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Meta-analyses of the relationship of creative achievement to both IQ and divergent thinking test scores

ABSTRACT

There is disagreement among researchers about whether IQ tests or divergent thinking (DT) tests are better predictors of creative achievement. Resolving this dispute is complicated by the fact that some research has shown a relationship between IQ and DT test scores (e.g., Runco & Albert, 1986; Wallach, 1970). The present study conducted meta-analyses of the relationships between creative achievement and both IQ and DT test scores. The analyses included 17 studies (with 5,544 participants) that established the correlation coefficients between IQ and creative achievement and 27 studies (with 47,197 participants) that established the correlation coefficients between DT test scores and creative achievement. Marginal, but statistically significant, Fisher's Z-transformed correlation coefficients were revealed. The analysis found a significantly higher relationship between DT test scores and creative achievement (r = .216) than between IQ test scores and creative achievement (r = .167). The differences in the correlation coefficients were explained by differences in DT tests, creative achievement types, predicted time periods, and creativity subscales. The significant independent moderator effect for different DT tests indicates that the Torrance Tests of Creative Thinking (TTCT) predict creative achievement better than any other DT test included in this study. Among the creative achievement types, music is predicted the best by IQ and all others are predicted best by DT tests. Among the time periods evaluated, the relationship between DT test scores and creative achievement had the highest correlation at the period of 11-15 years.

INTRODUCTION

The value of any test is dependent upon its ability to predict performance in the characteristic being measured (Cramond, 1994). One often used example of a valuable test is the Binet intelligence test which lacks the capacity to measure more than a few human abilities and which was originally designed to identify

intellectual deficits. However, the Binet intelligence test has endured and even been updated to its current form, the Stanford-Binet Intelligence Scales. One of the reasons is that children with high scores on the Binet intelligence test tend to well in school.

One characteristic, other than IQ, that society has come to value over the past 50 years is creativity. The definition of "giftedness" is being updated to include individuals with high creative potential rather than just high IQ (e.g., Georgia Department of Education; Renzulli, 1986). Thus, measures of creativity are becoming increasingly important.

Guilford (1950, 1962, 1966, 1968) hypothesized that creative individuals possess divergent thinking abilities including idea production, fluency, flexibility, and originality. Guilford also argued that traditional intelligence tests (such as the Binet IQ test) do not measure some or all of these creative abilities. Guilford's theories spawned an array of divergent thinking (DT) tests such as the Torrance Tests of Creative Thinking (TTCT), Wallach & Kogan Divergent Thinking Tasks, and Guilford Divergent Thinking Tasks[1]. It also spawned research that attempts to correlate scores on these DT tests with creative potential.

Research has generally concluded that DT test scores and creativity inventory scores are predictive of creative activities, interests, and accomplishments later in life (Cline, Richards, & Needham, 1963; Kogan & Pankove, 1972; Russ, Robins, & Christiano, 1999; Torrance, 2002, Rimm & Davis, 1976; Wakefield, 1985). However, the rationale that DT is related to creative potential remains controversial. Plucker (1999) found previous research that suggested that DT test scores have little predictive validity with respect to adult creative achievement, but his own research tended to support the predictive validity of DT tests. Prior to Torrance's longitudinal studies on his DT tests, the TTCT, skeptics expressed doubt that children that scored highly on the TTCT would produce useful creative achievement later in life (Torrance, 1972). Research has also indicated that the best predictor of creative achievement is past creative performance (Holland, 1961; McDermid, 1965; Taylor & Ellison, 1962) and that DT tests are no better than intelligence tests as predictors of real-life creativity (Cropley, 1972; Getzels & Csikszentmihalyi, 1964; Kogan & Pankove, 1974; Skager, Klein, & Schultz, 1967; Torrance, 1972; Wodtke, 1964). This controversy leads to a second issue: Do IQ tests or DT tests predict creative achievement better?

Researchers disagree whether DT tests measure significantly different traits than IQ tests. Some research has shown that divergent thinking tasks, DT test scores, and creative achievement are independent from IQ (e.g., Getzels & Jackson, 1958; Gough, 1976; Helson, 1971; Helson & Crutchfield 1970; Herr, Moore, & Hansen, 1965; Rossman & Horn, 1972; Rotter, Langland & Berger, 1971,

[1] Some researchers (e.g., Torrance, 1984) refer to their tests as creativity tests. However, this article attempts to address this underlying issue (whether DT tests measure creativity) so for the purposes of this article the author has chosen to refer to DT tests.

Torrance, 1977). However, some research has shown a relationship between DT test scores and IQ scores (e.g., Runco & Albert, 1986; Schmidt, 1973; Wallach, 1970). Additionally, many researchers agree with the threshold theory, which assumes that below a critical IQ level which is usually thought to be about 120, and which indicates that there is some correlation between IQ and creative potential, and above the threshold there is no correlation (Barron, 1961; Getzels & Jackson, 1961, 1962; Guilford, 1967; Guilford & Christensen, 1973; Hall, 1972; MacKinnon, 1961, 1962, 1967; Simonton, 1994; Walberg, 1988; Walberg & Herbig, 1991; Yamamoto, 1964). However, a recent meta-analysis indicated that the relationship between creativity test scores and IQ scores may be negligible which undermines the threshold theory (Kim, 2005). Regardless of this controversy, DT tests are in widespread use. The rationale for the widespread use of DT tests is based on two assumptions: i) divergent thinking is related to real life creative behavior; and ii) divergent thinking is more strongly associated with real-life creative behavior than intelligence (Hocevar, 1980).

Meta-analyses attempt to resolve apparent conflicts in literature; to discover consistencies and account variability in similarly appearing studies; and to identify core issues for future research (Cooper & Hedges, 1994). Thus, this study synthesized empirical research in the areas of creativity, DT tests, and intelligence tests for the purpose of creating a generalization about the relationships between creative achievement and both IQ and DT test scores. The five primary purposes of this synthesis were to:

1. Conduct a meta-analysis of correlations between IQ and creative achievement;
2. Conduct a meta-analysis of correlations between DT test scores and creative achievement;
3. Identify some of the variables that moderate those correlations and test whether correlation coefficient sizes vary systematically across differing levels of variables that are posited to influence the relationship between IQ and creative achievement (e.g., gender, IQ tests, creative achievement types, & predicted time periods[2]).
4. Identify some of the variables that moderate those correlations and test whether correlation coefficient sizes vary systematically across differing levels of variables that are posited to influence the relationship between DT test scores & creative achievement (e.g., gender, DT tests, creative achievement types, predicted time periods, & creativity subscales).
5. Use the correlations derived from the meta-analyses to investigate models of the relationships between creative achievement and both IQ and DT test scores.

[2] "Predicted time periods" refer to the future time period that was studied which was related to the results of an earlier test.

METHODS

Literature Searches

Over one hundred studies published from 1958 through the summer of 2005 were located in computer databases (e.g., Academic Search Premier, ERIC, Primary Search, PsycARTICLES, & PsycINFO) and bibliographic searches of each reference within the body of English creativity and intelligence literature. The keywords for the searches included: IQ, creativity, divergent thinking, intelligence, and creative achievement.

The criteria for inclusion in this meta analysis are: i) the reporting of the correlations between measures of intelligence and creative achievement, and/or the correlations between measures of DT and creative achievement; ii) a sample size for each correlation; iii) identification of the measure of IQ and/or DT; iv) and reporting of creative achievement in the area of quality or quantity, art, music, writing, science (including math, medical, and engineering), leadership, or social skills.

The above criteria were required by the limitations of statistical analysis. However, these criteria significantly limited the number of previous studies included in this meta-analysis. Many of the previous studies examined failed to report detailed information on procedures and/or results, making it difficult or impossible to generate correlation coefficients. Ideally, a meta-analysis researcher must try to collect and analyze the results of all existent studies related to the defined population. However, not all of the studies can be used because the statistics necessary for the analysis is not reported in some of them. According to Hunter et al. (1982), however, meta-analytic procedures are still valid even for convenience samples so that a complete sampling of the population is not necessary.

