychometric Characteristics of the CREA in an English Speaking Population

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**Título:** Características psicométricas del CREA en una población de idioma inglés

**Resumen:** Esta investigación examinó la fiabilidad y validez del CREA, una medida española de pensamiento divergente, en una población de idioma inglés. Los datos se obtuvieron durante dos años. En el primer año, las tres pruebas del CREA, los Torrance Tests de Creatividad (TTCT) Verbal y Figurativo, el inventario *How Do You Think?* (HDYT), el *Runco Ideational Behavior Scale* (RIBS), y el NEO fueron completados por una muestra estadounidense de estudiantes universitarios en dos sesiones. En el segundo año, las tres pruebas del CREA, los Torrance Tests de Creatividad Verbal y Figurativa, y el NEO fueron completados por una muestra de la misma población durante una sesión. Puntuaciones del CREA mostraron coeficientes de equivalencia altas y coeficientes de estabilidad moderadamente bajas. Tenían correlaciones significativas con puntuaciones globales en los TTCT Verbal y Figurativo sin excepción, y mostraron algunas correlaciones significativas pero bajas con inventarios biográficos y extraversión, y ninguna asociación con puntuaciones de rendimiento académico. Los resultados demostraron validez convergente del CREA con el TTCT, y validez divergente con medidas de otros constructos, sosteniendo así el uso del CREA como medida de pensamiento divergente.

**Palabras clave:** CREA; inteligencia creativa; creatividad; pensamiento divergente; valoración; validez; fiabilidad.

**Abstract:** This study examined the reliability and validity of the CREA, a Spanish measure of divergent thinking, in an English speaking population. Data were collected across two years. During the first year, three forms of the CREA as well as the *Verbal and Figural Torrance Tests of Creative Thinking* (TTCT), the *How Do You Think?* (HDYT) inventory, the *Runco Ideational Behavior Scale* (RIBS), and the NEO were completed by a sample of United States college students across two sessions. In the second year, three forms of the CREA, the *Verbal and Figural Torrance Tests of Creative Thinking* (TTCT), and the NEO were completed by a sample of the same population during one session. CREA scores showed strong alternate form but moderately weak test-retest reliability. They correlated significantly and consistently with overall Verbal and Figural TTCT scores, and showed some significant but weak correlations with biographical inventory and extraversion scores, and no association with academic achievement scores. Results demonstrated convergent validity of the CREA with the TTCT, and discriminant validity with measures of other constructs, thus supporting the use of the CREA as a divergent thinking measure.

**Key words:** CREA; creative intelligence; creativity; divergent thinking; assessment; validity; reliability.

### Introduction

The purpose of this study was to examine the reliability and validity of the CREA, an instrument for assessing divergent thinking, in an English speaking population. Studies with Spanish speaking populations from Spain and South America have supported the validity of the CREA for assessing divergent thinking (Corbalán et al., 2003; López & Navarro, 2008; Martínez, 2003). To date, an English version of this instrument has not been validated. In this study, the three existing forms of the CREA, forms A, B, and C, were tested for alternate form and test-retest reliability, as well as convergent and discriminant validity in the United States.

Based on a gradually accumulating body of research evidence, many experts support a complex model of creativity in which several factors are considered necessary for creative performance to flourish (Amabile, 1983; Batey & Furnham, 2006; Sternberg & Lubart, 1999). Different methods of assessing creativity have been developed that focus on the distinct factors associated with creative performance (Clapham, 2004; Heccevar & Bachelor, 1989; Michael & Wright, 1989). Divergent thinking, the ability to produce varied original ideas, is generally considered a critical component for creativity and innovation (Batey & Furnham, 2006; Clapham,

2003; Runco, 1990, 1993). The *Torrance Tests of Creative Thinking* (TTCTs) (Torrance, 1966) are popular divergent thinking tests that have been shown to predict various creative performance criteria (Plucker, 1999; Torrance, 1981a, 1981b), but because of lengthy test administration time and complex scoring procedures, these tests have limited practicality for use in organizational and educational settings.