Where non-significant correlation coefficients were reported and interpretation was not available through sample size and probability estimates (e.g., the correlation coefficients between IQ [Terman Concept Mastery Test] and creative achievement in Hall, 1972; the correlation coefficients between IQ [Milta Group Intelligence test] and creative achievement in Milgram & Hong, 199), a Pearson correlation coefficient of $r = .00$ was assumed (Rosenthal, 1991). Some of the previous studies were not used because they compared t-tests between high and low creative individuals (e.g., Carroll & Howieson, 1992; Getzels & Jackson, 1961; 1962; Lynch, 1970); they presented comparisons between creative and control groups (e.g., Anastasi & Schaefer, 1971; Lang & Ryba, 1976); they reported multiple regression analysis for the prediction of IQ, creativity, leadership, and academic achievement (Chan, 2001) or the Scales for Rating the Behavioral Characteristics of Superior Students (SRBCSS, Chan, 2000); or they reported correlation coefficients within limited IQ ranges (Gonzales & Campos, 1997).

Ultimately, only 17 studies that presented correlation coefficients between IQ and Creative Achievement and 27 studies that presented correlation coefficients between DT test scores and creative achievement were included in the present meta-analyses.

Effect Size Calculations

Two quantitative syntheses of the resulting 17 studies and 27 studies were conducted, which was assisted by Schwarzer's Meta 5.3 statistical software (1991). Fisher's *z* transformation of *r* was used for analyses to adjust for the non-normal distribution of *r*. Most researchers believe that studies which employ large samples should get more credit than those which are based on small samples because correlations become more stable as sample size increases (Schwarzer, 1991). Thus, the effect size *zr* was weighted by sample size: the weighted mean $zr = \Sigma(Nj - 3)\ zrj\ /\ \Sigma(Nj - 3)$, in this equation *zrj* is the Fisher *zr*, corresponding to any *r* (Rosenthal, 1991). Each mean *r* was tested using a random effects model of variance, and the reported values of *r* are back transformations from *z* (Hunter, Schmidt, & Jackson, 1982). A correlation coefficient was judged heterogeneous when the residual standard deviation exceeded ¾ of the effect size, and sampling error was less than 75% of the observed variance (Schwarzer, 1991). The residual standard deviation was used as the standard error in estimating 95% confidence intervals.

Ultimately, 368 correlation coefficients were retrieved from the studies: 94 correlation coefficients between IQ and Creative Achievement (from 17 studies involving a total sample size of 5,544 people); and 274 correlation coefficients between DT test scores and Creative Achievement (from 27 studies involving a total sample size of 47,197 people). Multiple correlation coefficients were obtained from studies that included more than one correlation using several creativity subscales or reported separate results for gender. A conservative statistical criterion ($p < .001$) was used to protect against Type I error (Rosenthal, 1991; Rosenthal & Rubin, 1984) when several correlation coefficients resulted in a study of moderators. Finally, as reported above, individual correlation coefficients were weighted by sample sizes (Hedges & Olkin, 1985; Hunter & Schmidt, 1990; Rosenthal, 1991) to adjust for sampling errors in *r*, giving more credence to studies with large samples because small sample sizes can increase Type II error (Hedges & Olkin, 1985).

Moderator Analyses

An analysis of moderator variables was conducted to test whether correlation coefficient sizes varied systematically because of the different variables that influence the relationships between IQ and Creative Achievement and between DT test scores and Creative Achievement. Correlation coefficient size heterogeneity can be explained through moderator variables. The moderator variables were categorized in a manner that seemed theoretically valid.

Previous research is inconclusive about whether gender affects creativity scores, thus a moderator analysis of gender was conducted to test whether correlation coefficient sizes vary systematically across male, female, and combined subjects. Previous studies found gender differences (e.g., Gupta, 1981; Jaquish & Ripple,

1980; Kim, 2004; Kim & Michael, 1995; Richardson, 1986; Vernon, 1972), whereas other studies (e.g., Ogawa, Kuehn-Ebert, & De Vito, 1991; Runco, 1991; Saeki, Fan, & Van Dusen, 2001) found no differences. Even among those studies that found gender differences there were inconsistencies in that some reported higher scores for males, others reported higher scores for females.

Previous research is inconsistent about whether DT test scores predict real-life creativity in a specific area of creativity such as art, math-science, drama, writing, music, etc. (e.g., Hocevar, 1980; Milgram & Milgram, 1976; Wallacch & Wing, 1969). Thus, a moderator analysis of Creative Achievement Type was conducted to test whether correlation coefficient sizes vary systematically in specific areas such as art, music, writing, science (including math, medial, and engineering), leadership, and social skills. However, some studies only presented results in general terms so the analysis included more general creativity areas, e.g., general creativity, quality of creative achievement, or quantity of creative achievement. Further, when data were entered, it was discovered that the studies varied how they classified specific areas, thus, for the present meta-analysis some of the fields were reclassified. For instance, in Carson, Peterson, and Higgins' study (2003), "accomplishment in art and science fields" was classified as general creative achievement. In Baron's study (1963), "overall performance in charades" was classified as quantity; "total effectiveness in improvisation" was classified as quality; both "overall effectiveness in command functions" and "overall effectiveness in staff function in the air force" were classified as quality. In Frederiksen and Ward's study (1978), "number of activities" in the Test of Scientific Thinking was classified as quantity; "publications" were classified as writing; "collaborative research" was classified as science; "number" was classified as fluency; "unusual" was classified as originality; "teacher rating" or "professor rating" (e.g., Lunneborg & Lunneborg, 1968; Rimm & Davis, 1976), "supervisor rating" (e.g., Getzels & Csikszentmihalyi, 1976), and "teacher rating" and "principal rating" (e.g., Storm & Larimore, 1970) were classified as general creative achievement; however in Gough's studies (1975, 1976), "supervisor rating" and "peer rating" were classified as science because their fields were science or engineering; "professors rating" was classified as art (Lunneborg & Lunneborg, 1968); and "business contact" was classified as social skills whereas "business organization" was classified as leadership (Wakefield, 1985).

Barron and Harrington's comprehensive review of creativity research (1981) found that correlation coefficients between creative thinking abilities and intelligence vary widely depending upon the DT test being studied, the heterogeneity of the sample, and even testing conditions. Different results from different studies may also be due to different IQ tests and/or different DT tests. Thus, a moderator analyses of IQ Tests and DT Tests was conducted to test whether correlation coefficient sizes vary systematically between the Torrance Tests of Creative Thinking (TTCT), Guilford Divergent Thinking Tasks, Wallach & Kogan Divergent Thinking Tasks, Sounds and Images (see Khatena, 1971), Group Inventory for Finding

Creative Talent (GIFT: see Rimm & Davis, 1976), and Word Association Tests (WAT: Kent-Rosanoff WAT & Scientific WAT: see Gough, 1975, 1976).

Different results from different studies may be due to different creativity subscales, thus, a moderator analyses of Creativity Subscale was conducted to test whether correlation coefficient sizes vary systematically across fluency, flexibility, originality, elaboration, inventiveness, creative strengths, and general creativity. Again when data was entered, it was discovered that the studies varied how they classified specific creativity subscales, thus, for the present meta-analysis some of the fields were reclassified: "associational fluency", "ideational fluency", "verbal fluency", and "figural fluency" were classified as fluency; "spontaneous flexibility", "adaptive flexibility", "verbal flexibility", and "figural flexibility" were classified as flexibility; and "verbal originality" and "figural originality" were categorized as originality. In several of the DT tests in the present study (e.g., Flescher, 1963; Hocevar, 1980; Kogan & Pankove, 1972; Vernon, 1972; Wallach & Kogan, 1965), subscales were not reported. Thus, the tasks in these studies were examined and categorized based on the nature of those tasks. In Cline, Richards, and Needham (1963), "consequences immediate", "brick uses-total", and "word association" were classified as general creativity subscale; "hidden figures", "brick uses-change", and "match problems" were classified as flexibility; "consequences-remote" was classified as originality. In Gough (1975, 1976), "total responses" were classified as fluency, and "Word Association Test" (Cline, Richards, & Needham, 1963; Gough, 1975, 1976) was classified as general creativity subscale. In Lunneborg and Lunneborg's study (1968), "Architectural School Aptitude Test (ASAT)" was classified as general.

Different results from different studies may be due to the time period each study investigated, thus a moderator analysis of Predicted Time Period was conducted to test whether correlation coefficient sizes vary systematically from the present and in years 1-5, 6-10, 11-15, 16-20, and 21 and over.

Factors that might moderate the estimated population correlation coefficients between IQ and Creative Achievement were considered by comparing correlation coefficients based on Gender, IQ Test, Creative Achievement Type, and Predicted Time Period. Factors that might moderate the estimated population correlation coefficients between DT test scores and Creative Achievement in the present study were considered by comparing correlation coefficients based on Gender, Creative Achievement Type, DT Test, Creativity Subscale, and Predicted Time Period. Most studies did not report information about their subjects' ethnicity so ethnicity was not considered as a moderator variable.