Other critical components for creative performance include appropriate motivation and personality characteristics. Self-report inventories such as biodata questionnaires and personality inventories have been used to assess these aspects of creativity. Biodata questionnaires ask respondents about their past behaviors, interests and preferences. The *How Do You Think?* (HDYT) (Davis, 1975) and the *Runco Ideational Behavior Scale* (RIBS) (Runco, Plucker & Lim, 2001), are two of these inventories that have been shown to predict creative performance (Ames & Runco, 2005; Davis, 1975, 1989; Davis & Bull, 1978, Davis & Rimm, 1977; Plucker, Runco & Lim, 2006). Numerous personality inventories contain dimension scores that may relate to creativity. The *NEO Five Factor Inventory* (NEO-FFI) is a self-report questionnaire that assesses Neuroticism, Extraversion/Introversion, Openness to Experience, Agreeableness, and Conscientiousness. According to the test manual, Openness is associated with imagination, and Extraversion is associated with risk-taking (Costa & McCrae, 1992). Although both of these have been considered important characteristics for creativity, research suggests that extraversion is more consistently associated with creative performance across do-

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mains while openness to experience shows more domain specificity in its association with creative performance (Batey & Furnham, 2006; Dinca, 1993, 1994).

In order to examine the validity of the CREA, its scores can be compared to those of established divergent thinking tests, such as the TTCTs, as well as to scores on other instruments such as the HDYT, the RIBS, and dimensions of the NEO-FFI, that are believed to assess factors related to creativity that are distinct from divergent thinking. Validation of the CREA in English has value for several reasons. From a practical perspective, it is a quick, four-minute timed divergent thinking test that is much easier to score than the TTCTs. The CREA could therefore become an efficient alternative to these popular tests. It could be used to assess the effectiveness of programs to enhance divergent thinking and innovation and to develop interventions for individuals showing various levels of divergent thinking performance. From a theoretical perspective, validation of the CREA can contribute to our understanding of the concept of divergent thinking and its role in creative performance. Of the primary components of divergent thinking, fluency, flexibility and originality, the CREA focuses on fluency. Examining how this test compares to tests that emphasize all three components will add to our understanding of the role each of these constructs plays in creative performance. In addition, understanding CREA's relation to alternate approaches for assessing creativity can provide further clarification of the construct measured by the CREA.

## Method

### Procedure

In the first year of data collection, the study involved a test and retest phase. During the test phase, participants completed several inventories: a brief questionnaire asking for demographic information and self-report academic achievement ACT scores, the three forms of the CREA, the NEO-FFI, the HDYT and the RIBS. The retest phase, approximately four weeks later on average ( $M_{\text{days}} = 29.76$ ,  $SD = 15.23$ ) consisted of retesting a subset of participants from the test phase on the three forms of the CREA and administering the Verbal and Figural TTCTs. The order in which all the inventories were completed in each phase was varied to control for an order effect. In the second year, data collection was conducted in one session during which participants completed the demographic questionnaire, the three forms of the CREA, the NEO-FFI, and the Verbal and Figural TTCTs. As in the first year, the order in which inventories were administered was varied to control for order effects.

Reliability of the CREA was examined by comparing participant scores on forms A, B and C within test phase (alternate form reliability) and across test phases in the case of the first year (test-retest reliability).

Validity of the CREA was examined by comparing participant scores on the CREA to scores on other measures of the same and different constructs. CREA scores were first compared to established measures of divergent thinking, the TTCTs. It was expected that CREA scores would show a high association with TTCT scores since both are intended to assess the same construct. CREA scores were also compared to scores on other types of creativity inventories, the HDYT and RIBS. Lower associations between the CREA and HDYT/RIBS were expected than between CREA and TTCT scores because these tests do not assess divergent thinking. Based on past research, CREA scores were expected to show higher association with some personality dimensions, Openness and Extraversion, than others, Neuroticism, Agreeableness, and Conscientiousness. Finally CREA scores were expected to show the lowest association with ACT scores because this measures a different construct, academic achievement.