Hedges' g was derived for each individual correlation coefficient in the moderator analysis using Johnson's DSTAT 1.10 meta-analysis software (1993). When significant moderator effects were found, the proportion of variance caused by the moderators was determined. Variables that were significant moderators were entered into a weighted linear multiple regression model (weighted by N-3, [Rosenthal, 1991]) using SPSS to clarify their independent effects for explaining variations in zr.

RESULTS

A stem-and leaf display of the 94 effects between IQ scores and Creative Achievement is presented in Figure 1, and a stem-and-leaf display of the 274 effects between DT test scores and Creative Achievement is presented in Figure 2. Both of the stem-and-leaf displays indicate a nearly normal distribution of correlation coefficients. After weighting by sample size, the mean value of *r* between IQ and Creative Achievement was .167 (95% CI = .141 – .193) and the mean value of *r* between DT test scores and Creative Achievement was .216 (95% CI = .207 – .225). Thus, a higher correlation coefficient was found between DT test scores and Creative Achievement than between IQ and Creative Achievement. Both of the mean correlation coefficients were judged to be small and statistically significant. However, both of the correlation coefficients were heterogeneous: Q (93) for correlation coefficients between IQ and Creative Achievement was 174.514 ($p < .0001$), whereas Q (273) for correlation coefficients between DT test scores and Creative Achievement was 842.431 ($p < .0001$); both of the residual standard deviations were greater than one fourth of population correlation coefficient size

FIGURE 1. Stem-and-Leaf-Display for 94 Correlation Coefficients (r) between IQ and Creative Achievement.

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–.9 I
–.8 I
–.7 I
–.6 I
–.5 I
–.4 I
–.3 I
–.2 I 24
–.1 I 122678
–.0 I 0000113345599
+.0 I 0000244566889
+.1 I 00123333334566677
+.2 I 0111112224456677888999
+.3 I 013355578888
+.4 I 0014455566678
+.5 I
+.6 I
+.7 I
+.8 I
+.9 I
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Note. The correlation coefficients *r* ranged from –.24 in the first row of the display to +.48 in the last row.

(.042 for the correlation coefficients between IQ and Creative Achievement; .054 for the correlation coefficients between DT test scores and Creative Achievement); Percent of observed variance accounted for by sampling error for the correlation coefficients between IQ and Creative Achievement was 52.81% and between DT test scores and Creative Achievement was 33.39%, and both of which were less than 75%. Because the data set was heterogeneous, it was necessary to search for moderators that may account for the remaining systematic variation in the data (see Schwarzer, 1991). The analyses of moderators were performed by breaking down the data into at least three subsets with respect to theoretically relevant variables. Moderator analyses were conducted to determine whether moderators describing subjects or features of IQ and Creative Achievement and DT test scores and Creative Achievement might account for variability in the magnitude of correlation coefficients. Each simple contrast tested as z at $p < .001$. Correlation coefficients for each moderator are reported in Table 1 through Table 5 as mean r. Variability in the magnitude of correlation coefficients between IQ and Creative Achievement for Gender (QB [2] = 27.582, $p < .0001$), IQ Test (QB [3] = 102.415,

FIGURE 2. Stem-and-Leaf-Display for 274 Correlation Coefficients (r) between DT test scores and Creative Achievement.

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-.9 I
-.8 I
-.7 I
-.6 I
-.5 I
-.4 I
-.3 I 00
-.2 I 13778
-.1 I 012244455778
-.0 I 02222333345558
+.0 I 01112333444556788899
+.1 I 12223334455556667788888999999999
+.2 I 000011111222222222222344455555555566677777777788888888999999
+.3 I 00000001111111122222222233344444444455555556666666667777777888999999
+.4 I 0000000111122333334444555566677888889999
+.5 I 022344455578899
+.6 I 00237
+.7 I
+.8 I
+.9 I
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Note. The correlation coefficients r ranged from –.30 in the first row of the display to +.67 in the last row.

$p < .0001$), Creative Achievement Type (QB [8] = 114.381, $p < .0001$), and Predicted Time Period (QB [5] = 115.192, $p < .0001$) were significant, implying that the mean correlation coefficients of the different classes or levels for each moderator differed from each other. Variability in the magnitude of correlation coefficients between IQ and Creative Achievement for Gender (QB [2] = 127.385, $p < .0001$), DT Test (QB [6] = 464.785, $p < .0001$), Creative Achievement Type (QB [8] = 274.390, $p < .0001$), Predicted Time Period (QB [5] = 362.915, $p < .0001$), and Creativity Subscale (QB [6] = 132.310, $p < .0001$) were significant, implying that the mean correlation coefficients of the different classes or levels for each moderator differed from each other.

MODERATOR ANALYSES

Gender

As Table 1 shows, the mean correlation coefficients between DT test scores and Creative Achievement were higher than the mean correlation coefficients between IQ and Creative Achievement for all of the three groups (male, female, and combined). The heterogeneities observed within the different levels or classes imply that the mean correlation coefficients for each level or class cannot be adequately described with a single correlation coefficient. In other words, the variation in the relationships is due to one or more additional factors that the levels or classes do not capture. There were no statistically significant differences between males and females for the mean correlation coefficient between IQ and Creative Achievement ($p = .350$), whereas the mean correlation coefficient between DT test scores and Creative Achievement for males was higher than for females ($p = .0005$).

TABLE 1. Gender as a Moderator.

Gender	IQ & Creative Achievement			DT test scores & Creative Achievement		
	N (# of *r*)	Mean *r*	Homogeneity	N (# of *r*)	Mean *r*	Homogeneity
Male	15	.216	homogeneous	49	.313	heterogeneous
Female	14	.246	homogeneous	37	.257	heterogeneous
Combined	.130	.193	heterogeneous	188	.199	heterogeneous

Note. No statistically significant differences between male and female groups ($p > .001$).

Homogeneity: heterogeneous when $p < .001$.

Model for Gender, QB (2) = 27.582 ($p < .0001$) for the correlation coefficients between IQ & Creative Achievement; QB (2) = 127.385 ($p < .0001$) for the correlation coefficients between DT test scores & Creative Achievement.

IQ Tests and DT Tests

As Table 2 shows, the contrasts between IQ Tests revealed that the correlation coefficient between IQ Tests and Creative Achievement for Lorge Thorndike Intelligence Tests as a measure of IQ was statistically significantly higher than the correlation coefficients for either California Test of Mental Maturity ($p < .0001$) or Terman Concept Mastery Test ($p < .0001$). The contrasts between DT Tests revealed that the correlation coefficients between DT Tests and Creative Achievement for TTCT, GIFT, and WAT were statistically significantly higher than the correlation coefficients for either Guilford Divergent Thinking Tasks ($p < .0001$) or Wallach & Kogan Divergent Thinking Tasks ($p < .0001$).

TABLE 2. IQ Tests and DT Tests as Moderators.

IQ/DT test	N (# of *r*)	Mean *r*	Homogeneity	Contrast	*p*-value for Contrast
California	41	.073	heterogeneous	California/Lorge	*P* < .0001
Lorge	17	.310	heterogeneous	Lorge/Terman	*P* < .0001
Terman	32	.180	heterogeneous	Terman/California	*P* < .0001
Others	4	.032	homogeneous		
TTCT	142	.328	heterogeneous	TTCT/Guilford	*P* < .0001
Guillford	38	.108	heterogeneous	GIFT/Guilford	*P* < .0001
Wallach	46	.137	heterogeneous	TTCT/Wallach	*P* < .0001
Sounds	4	.163	heterogeneous		
GIFT	5	.334	homogeneous	GIFT/ Wallach	*P* < .0001
WAT	6	.306	homogeneous	Guilford/WAT	*P* < .0001
Others	33	.186	heterogeneous		

Note. California = California Test of Mental Maturity; Lorge = Lorge Thorndike Intelligence Tests; Terman = Terman Concept Mastery Test; TTCT = Torrance Tests of Creative Thinking; Wallach = Wallach & Kogan Divergent Thinking Tasks; Guilford = Guilford Divergent Thinking Tasks; Sounds = Sounds and Images; GIFT = Group Inventory for Finding Creative Talent; WAT = Word Association Tests.

Homogeneity: heterogeneous when $p < .001$.

Model for IQ Tests and DT tests, QB (3) = 102.415 ($p < .0001$) for the correlation coefficients between IQ & Creative Achievement; QB (6) = 464.785 ($p < .0001$) for the correlation coefficients between DT test scores & Creative Achievement.

Creative Achievement

As Table 3 shows, for general creative achievement and quality, the mean correlation coefficients between Creative Achievement and DT test scores was higher than IQ. On the contrary, for quantity, the mean correlation coefficient between

Creative Achievement and IQ was higher than DT test scores. Contrasts between the coefficients for general creative achievement and quality (p = .017) and quantity (p = .003), and between quality and quantity (p = .050) revealed that no statistically significant differences for the mean correlation coefficients between IQ and Creative Achievement. Whereas the mean correlation coefficients for both general creative achievement (p < .0001) and quality (p < .0001) were statistically significantly higher than for quantity between DT test scores and Creative Achievement.

TABLE 3. Creative Achievement Type as a Moderator.

Type	IQ & Creative Achievement			DT test scores & Creative Achievement.		
	N (# of *r*)	Mean *r*	Homogeneity	N (# of *r*)	Mean *r*	Homogeneity
a. General	12	.235	heterogeneous	22	.306	heterogeneous
b. Quality	9	.316	homogeneous	53	.325	heterogeneous
c. Quantity	6	.238	homogeneous	48	.219	heterogeneous
Contrast	No significant differences(p>.001)			ac, bc (p < .0001)		
a. Art	20	.056	heterogeneous	27	.232	heterogeneous
b. Music	7	.210	homogeneous	12	.148	homogeneous
c. Writing	12	.172	heterogeneous	44	.187	heterogeneous
d. Science	18	.061	heterogeneous	52	.166	heterogeneous
e. Leadership	4	.365	homogeneous	6	.302	homogeneous
f. Social Skills	6	.119	homogeneous	10	.171	heterogeneous
Contrast	ba, bd, ca (p < .001) ea, ed, ef (p < .0001)			ad, eb, ec (p < .001) ed (p < .0001)		

Note. Homogeneity: heterogeneous when p < .001.

Model for Creative Achievement Type, QB (8) = 114.381 (p < .0001) for the correlation coefficients between IQ & Creative Achievement; QB (8) = 274.390 (p < .0001) for the correlation coefficients between DT test scores & Creative Achievement.

For art, writing, science, and social skills, the mean correlation coefficients between DT test scores and Creative Achievement were higher than the mean correlation coefficients between IQ and Creative Achievement. On the contrary, for music and leadership, the mean correlation coefficients between IQ and Creative Achievement were higher than the mean correlation coefficients between DT test scores and Creative Achievement. Contrasts among art, music, writing, science, leadership, and social skills revealed that the mean correlation

coefficients between IQ and Creative Achievement for leadership was statistically significantly higher than art ($p < .0001$), science ($p < .0001$), and social skills ($p = .0003$); music was statistically significantly higher than art ($p = .0004$), and science ($p = .0008$); and writing was statistically significantly higher than art ($p = .0005$). The mean correlation coefficients between DT test scores and Creative Achievement for leadership was statistically significantly higher than music ($p = .0002$), writing ($p = .0001$), and science ($p < .0001$); and art was statistically significantly higher than science ($p = .0002$). However, the sample set for leadership was limited with only four cases between IQ and Creative Achievement Type and only six cases between DT test scores and Creative Achievement Type, which limits the generalization of the result for leadership.

Predicted Time Period

As Table 4 shows, in all time periods except 6-10 years and over 21 years, the correlation coefficients between DT test scores and Creative Achievement were higher than the correlation coefficients between IQ and Creative achievement. In the periods of 6-10 years and over 21 years, the comparison between IQ and Creative Achievement had higher correlation coefficients.

TABLE 4. Predicted Time Period as a Moderator.

	IQ & Creative Achievement			DT test scores & Creative Achievement.		
	N (# of *r*)	Mean *r*	Homogeneity	N (# of *r*)	Mean *r*	Homogeneity
a. 0 Year	28	.050	heterogeneous	72	.232	heterogeneous
b. 1-5 Year	2	.178	homogeneous	23	.181	heterogeneous
c. 6-10 Year	26	.218	heterogeneous	32	.157	heterogeneous
d. 11-15 Year	8	.289	heterogeneous	73	.364	heterogeneous
e. 16-20 Year	23	.172	homogeneous	52	.224	heterogeneous
f. 21+ Year	7	.352	homogeneous	22	.246	homogeneous
Contrast	fc, de ($p < .001$) ca, da, ea, fa, fe ($p < .0001$)			ac, eb, fb ($p < .001$) ab, da, db, dc, de, df ($p < .0001$)		

Note. Homogeneity: heterogeneous when $p < .001$.

Model for Predicted Time Period, QB (5) = 115.192 ($p < .0001$) for the correlation coefficients between IQ & Creative Achievement; QB (5) = 362.915 ($p < .0001$) for the correlation coefficients between DT test scores & Creative Achievement.

Contrasts among the Predicted Time Periods revealed that for the mean correlation coefficients between IQ and Creative Achievement, the time period of 21 year and more was statistically significantly higher than 0 year ($p < .0001$), 6-10

year (p = .0006), and 16-20 year (p < .0001); 11-15 year was statistically significantly higher than 0 year (p < .0001) and 16-20 year (p = .0002); and both 6-10 year (p < .0001) and 16-20 year (p < .0001) were statistically significantly higher than 0 year. For the mean correlation coefficients between DT test scores and Creative Achievement, the time period of 11-15 year was statistically significantly higher than 0 year (p < .0001), 1-5 year (p < .0001), 6-10 year (p <.0001), 16-20 year (p <.0001), and 21 year and more (p <.0001); 0 year was statistically significantly higher than 1-5 year (p < .0001) and 6-10 year (p = .0005); and both 16-20 year (p = .0005) and 21 year and more (p = .0006) were statistically significantly higher than 1-5 year.

Creativity Subscale

As Table 5 shows, the contrasts between Creativity Subscale revealed that the correlation coefficient between DT test scores and Creative Achievement for inventiveness was statistically significantly higher than fluency (p < .0001), flexibility (p < .0001), originality(p < .0001), and general creativity (p < .0001); creative strengths was statistically significantly higher than fluency (p < .0001), flexibility (p < .0001), originality (p < .0001), and general creativity(p < .0001); and elaboration was statistically significantly higher than fluency (p < .0001), flexibility(p < .0001), originality(p < .0001), and general creativity (p < .0001).

Multiple Regression Analysis

Variables that were statistically significant moderators (based on the results of the contrasts) were entered into a weighted linear multiple regression model to determine their independent effects for explaining variation in the magnitude of correlation coefficients.

TABLE 5. Creativity Subscale as a Moderator.

Creativity Subscale	N (# of r)	Mean r	Homogeneity	Contrast	p-value for Contrast
a. Fluency	58	.195	heterogeneous	da, ea, fa	p < .0001
b. Flexibility	37	.205	heterogeneous	db, eb, fb	p < .0001
c. Originality	51	.202	heterogeneous	dc, ec, fc	p < .0001
d. Elaboration	15	.300	homogeneous		
e. Inventiveness	6	.401	homogeneous		
f. Strengths	28	.322	homogeneous		
g. General	79	.214	heterogeneous	dg, eg, fg	p < .0001

Note. Homogeneity: heterogeneous when p < .001.

Model for Creativity Subscale, QB (6) = 132.310 (p < .0001) for the correlation coefficients between DT test scores & Creative Achievement.

For the correlation coefficients between IQ and Creative Achievement Type, leadership was reported for only four cases, and the correlation coefficients between IQ and it were homogeneous (p = .315). For the correlation coefficients between DT test scores and Creative Achievement Type, leadership was reported for only six cases, and the correlation coefficients between DT test scores and it were homogeneous (p = .004). Thus, leadership was included under general creative achievement for the input for multiple regression analyses. For the correlation coefficients between DT test scores and Creativity Subscale, inventiveness was reported for only six studies, and the correlation coefficients between DT test scores and it were homogeneous (p = .035). Thus, inventiveness was included under general creativity for the input for multiple regression analyses. For the correlation coefficients between DT test scores and DT test, GIFT was reported for only five studies (p = .105) and WAT was reported for only six studies (p = .872), and the correlation coefficients between DT test scores and both of GIFT and WAT heterogeneous. Thus, both of them were included under "others".