In summary, expected results were as follows:

- Alternate form reliability as indicated by large correlations between CREA forms A, B, and C within phase.
- Test-retest reliability as indicated by large correlations between the CREA scores in the two phases of the study.
- Convergent validity with other divergent thinking measures as indicated by moderately strong correlations between the TTCT and CREA scores.
- Discriminant validity with other types of creativity measures and measures of personality associated with creativity, as indicated by low correlations between CREA scores and HDYT, RIBS, Openness and Extraversion scores.
- Discriminant validity with non-creativity related personality characteristics, as indicated by small/no correlations between CREA and Agreeableness, Neuroticism and Conscientiousness scores.
- Discriminant validity with measures of other constructs indicated by small/no correlations between CREA and ACT scores.

### Measures

- *CREA*: The CREA is a timed four minute divergent thinking test that contains a picture and asks respondents to generate questions about the picture. Responses are given in writing. There are three forms, each with a different picture, but the same task and instructions. A single score is based on the total number of appropriate responses. The test manual reports strong reliability, convergent validity with Guilford's divergent thinking tasks, and discriminant validity with academic aptitude measures in children and adults (Corbalán et al, 2003). For this study, the brief CREA instructions were translated to English by the authors.
- *Torrance Tests of Creative Thinking*: Forms B of both the Verbal and Figural TTCT were used (Torrance, 1966). They

provide overall scores as well as subscores. The subscores are reported as standard scores with a mean of 100 and a standard deviation of 20. The Verbal TTCT has three subscores, fluency, flexibility and originality. The mean of these three subscores is the overall verbal creativity score. The Figural TTCT has five subscores: fluency, originality, abstractness of titles, elaboration, and resistance to premature closure. In addition to these subscores, the Figural TTCT provides scores on thirteen creative strengths. The total creative strength points are added to the mean of the five subscores to produce an overall figural creativity score. The TTCTs were professionally scored in this study. Age-normed scores were used in the analyses.

- *How Do You Think? Form E (HDYT)*: This inventory (Davis, 1975) consists of 100 self-report items which result in one overall score ranging from 100 to 500. The items of the HDYT, presented in a five point likert scale format, cover a variety of areas including energy level, originality, interests, activities, self-confidence, sense of humor, flexibility, risk-taking, and playfulness (Davis & Subkoviak, 1975). Administration is relatively fast and scoring is easy.
- *Runco Ideational Behavior Scale (RIBS)*: The RIBS (Runco, Plucker, & Lim, 2001) is a self-report ideation inventory containing 23 items that are rated using a five point likert rating scale. Based to confirmatory factor analysis results, Runco et al. (2001) stated that one or two factor solutions may be appropriate for the RIBS. They favored a one factor solution because of its theoretical fit with the construct of interest. Analyses in this study involved one overall RIBS score that can range from 23 to 115.
- *NEO-Five Factor Inventory (NEO-FFI)*: This inventory is a short, 60 item version of the NEO PI-R. The test manual shows that it has strong dimension score reliability and compares favorably to the longer version of the NEO. The five personality characteristics measured by the NEO have been studied extensively over the years, and have been found useful in predicting a wide variety of criteria (Costa & McCrae, 1992).
- *ACT*: The ACT is considered an academic achievement test. It includes subscores in English, Math, Reading, and Science reasoning, and is widely used as a college admission screening instrument. Self-report ACT scores were collected from the participants. In both years of data collection, some respondents did not provide ACT scores.