The results of the direct entry of the three statistically significant moderating variables of IQ Test, Creative Achievement Type, and Predicted Time Period for the correlation coefficients between IQ and Creative Achievement into a weighted multiple linear regression analysis indicated that Creative Achievement Type and Predicted Time Period independently accounted for variation in zr. The regression model yielded R^2 = .301, adjusted R^2 = .278, F (93) = 12.923, p < .0001.

The results of the direct entry of the four statistically significant moderating variables of DT Test, Creative Achievement Type, Creativity Subscale, and Predicted Time Period for the correlation coefficients between DT test scores and Creative Achievement into a weighted multiple linear regression analysis indicated that DT test and Creative Achievement Type independently accounted for variation in zr. The regression model yielded R^2 = .237, adjusted R^2 = .226, F (273) = 20.883, p < .0001.

According to Johnson (1993), the tests of meta-analytic predictor's significance are inappropriate because the error degrees of freedom in the weighted regression procedure of SPSS are too large. Thus, the appropriate corrections in its regression model were made using DSTAT. The results of the weighted multiple linear regression of effect size zr on moderator variables are presented in Tables 6 and 7.

Table 6 shows the results of the multiple linear regression of effect size zr on moderator variables for the correlation coefficients between IQ and Creative Achievement (Weighted by Sample Size). Creative Achievement Type (β = –.026, z = –4.314, p < .0001) and Predicted Time Period (β = .041, z = 5.291, p < .0001) had significant effects on the magnitude of the correlation coefficients between IQ and Creative Achievement. Various IQ tests (β = –.012, z = –.820, p = .412) were uncorrelated with the magnitude of the correlation coefficients.

Table 7 shows the results of the multiple linear regression of effect size zr on moderator variables for the correlation coefficients between DT test scores and Creative Achievement (Weighted by Sample Size). Various DT Test (β = –.051, z = –7.898, p < .0001), Creative Achievement Type (β = –.015, z = –5.807, p < .0001),

Predicted Time Period (β = –.020, z = –3.097, p < .01), and Creativity Subscale (β = .010, z = 2.581, p < .01) had significant effects on the magnitude of the correlation coefficients between DT test scores and Creative Achievement.

TABLE 6. Multiple Linear Regression of Effect Size zr on Moderator Variables for the Correlation Coefficients between IQ and Creative Achievement (Weighted by Sample Size).

Moderator	Standardized β	z-value	p-value
IQ Test	–.012	–.820	p = .412
Creative Achievement Type	–.026	–4.314	p < .0001
Predicted Time Period	.041	5.291	p < .0001

Note. Overall regression effect = 52.279, df = 3, p < .0001 (two-tailed).

TABLE 7. Multiple Linear Regression of Effect Size zr on Moderator Variables for the Correlation Coefficients between DT Test Scores and Creative Achievement (Weighted by Sample Size).

Moderator	Standardized β	z-value	p-value
DT Test	–.051	–7.898	p < .0001
Creative Achievement Type	–.015	–5.807	p < .0001
Predicted Time Period	–.020	–3.097	p < .01
Creativity Subscale	.010	2.581	p < .01

Note. Overall regression effect = 200.275, df = 4, p < .0001 (two-tailed).

DISCUSSION

The quantitative syntheses of the literature results indicate that the correlation coefficient between DT test scores and Creative Achievement is higher than the correlation coefficient between IQ and Creative Achievement. Thus, it can be concluded that DT test scores account for more variance in the particular achievement measures in this study than IQ scores do. Because the correlation coefficients were heterogeneous, moderator analyses were conducted in order to examine systematic variations in the data.

The results of moderator analyses for the correlation coefficients between IQ and Creative Achievement indicate that correlation coefficient sizes vary systematically across differing kinds of different IQ Test, Creative Achievement Type, and Predicted Time Period, but do not vary across different Gender groups. The results of moderator analyses for the correlation coefficients between DT test scores and Creative Achievement indicate that correlation coefficient sizes vary

systematically across differing kinds of DT Test, Creative Achievement Type, Creativity Subscale, and Predicted Time Period, but do not vary across different gender groups.

Moderator Analyses of IQ Test for the correlation coefficients between IQ and Creative Achievement indicate that the Lorge Thorndike Intelligence Test may predict Creative Achievement better than some other IQ tests, especially statistically significantly better than California Test of Mental Maturity and Terman Concept Mastery Test. The results of the contrasts revealed that IQ Test, Creative Achievement Type, and Predicted Time Period explain the differences in the correlation coefficients between IQ and Creative Achievement. However, the variance in the magnitude of the correlation coefficients is not significantly explained by the various IQ Test, but it is significantly explained by Creative Achievement Type and Predicted Time Period according to the results of the weighted multiple linear regression, which determines moderators' independent effects for explaining variation.

The results of the contrasts revealed that DT Test, Creative Achievement Type, Predicted Time Period, and Creativity Subscale explain the differences in the correlation coefficients between DT Test and Creative Achievement. The variance in the magnitude of the correlation coefficients are statistically significantly explained by DT Test, Creative Achievement Type, Predicted Time Period, and Creativity Subscale according to the results of the weighted multiple linear regression, which determines moderators' independent effects for explaining variation.

DT Test

The mean weighted correlation coefficients between TTCT and Creative Achievement are much higher than both Guilford Divergent Thinking Tasks and Wallach & Kogan Divergent Thinking Tasks. This indicates that the TTCT may predict Creative Achievement better than other DT tests. This finding is consistent with many previous studies such as: Torrance's conclusion (2002) that TTCT scores are good predictors of creative accomplishments later in life; and Plucker's conclusion (1999), based on a reanalysis of Torrance's data, that the best predictor for adult creative achievements was TTCT scores and that the TTCT had a correlation with creative achievement almost three times higher than IQ scores. The TTCT is known for having one of the largest norming samples with valuable longitudinal validations (Davis, 1997) and high predictive validity over a very wide age range (Cropley, 2000, for more information, see Kim, 2006).

Creative Achievement Type

The mean weighted correlation coefficients between IQ and music are much higher than both art and science. In contrast, the mean weighted correlation coefficients between DT test scores and art are much higher than science. When analyzing the mean weighted correlation coefficients between Creative Achievement Type and both IQ and DT test scores, music is predicted the best by IQ, and all others, including art, writing, science, and social skills, are predicted best by DT

test scores. Leadership was highly predicted by both, however, the small sample size for leadership for both IQ and DT test scores limits any generalization of this result. This finding is consistent with Runco's conclusion (1986) that particular areas of performance, including writing and art, are more related to divergent thinking than other areas such as music and science.

Predicted Time Period

The mean weighted correlation coefficient between IQ and the Predicted Time Period of 21 years and more is much higher than the mean weighted correlation coefficients for the other time periods. However, there were only seven cases reported for the time period of 21 year and more which limits its generalization. In addition, the periods of 6-10 year and 11-15 year, have higher coefficients than both 1-5 year and 16-20 year.

In contrast, mean weighted correlation coefficient between DT test scores and the Predicted Time Period of 11-15 years is much higher than the mean weighted correlation coefficients for the other time periods. In addition, the periods of 16-20 year and 21 year and more, have higher coefficients than both 1-5 year and 6-10 year. The "10-year rule" (Gardner, 1983; Hayes, 1989; Simon & Chase, 1973) may help explain the finding that creative achievement seems to take several years to manifest itself after taking either an IQ or a DT test. However, limited information was presented on what ages the tests were taken which limits this generalization.

Creativity Subscale

The mean weighted correlation coefficients between Creative Achievement and both creative strengths and elaboration, are much higher than fluency, flexibility, originality and general creativity. The high correlation of Creative Achievement to the creativity subscale of creative strengths supports Torrance's conclusion (1979) that creative strengths are the most important predictor of Creative Achievement among the TTCT subscales. Torrance (E. P. Torrance, personal communication, October 30, 2002) also warned that creative strengths are too important to be excluded from full explanations of TTCT scores.

The high correlation of Creative Achievement to the Creativity Subscale of elaboration may support Kirton's (1976, 1978, 1989) Adaptor-Innovator (A-I) Theory. Recent studies (Kim, 2006; Kim, Cramond, & Bandalos, 2006) explored the possibility of a two-factor model of creativity based on Kirton's A-I Theory. These studies concluded that a proposed model of Innovators and Adaptors was a good fit. Innovators, creative types who tended to be wildly creative, should score higher on fluency and originality. Adaptors, creative types that tend to adapt existing constructs, should score higher on elaboration and abstractness of titles. The results that fluency and originality had lower relationships with Creative Achievement and elaboration had a higher relationship with Creative Achievement might indicate that Adaptors are more common. However, further studies are needed in order to support this hypothesis.