### Participants

Participants in the first year of the study consisted of 94 volunteer students from an introductory psychology course. Their mean age was 19.1 ( $SD = 2.42$ ). Of these, 62 were female (66%) and 32 were male (34%). From these participants, a total of 57 returned for the retest phase. Of these, three did not complete the CREA C. The average age of the retest participants was 19.3 ( $SD = 2.95$ ), of which 38 were

female (66.7%) and 19 were male (33.3). Participants in the second year were 28 participants from the same population. Their average age was 19.1 ( $SD = 1.09$ ), of which 21 were female (75%) and 7 were male (25%).

### Results

Descriptive statistics for the variables of interest are presented in Table 1. Analyses showed that scores on the CREA-B retest were significantly positively skewed. As a result, non-parametric statistics were conducted for analyses involving the CREA-B retest. No other scores in either year were significantly skewed. Analyses to compare scores by gender found that men and women had significantly different scores on only one variable. In the first year data, scores on the Resistance to Premature Closure subscore of the Figural TTCT showed a gender difference: women ( $M = 119.82$ ,  $SD = 13.58$ ) scored significantly higher ( $t = 2.62$ ,  $p = .01$ ,  $df = 55$ ) than men ( $M = 109.21$ ,  $SD = 16.00$ ). This difference was not found in the second year data.

Reliability coefficients are presented in Table 2. The average alternate form reliability in the first administration across years was  $r = .800$ . During the second administration, the average alternate form reliability was  $r = .674$ . This lower reliability coefficient may be a reflection of the skewed distribution of the CREA-B, as the coefficient between CREA-A and CREA-C was  $r = .780$ , comparable to those of the first administration. The average test-retest reliability coefficient across the three forms over a period of approximately 4 weeks was  $r = .661$ . These results indicate some fluctuation in performance on the tests over time.

Validity coefficients of CREA scores with TTCT scores are presented in Table 3. Results showed that the average CREA validity coefficient with the overall Verbal TTCT across years and administrations was  $r = .503$ . The subscore of the Verbal TTCT that appeared to be most strongly and consistently associated with the CREA was Fluency. The average CREA validity coefficient with the figural TTCT was  $r = .442$ , similar to that of the Verbal TTCT. The subtests of the Figural TTCT that appeared most strongly and consistently related to CREA scores were Originality and Abstractness of Titles. Caution should be taken, however, in interpreting TTCT subscores due to high interrelations between these scores and concerns about their level of reliability (Clapham, 2004). As expected, associations with the TTCT tests were generally stronger when the CREA and TTCTs were administered in the same session than when there was a time interval between their administrations. The CREA form most strongly associated with the Verbal and Figural TTCT was form A, possibly because of more variability in responses on this form. Perhaps the greater detail of the picture presented in form A compared to forms B and C elicited more questions from participants.

**Table 1:** Descriptive statistics of measures.

	1 <sup>st</sup> Year				2 <sup>nd</sup> Year	
	All Participants (n=94)		2 <sup>nd</sup> Admin Participants (n=57)		All Participants (n=28)	
	Mean	SD	Mean	SD	Mean	SD
CREA-A	16.70	5.55	16.26	5.03	14.07	4.29
CREA-B	15.53	4.51	15.09	4.03	12.54	4.24
CREA-C	15.41	4.71	14.68	4.54	13.43	4.21
CREA-A Retest	-	-	16.16	5.77	-	-
CREA-B Retest	-	-	14.89	4.76	-	-
CREA-C Retest	-	-	15.15 (n=54)	4.78	-	-
TTCT-Verbal	-	-	103.35	19.63	115.43	10.66
Fluency	-	-	102.81	18.01	111.46	11.13
Flexibility	-	-	101.70	20.35	122.36	12.67
Originality	-	-	106.54	23.79	113.32	11.01
TTCT- Figural	-	-	120.56	13.17	133.00	14.75
Fluency	-	-	117.37	15.21	106.18	21.07
Originality	-	-	112.02	16.55	115.36	18.35
Titles	-	-	100.93	19.53	127.50	14.38
Elaboration	-	-	101.42	17.55	131.79	13.65
Resistance	-	-	116.28	15.15	113.96	17.90
HDYT	302.01	41.20	297.30	43.56	-	-
RIBS	72.63	16.79	70.32	16.43	-	-
N	21.86	8.06	22.54	7.98	22.54	7.44
E	32.41	6.14	31.30	6.64	31.50	8.00
O	28.40	6.76	28.98	7.03	28.32	6.70
A	31.10	6.05	31.84	5.90	29.68	5.90
C	31.76	7.08	32.44	6.68	31.68	5.13
ACT	25.56 (n=88)	3.15	26.10 (n=51)	3.20	26.33 (n=24)	3.13

Note: Variations in sample sizes are indicated in parentheses.

**Table 2:** CREA alternate forms and test-retest reliability.

	1 <sup>st</sup> Year			2 <sup>nd</sup> Year		
	CREA-A	CREA-B	CREA-C	CREA-A	CREA-B	CREA-C
CREA-A	<b>.662**</b> (57)	<i>.650**</i> (57)	<i>.780**</i> (54)	-	-	-
CREA-B	<i>.776**</i> (94)	<b>.667**</b> (57)	<i>.592**</i> (54)	<i>.779**</i> (28)	-	-
CREA-C	<i>.787**</i> (94)	<i>.803**</i> (94)	<b>.655**</b> (54)	<i>.848**</i> (28)	<i>.804**</i> (28)	-

\*  $p < .05$ , \*\*  $p < .01$

Note: Coefficients of equivalence for the first administration are below the diagonal, and those for the second administration are above the diagonal. Coefficients of stability are in the diagonal. Number of participants is in parentheses. Italicized coefficients are Spearman Rho due to skewed distribution of CREA-B second administration data.

The relationships of the CREA scores with biodata, personality, and academic achievement scores are found in Table 4. As can be seen, the CREA scores from the first administration of the first year did not correlate significantly with the HDYT, but those from the second administration showed small significant correlations with the HDYT. In contrast, RIBS scores showed weak significant associations

with first, but not second administration CREA scores. Correlations with the NEO-FFI showed small significant positive correlations between the CREA and Extraversion. The other four personality dimensions showed no significant positive associations with the CREA. As expected, ACT scores showed no association with CREA scores.

**Table 3:** Correlations of CREA with Torrance scores.

	TTCT-Verbal				TTCT-Figural					
	Overall	Flu	Flex	Orig	Overall	Flu	Orig	Title	Elab	Res
<i>1<sup>st</sup> Year (n = 57)</i>										
CREA-A	.559**	.598**	.512**	.494**	.398**	.081	.352**	.308*	.287*	.210
CREA-B	.322*	.390**	.306*	.245	.305*	.305*	.336*	.093	.079	.333*
CREA-C	.340**	.414**	.360**	.227	.314*	.076	.259	.217	.235	.119
<i>CREA-A Retest</i>										
CREA-A Retest	.542**	.634**	.487**	.447**	.637**	.345**	.474**	.439**	.482**	.264*
<i>CREA-B Retest</i>										
CREA-B Retest	.330*	.424**	.324*	.256	.336*	.191	.232	.303*	.272*	.036
<i>CREA-C Retest</i>										
CREA-C Retest	.434**	.498**	.484**	.283*	.470**	.332*	.269*	.295*	.359**	.146
(n=54)										
<i>2<sup>nd</sup> Year (n=28)</i>										
CREA-A	.630**	.708**	.343	.709**	.554**	.119	.523**	.584**	.428*	.424*
CREA-B	.681**	.704**	.443*	.753**	.390*	-.060	.271	.655**	.378*	.117
CREA-C	.690**	.733**	.431*	.772**	.577**	.129	.520**	.625**	.388*	.455*

\*  $p < .05$ , \*\*  $p < .01$ 

Note: During the first year, TTCTs were given during the retest phase. Italicized coefficients are Spearman Rho due to skewed distribution of CREA-B second administration data. Sample size for the CREA-C in the first year was 54.