In conclusion, DT test scores correlated better to Creative Achievement when compared with IQ, this indicates that DT test scores account for more variance in the achievement measures included in this study than IQ and may predict Creative Achievement better than IQ. The various IQ Tests or Gender did not significantly explain the differences in the correlation coefficients between Creative Achievement and either IQ or DT test scores, whereas different DT Tests, Creative Achievement Types, Predicted Time Periods, and Creativity Subscales were consistent moderator variables. The significant independent moderator effect for DT tests indicates that among the DT tests, the TTCT may predict Creative Achievement better than other DT tests, while the Guilford Divergent Thinking Tasks, Sounds and Images, and the Wallach & Kogan Divergent Thinking Tasks had significantly less predictability. Among the Creative Achievement Types, IQ may predict music better than DT test scores. However, all other Creative Achievement Types, including art, science, writing, and social skills , are predicted the best by DT test scores. Leadership is highly predicted by both IQ and DT tests but this generalization is limited by a small sample size. Among the Predicted Time Period, 11-15 year explains the relationship between DT test scores and Creative Achievement the best, however, higher Creative Achievement tends to be measured in all longer time periods for both IQ and DT tests. Therefore, the advantage of using DT tests over IQ tests is shown by the results in that the scores are somewhat independent of the specifics of any one achievement measure or time.

The findings of the present study in terms of predictive validity of IQ or DT test scores are limited its generalization because there were only 94 correlation coefficients between IQ and Creative Achievement, whereas there were 274 correlation coefficients between DT test scores and Creative Achievement. Thus, further studies that report correlation coefficients between IQ and Creative Achievement are needed to confirm the results of this study. In addition, the results of the meta-analyses are only as good as the measures of Creative Achievement used in the underlying studies and some researchers have questioned at least some of the measures.

REFERENCES

References marked with an asterisk (*) indicate studies that included in the meta-analysis. References marked with double asterisks (**) indicate studies that initially qualified for inclusion, but were excluded because of the inability to calculate an effect size.

**ANASTASI, A., & SCHAEFER, C. E. (1971). The Frank Drawing Completion Test as a measure of creativity. *Journal of Genetic Psychology, 119*, 3-12.

**BABAEVA, J. D. (1999). A dynamic approach to giftedness: Theory and practice. *High Ability Studies, 10*(1), 51-68.

BARRON, F. (1961). Creative vision and expression in writing and painting. In D. W. MacKinnon (Ed.), *The creative person* (pp.237-251). Berkeley, CA: Institute of Personality Assessment Research, University of California.

*BARRON, F. (1963). *Creativity and psychological health*. Princeton, NJ: Van Nostrand.

BARRON, F., & HARRINGTON, D. M. (1981). Creativity, intelligence, and personality. *Annual Review of Psychology, 32*, 439-476.

*BENTLEY, J. C. (1966). Creativity and academic achievement. *Journal of Educational Research, 59*, 269-272.

**BLOOM, B. S. (1963). Report on creativity research by the examiner's office at the University of Chicago. In C. W. Taylor & F. Barron (Eds.), *Scientific creativity: Its recognition and development* (pp. 251 – 264). New York: Wiley.

**CARROLL, J., & HOWIESON, N. (1992). Recognizing creative thinking talent in the classroom. *Roeper Review, 14*, 209-212.

*CARSON, S. H., PETERSON, J. B., & HIGGINS, D. M. (2003). Decreased latent inhibition is associated with increased creative achievement in high-functioning individuals. *Journal of Personality and Social Psychology, 85*, 499-506.

**CHAN, D. W. (2000). Exploring identification procedures of gifted students by teacher ratings: parent ratings and student self-reports in Hong Kong. *High Ability Studies, 11*, 69-82.

**CHAN, D. W. (2001). Assessing giftedness of Chinese secondary students in Hong Kong: A multiple intelligence perspective. *High Ability Studies, 12*, 215-234.

**CLINE, V. B., RICHARDS, J. M., & ABE, C. (1962). The validity of a battery of DT tests in a high school sample. *Educational and Psychological Measurement, 22*(4), 781-784.

*CLINE, V. B., RICHARDS, J. M. JR., & NEEDHAM, W. E. (1963). DT tests and achievement in high school science. *Journal of Applied Psychology, 47*, 184-189.

BUTCHER, H. J. (1972). Divergent thinking and creativity. In W. D. Wall, & V. P. Varma (Eds.), *Advances in educational psychology*, Vol. 1. London: University of London Press, Ltd.

COOPER. H., & HEDGES, L. V. (1994). Research synthesis as a scientific enterprise. In H. Cooper & L. V. Hedges (Eds), *The handbook of research synthesis* (pp. 3-14). New York: Russell Sage Foundation.

CRAMOND, B. (1994). The Torrance Tests of Creative Thinking: From design through establishment of predictive validity. In R. F. Subotnik & K. D. Arnold (Eds.), *Beyond Terman: Contemporary longitudinal studies of giftedness and talent* (pp. 229-254). Norwood, NJ: Ablex.

CROCKENBURG, S. B. DT tests: A boon or boondoggle for education. *Review of Educational Research, 1*(42), 27-45.

*CROPLEY, A. J. (1971). Some Canadian creativity research. *Journal of Research and Development in Education, 4*(3), 113-115.

CROPLEY, A. J. (1972). A five-year longitudinal study of DT tests. *Developmental Psychology, 6*, 119-124.

CROPLEY, A. J. (2000). Defining and measuring creativity: Are DT tests worth using? *Roeper Review*, *23* (2), 72-79.

DAVIS, G. A. (1997). Identifying creative students and measuring creativity. In N. Colangelo & G. A.Davis (Eds.), *Handbook of gifted education* (pp269-281). Needham Heights, MA: Viacom.

DAVIS, G. A., & BELCHER, T. L. (1971). How shall creativity be measured? Torrance Tests, RAT, Alpha Biographical, and IQ. *Journal of Creative Behavior, 5*(3), 153-161.

DELLAS, M., & GAIER, E. L. (1970). Identification of creativity: The individual. *Psychological Bulletin, 73*, 55-73.

FLESCHER, I. (1963). Anxiety and achievement of intellectually gifted and creatively gifted children. *Journal of Psychology, 56*, 251-268.

*FREDERIKSEN, N., & WARD, W. C. (1978). Measures for the study of creativity in scientific problem solving. *Applied Psychological Measurement, 2*, 1-24.

GARDNER, H. (1983). *Frames of mind.* New York: Basic.

GEORGIA DEPARTMENT OF EDUCATION (1998). 160-4-2-.38 Education program for gifted students, Retrieved February 2, 2006, from http://www.gadoe.org/_documents/doe/legalservices/160-4-2-.38.pdf

**GETZELS, J.W., & JACKSON, P.W. (1958). The meaning of "Giftedness"-An examination of an expanding concept. *Phi Delta Kappan, 40*, 75-77.

**GETZELS, J. W., & JACKSON, P. W. (1961). Family environment and cognitive style: A study of the sources of highly intelligent and of highly creative adolescents. *American Sociological Review, 26*, 351-?

**GETZELS, J. W., & JACKSON, P. W. (1962). *Creativity and Intelligence.* New York: John Wiley & Sons.

GETZELS, J. W., & CSIKSZENTMIHALYI, M. (1964). *Creative thinking in art students: An exploratory study*. Cooperative research Project No. E-008. Office of Education, U.S. Department of Health, Education and Welfare, University of Chicago.

GETZELS, J. W., & CSIKSZENTMIHALYI, M. (1976). *The creative vision: A longitudinal study of problem finding in art*. New York: John Wiley & Sons.

**GONZALES, M. A., & CAMPOS, A. (1997). Mental imagery and creative thinking. *Journal of Psychology, 131*, 357-364.

*GOUGH, H. G. (1975). A new scientific uses test and its relationship to creativity in research. *Journal of Creative Behavior, 9*, 245-252.

*GOUGH, H. G. (1976). Studying creativity by means of word association tests. *Journal of Applied Psychology, 61*, 348-353.

**GUILFORD, J. P. (1956). The structure of intellect. *Psychological Bulletin, 53*, 267-293.

**GUILFORD, J. P. (1959a). *Personality*, New York: McGraw-Hill.

**GUILFORD, J. P. (1959b). Three faces of intellect, *American Psychologist, 14*, 469-479.

**GUILFORD, J. P. (1959c). Traits of creativity. In H. H. Anderson (Ed.), *Creativity and its cultivation.* New York: Harper, 142-161.

GUILFORD, J. P. (1962a). Factors that aid and hinder creativity. *Teachers College Record, 63*, 380-392.

**GUILFORD, J. P. (1962b). Potentiality for creativity and its measurement. In: *Proceedings of the 1962 invitational conference on testing problems* (31-39). Princeton, N.J.: Educational Testing Service.

GUILFORD, J. P. (1966). Intelligence: 1965 model. *American Psychologist, 21*, 20-26.

GUILFORD, J. P. (1967). *The nature of human intelligence*, New York: McGraw-Hill.

GUILFORD, J. P. (1968). *Intelligence, creativity, and their educational implications*. San Diego, CA: Robert R. Kmapp.

GUILFORD, J. P., & CHRISTENSEN, P. R., (1973). The one-way relation between creative potential and IQ. *Journal of Creative behavior, 7*, 247-252.

GUPTA, A. K. (1981). Sex differences in Creativity: Some fresh evidence. *Journal of Creative Behavior*, 15, 269.

*HALL, W. B. (1972). A technique for assessing aesthetic predispositions: Mosaic Construction Test. Journal of Creative behavior, 6, 225-235.

HAYES, J. R. (1989). Cognitive process in creativity. In J. A. Glover, R. R. Ronning, & C. R. Reynolds (Eds.), *Handbook of creativity* (pp. 135-145). New York: Plenum.

HEDGES, L. V., & OLKIN, I. (1985). *Statistical methods for meta-analysis*. San Diego, CA: Academic Press.

HELSON, R. (1971). Women mathematicials and the creative personality. *Journal of Counsulting and Clinical Psychology, 36*, 210-220.

HELSON, R. & CRUTCHFIELD, R. S. (1970). Mathematicians: the creative researcher and the average PhD. *Journal of consulting and clinical psychology, 34*(2), 250-257.

**HELSON, R. & CRUTCHFIELD, R. S. (1971). Women mathematicians and the creative personality. *Creative achievements, 32*(2), 210-220.

HERR, E. L., MOORE, G. D., & HANSEN, J. C. (1965). Creativity, intelligence, and values: A study of relationships. *Exceptional Children, 32*, 114-115.

*HOCEVAR, D. (1980). Intelligence, divergent thinking, and creativity. *Intelligence, 4*, 25-40.

HOLLAND, J. L. (1961). Creative and academic performance among talented adolescents. *Journal of Educational Psychology, 52*, 136-147.

HUNTER, J. E., & SCHMIDT, F. L. (1990). *Methods of meta-analysis: Correcting error and bias in research findings*. Newbury Park, CA: Sage Publications.

HUNTER, J. E., SCHMIDT, F. L., & JACKSON, G. B. (1982). *Meta-analysis: Cumulating research findings across studies.* Beverly Hills, CA: Sage Publications.

**ISCOE, I., & PIERCE-JONES, J. (1964). Divergent thinking, age, and intelligence in white and Negro children. *Child Development, 35*, 785-798.

JAQUISH, G. A., & RIPPLE, R. E. (1980). Divergent thinking and self-esteem in preadolescents. *Journal of Youth and Adolescence, 9*(2), 143-152.

JOHNSON, B. T. (1993). *DSTAT 1.10: Software for the meta-analytic review of research literatures.* Hillsdale, NJ: Lawrence Erlbaum.

**KAUFMAN, J. C. (2002). Dissecting the golden goose: components of studying creative writers. *Creativity research journal, 14*(1), 27-40.

**KERSHNER, J. R. & LEDGER, G. (1985). Effect of sex, intelligence, and style of thinking on creativity: a comparison of gifted and average IQ children. *Journal of personality and social psychology, 48*(4), 1033-1044.

*KHATENA, J. (1971). Evaluation and the creative potential in music. *Gifted Child Quarterly, 15*, 19-22.

KIM, J., & MICHAEL, W. B. (1995). The relationship of creativity measures to school achievement and to preferred learning and thinking style in a sample of Korean high school students. *Educational and Psychological Measurement, 55*(1), 60-74.

KIM, K. H. (2004). *Cultural influence on creativity: The relationship between creativity and Confucianism*. Unpublished Doctoral Dissertation, The University of Georgia, Athens, GA.

KIM, K. H. (2006). Can we trust DT tests?: A review of the Torrance Tests of Creative Thinking (TTCT). *Creativity Research Journal, 18*, 3-14.

KIM, K. H., CRAMOND, B., & BANDALOS, D. L. (in press), The latent structure and **measurement invariance** of scores on the Torrance Tests of Creative Thinking –Figural. *Educational and Psychological Measurement*.

KIRTON, M. J. (1976). Adaptors and innovators: A description and measure. *Journal of Applied Psychology, 61*, 622-629.

KIRTON, M. J. (1978). Have adaptors and innovators equal levels of creativity? *Psychological Reports, 42*, 695-698.

KIRTON, M. J. (1989). Adaptors and innovators at work. In M. J. Kirton (Ed.), *Adaptors and innovators: Styles of creativity and problem-solving* (pp. 56-78). London: Routledge.

KOGAN, N. & PANKOVE, E. (1972). Creative ability over a five-year span. *Child development, 43,* 427-442.

**KOGAN, N. & PANKOVE, E. (1974). Long-term predictive validity of divergent-thinking tests: some negative evidence. *Journal of Educational Psychology, 66*, 802-810.

**LANG, R. J., & RYBA, K. A. (1976). The identification of some creative thinking parameters common to the artistic and musical personality. *British Journal of Educational Psychology, 46*,267-279.

*LUNNEBORG, C. E., & LUNNEBORG, P. W. (1968). Architecture school performance predicted from ASAT, intellective, and nonintellective measures. *Journal of Applied Psychology, 53*, 209-213.

**LYNCH, P. M. (1970). Creativity in Irish children. *Journal of Creative Behavior, 4*, 53-61.

LYTTON, H. (1971). *Creativity and education*. London: Routledge & Kegan Paul.

MACKINNON, D. W. (1961). Creativity in architects. In D. W. MacKinnon (Ed.), *The creative person* (pp. 291-320). Berkeley, CA: Institute of Personality Assessment Research, University of California.

MACKINNON, D. W. (1962). The nature and nurture of creative talent. *American psychologist. 17*(7), 484-495.

MacKINNON, D. W. (1967). Educating for creativity: a modern myth? In P. Heist (Ed.), *Education for creativity* (pp. 1-20). Berkeley: Center for Research and Development in Higher Education.

**MacKINNON, D. W. (1968). Selecting students with creative potential. *The creative college student*. 101-116.

**MANSFIELD, R. S., & BUSSE, T. V. (1981). *The psychology of creativity and discovery: Scientists and their work*. Chicago, IL: Nelson-Hall Inc.

*McDERMID, C. D. (1965). Some correlates of creativity in engineering personnel. *Journal of Applied Psychology. 49*(1), 14-19.

McNEMAR, Q. (1964). Lost: Our intelligence? Why? *American Psychologist, 19*, 871-882.

MILGRAM, R. M., & MILGRAM, N. A. (1976). Creative thinking and creative performance in Israeli students. *Journal of Educational Psychology, 68*, 255-259.

**MILGRAM, R. M., YITZHAK, V., & MILGRAM, N. A. (1977). Creative activity and sex-role identity in elementary school children. *Perceptual and Motor Skills. 45*, 371-376.

*MILGRAM, R. M., & HONG, E. (1993). Creativity thinking and creative performance in adolescents as predictors of creative attainments in adults: A follow-up study after 18 years. *Roeper Review, 15*, 135-139.

**NAGLIERI, J. A. (2001). Understanding intelligence, giftedness and creativity using the pass theory. *Roeper review. 23(3),* 151-157.

NICHOLLS, J. G. (1972). Creativity in the person who will never produce anything original and useful: The concept of creativity as a normally distributed trait. American *Psychologist, 27*, 717-727.

OGAWA, M., KUEHN-EBERT, C., & De VITO, A. (1991). Differences in creative thinking between Japanese and American fifth-grade children. *Ibaraki University Faculty of Education Bulletin, 40*, 53-59.