**Table 4:** Correlations of CREA with personality, biodata, and academic achievement scores.

	N	E	O	A	C	HDYT	RIBS	ACT
<i>1<sup>st</sup> Year. 1<sup>st</sup> Session (n=94)</i>								
CREA-A	-.086	.192	.000	.029	-.053	.163	.252*	.009 (88)
CREA-B	-.061	.224*	-.033	.017	-.167	.117	.151	-.156 (88)
CREA-C	-.105	.257*	-.039	-.037	-.149	.166	.204*	-.047 (88)
<i>1<sup>st</sup> Year. 2<sup>nd</sup> Session (n=57)</i>								
CREA-A Retest	-.074	.132	.182	.058	-.080	.266*	.231	.071 (51)
CREA-B Retest	-.206	.314*	.192	.103	-.010	.254	.214	-.035 (51)
CREA-C Retest	-.161(54)	.201(54)	.204(54)	.033(54)	-.006(54)	.323*(54)	.209(54)	.003 (48)
<i>2<sup>nd</sup> Year (n=28)</i>								
CREA-A	-.129	.197	.049	.013	.136	-	-	.114 (24)
CREA-B	-.080	.016	.071	-.048	-.041	-	-	.166 (24)
CREA-C	-.131	.003	.046	-.069	-.127	-	-	.070 (24)

\*  $p < .05$ , \*\*  $p < .01$ 

Note: Variations in sample sizes are indicated in parentheses. Italicized coefficients are Spearman Rho due to skewed distribution of CREA-B second administration data.

## Discussion

Results of this study generally are in accordance with the pattern of results that was expected. Alternate form reliability for the CREA A, B and C was strong. Test-retest reliability was a bit weaker and suggested some fluctuation in scores across time. Although creativity is expected to show some variability over time, reasons for the fluctuation warrants further investigation.

The CREA scores showed strong convergent validity with Verbal and Figural TTCT scores. These results indicate that the CREA measures a construct similar to that measured by the TTCTs. The generally stronger associations of the CREA with the Verbal TTCT than the Figural TTCT are

expected as the Verbal TTCT and the CREA both involve constructing written verbal responses. Common method variance or domain specificity of divergent thinking may be the basis for these results.

Validity coefficients were much lower between the CREA scores and the biodata inventories than between the CREA scores and the divergent thinking tests, supporting the distinction between these two types of creativity measures. Even weaker associations were found between the CREA scores and the big five personality dimension scores. Of the two personality dimensions expected to show an association with divergent thinking, only extraversion showed some significant correlations. Correlations of CREA scores with extraversion, however were small and inconsistent. Openness to experience was not associated with CREA

scores. Finally, no association was found between CREA divergent thinking scores and scholastic achievement measures.

## Conclusions

In summary, this study indicates that the CREA has positive psychometric characteristics. It showed strong alternate form reliability and moderate test-retest reliability. Convergent validity was demonstrated with the Verbal and Figural TTCT, and discriminant validity was established with creativity biodata inventories, personality dimensions, and scholastic achievement. Furthermore, no gender differences were found on scores obtained from any of the three CREA forms. These results suggest that the CREA is a quick, easy,

useful measure of divergent thinking for English speaking populations. The test manual presents interpretive guidelines for CREA scores that educators and organizational leaders may find useful. It presents potential positive characteristics and limitations of individuals with low, medium and high CREA scores, and suggests possible interventions for each level. It suggests that those individuals with moderate/midrange scores may benefit most from creativity training, while those with high CREA scores may benefit most from an environment that supports their existent ideational tendencies. While further examination of this test is warranted to determine the stability and generalizability of these preliminary results, this study represents a positive first step in examining the validity of an English version of the CREA.

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(Artículo recibido: 29-3-2010; revisado: 26-4-2010; aceptado: 27-4-2010)