**PANKOVE, E., & KOGAN, N. (1968). Creative ability and risk taking in elementary school children. *Journal of Personality, 36*, 420-439.

**PEARLMAN, C. (2001). Teachers as an informational resource in identifying and rating student creativity. *Education, 103*(3), 215-222.

PLUCKER, J. A. (1999). Is the proof in the pudding? Reanalysis of Torrance's (1958 to present) longitudinal data. *Creativity Research Journal, 12*, 103-114.

**RENZULLI, J. S. (1986). The three-ring conception of giftedness: a developmental model for creative productivity. In R. J. Sternberg & J. E. Davidson (Eds.), *Conceptions of giftedness* (pp.53-92), New York: Cambridge University Press.

**RICHARDS, R. L. (1976). A comparison of selected Guilford and Wallach-Kogan creative thinking tests in conjunction with measures of intelligence. *Journal of Creative Behavior. 10*(3), 151-164.

RICHARDSON, A. G. (1986). Sex differences in creativity among a sample of Jamaican adolescents. *Journal of Creative Behavior*, *20*, 147.

*RIMM, S., & DAVIS, G. A. (1976). GIFT: An instrument for the identification of creativity. *Journal of Creative Behavior, 10*, 178-182.

**ROE, A. (1952/1953). *The making of a scientist*. New York: Dodd, Mead & Company.

ROSENTHAL, R. (1991). *Meta-analytic procedures for social research*. Beverly Hills, CA: Sage Publications.

ROSENTHAL, R., & RUBIN, D. B. (1984). Multiple contrasts and ordered Bonferroni procedures. *Journal of Educational Psychology, 76*, 1028-1034.

ROSSMAN, B. B., & HORN, J. L. (1972). Cognitive, motivational and temperamental indicants of creativity and intelligence. *Journal of Educational Measurement. 9*(4), 265-286.

*ROTTER, D. M., LANGLAND, L., & BERGER, D. (1971). The validity of tests of creative thinking in seven-year-old children. G*ifted Child Quarterly. 15*, 273-278.

RUNCO, M. A. (1986). Divergent thinking and creative performance in gifted and nongifted children. *Educational and Psychological Measurement, 46*, 375-384.

** RUNCO, M. A. (1999). A longitudinal study of exceptional giftedness and creativity. *Creativity Research Journal. 12*(2), 161-165.

RUNCO, M. A., & ALBERT, R. S. (1986). The threshold theory regarding creativity and intelligence: an empirical test with gifted and nongifted children. C*reative Child and Adult Quarterly 11*(4), 212-218.

*RUSS, S. W., ROBINS, A. L., & CHRISTIANO, B. A. (1999). Pretend play: Longitudinal prediction of creativity and affect in fantasy in children. *Creativity Research Journal, 12*, 129-139.

SAEKI, N., FAN, X., & VAN DUSEN, L. V. (2001). A comparative study of creative thinking of American and Japanese college students. *Journal of Creative Behavior, 35*(1), 24-38.

** SCHAFER, A. B. (1999). Relation of the big five and factor V subcomponents to social intelligence. *European journal of personality, 13,* 225-240.

*SCHMIDT, H. E. (1973). The identification of high and low creativity in architecture students. *Psychologia Africana, 15*, 15-40.

SCHWARZER, R. (1991). *Meta: Programs for secondary data analysis, 5. 3*. Berlin: Free University of Berlin.

**SHAW, G. A. (1985). The use of imagery by intelligent and by creative schoolchildren. *Journal of General Psychology, 112(*2), 153-171.

SIMON, H. A., & CHASE, W. (1973). Skill in chess. American scientist, 61, 364-403.

**SIMONTON, D. K. (1976). Biographical determinants of achieved eminence: A multivariate approach to the Cox Data. *Journal of Personality and Social Psychology, 33*(2), 218-226.

SIMONTON, D. K. (1994). *Greatness: Who makes history and why.* New York: Guilford Press.

SKAGER, R. W., KLEIN, S. P., & SCHULTZ, C. B. (1967). The prediction of academic and artistic achievement at a school of design. *Journal of Educational Measurement, 4*, 105-117.

*STORM, R. D., & LARIMORE, D. (1970). *Predicting Teacher success" The inner city*. Columbus, OH: The Ohio State university.

TAYLOR, C. W. & ELLISON, R. (1962). Summary of Ytah biographical results for the prediction of success in science. Progress Report, *National Aeronautics and Space Administration, Research Report NASw-105*.

*TORRANCE, E. P. (1969). Prediction of adult creative achievement among high school seniors. *gifted child quarterly, 13*, 223-229.

TORRANCE, E. P. (1979). *The search for Satori and Creativity*. Buffalo, NY: Bearly Limited.

*TORRANCE, E. P. (1972a). Career patterns and peak creative achievements of creative high school students twelve years later. Gifted Child Quarterly, 16, 75-88.

*TORRANCE, E. P. (1972b). Predictive validity of the Torrance Tests of Creative Thinking. *Journal of Creative Behavior, 6*, 236- 252.

TORRANCE, E. P. (1977). *Creativity in the classroom*. Washington, DC: National Education Association.

*TORRANCE, E. P. (1982). "Sounds and images" productions of elementary school pupils as predictors of the creative achievements of young adults. *Creative Child and Adult Quarterly, 7*, 8-14.

*TORRANCE, E. P. (1992). The beyonders in a thirty year longitudinal study of creative achievement. *Roeper Review, 15*, 131-135.

*TORRANCE, E. P. (2002). *The Manifesto: A guide to developing a creative career*. Westport, CT: Ablex Publishing.

**TORRANCE (2004). Great expectations: Creative achievement of the sociometric stars in a 30-year study. *Journal of Secondary Gifted Education, 16*(1), 5-13.

VERNON, P. E. (1967). Psychological studies of creativity. *Journal of Child Psychology and Psychiatry, 8*, 153-164.

VERNON, P. E. (1972). The validity of DT tests. *Alberta Journal of Educational Research, 18*, 249-258.

*WAKEFIELD, J. F. (1985, November). *Prediction of interest in the creative arts from scores on creativity measures*. Paper presented at the 13th Annual Meeting of the Mid-South Educational Research Association, Biloxi, MS.

**WALBERG, H. J. (1967). A portrait of the artist and scientist as young men. *Exceptional Children, 36*, 5-11.

**WALBERG, H. J. (1971). Varieties of adolescent creativity and the high school environment, *Exceptional Children, 38*(2), 111-116.

WALBERG, H. A. (1988). Creativity and talent as learning. In R. J. Sternberg (Ed.), *The nature of creativity* (pp. 340-361). New York: Cambridge University Press.

WALBERG, H. A., & HERBIG, M. P. (1991). Developing talent, creativity, and eminence. In N. Colangelo & G. A. Davis (Eds.), *Handbook of gifted education* (pp. 245-255). Needham Heights, MA: Allyn & Bacon.

WALLACE, B. H. (1972). A Technique for assessing aesthetic predispositions: Mosaic Construction Test. *Journal of Creative Behavior, 6*, 225-235.

WALLACH, M. A. (1970). Creativity. In P. H. Mussen (Ed.), *Carmichael's manual of child psychology* (pp.1273-1365). New York: Wiley.

WALLACH, M. A., & KOGAN, N. (1965). *Modes of thinking in young children*. New York: Holt, Rinehart & Winston.

WALLACH, M. A., & WING, C. W., JR. (1969). *The talented student: a validation of creativity-intelligence distinction*. New York: Holt, Rinehart & Winston.

**WARD, W. C. (1968). Creativity in young children. *Child Development, 39*, 736-754.

**WARD, W. C., KOGAN, N., & PANKOVE, E. (1972). Incentive effects in children's creativity. *Child Development, 43*, 669-676.

**WELLER, L. (1964). The relationship of birth order to cohesiveness. *Journal of Social Psychology, 63*, 249-254.

**YAMAMOTO, K. (1964a). A further analysis of the role of creative thinking in high-school achievement. *Journal of Psychology, 58*, 277-283.

**YAMAMOTO, K. (1964b). Role of creative thinking and intelligence in high school achievement. *Psychological Reports, 14*, 783-789.

YAMAMOTO, K. (1964c). Threshold of intelligence in academic achievement of highly creative students. *Journal of Exceptional Education. 32*(4), 401-405.

WODTKE, K. H. (1964). Some data on the reliability and validity of DT tests at the elementary school level. *Educational and Psychological Measurement, 24*, 399-408.

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