Journal of Educational Psychology
2017, Vol. 109, No. 2, 269–299

0022-0663/17/$12.00 http://dx.doi.org/10.1037/edu0000133

Creativity and Academic Achievement: A Meta-Analysis

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This article reports on a meta-analysis of 120 studies (total N = 52,578; 782 effects) examining the relationship between creativity and academic achievement in research conducted since the 1960s. Average correlation between creativity and academic achievement was r = .22, 95% CI [.19, .24]. An analysis of moderators revealed that this relationship was constant across time but stronger when creativity was measured using creativity tests compared to self-report measures and when academic achievement was measured using standardized tests rather than grade point average. Moreover, verbal tests of creativity yielded significantly stronger relationships with academic achievement than figural tests. Theoretical and practical consequences are discussed.

Keywords: creativity, school grades, academic achievement, meta-analysis

Supplemental materials: http://dx.doi.org/10.1037/edu0000133.supp

Is there a relationship between creativity and academic achievement? This is a longstanding and largely unresolved question. For more than half a century, educators and psychologists have attempted to address this issue (Cline, Richards, & Abe, 1962; Mednick, 1963). At a conceptual level, scholars have asserted that creativity and learning represent interrelated phenomena (e.g., Beghetto, 2016a; Guilford, 1967; Piaget, 1962, 1981; Sawyer, 2012; Vygotsky, 1967/2004). Some of the earliest and most prominent theorists in the field have noted this link. Guilford (1967), for instance, asserted that creativity and learning are essentially the same phenomenon. Vygotsky (1967/2004) similarly argued that the creative imagination "is a completely essential condition for almost all human mental activity" (p. 17). Another example is Piaget's theory of genetic epistemology. Indeed, creativity is central to Piaget's theory of learning. As Gruber (in Bringuier, 1980) has explained in reference to Piaget's theory, "The child does not learn simply what the adult tells him, he reinvents. It's a kind of creativity" (p. 67).

Regardless of the theoretical stance one takes on learning—be it behavioral, cognitive, constructivist, situated, sociomaterial, or some other theoretical orientation—creativity and learning share fundamental similarities. Indeed, both creativity and learning involve change. More specifically, creativity refers to new and meaningful changes in thoughts, products, and actions (Beghetto, 2016a; Sternberg, 1999). Similarly, learning represents relatively stable changes in understanding and behavior (Alexander, Schallert, & Reynolds, 2009). Moreover, both learning and creativity can be viewed as processes and products (e.g., Alexander et al., 2009; Beghetto, 2016a; Donovan & Bransford, 2005; Mumford, Medeiros, & Partlow, 2012; Wallas, 1926). It is therefore possible to say that "a creative act [as a product] is an instance of learning [as a process], for it represents a change in behavior" (Guilford, 1950, p. 446). Along these same lines, it is also possible to say learning (as a product) is a creative process, because it results from new and personally meaningful changes in one's prior understanding (Beghetto, 2016a). Given the theoretical links between creativity and learning, it seems reasonable to assume that there would be a positive relationship between creativity and measures of academic achievement. The empirical work that has examined this link, however, has yielded a more equivocal picture. Some researchers have, for instance, reported positive associations ranging from .10–.56 (Cicirelli, 1967; Getzels & Jackson, 1962; Niaz, Núñez, & Pineda, 2000; Ohnmacht, 1966). Others have reported little or no association (e.g., Edwards & Tyler, 1965; Grigorenko et al., 2009). Still others have reported negative associations (e.g., Anderson, White, & Stevens, 1969). In fact, some researches have noted all three patterns within the same study (e.g., Gralewski & Karwowski, 2012). Consequently, the best that can be said about whether there is a link between creativity and academic achievement is this: *It depends.*

Why might this be the case? The present meta-analysis endeavors to address this question. More specifically, we have two primary aims for our study. Our first goal is to provide an average effect size of the relationship between creativity and academic achievement. Our second goal is to examine the potential impact of factors that may moderate the relationship between creativity and academic achievement. Although there are examples of meta-analytic studies that have addressed related issues (e.g., the relationship between creativity and intelligence; see Kim, 2005), we are not aware of any published meta-analytic studies of creativity

This article was published Online First August 18, 2016.

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The preparation of this article was supported by a grant from the National Science Centre, Poland (UMO-2011/03/N/HS6/05073).

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and academic achievement.[1] We therefore endeavor to shed light on the mixed findings of prior research by providing a more stable estimate of the relationship between creativity and academic achievement and by examining factors that may potentially moderate this relationship.

Creativity and Academic Achievement

Creativity

Creativity scholars generally agree that creativity represents a combination between originality, novelty, or newness *and* usefulness, meeting task constraints, or meaningfulness as defined within a particular sociocultural and historical context (Amabile, 1996; Kaufman & Beghetto, 2009; Plucker, Beghetto, & Dow, 2004; Simonton, 2012; Sternberg & Lubart, 1999). The following simplified notation captures this definition (adapted from Beghetto & Kaufman, 2014; Simonton, 2012):

$$C = O \times TC$$

$$[\text{——CONTEXT——}]$$

In the above notation, C refers to creativity, O refers to originality, and TC refers to task constraints. As specified by this formulation, creativity is a multiplicative combination of originality and task constraints as situated within a particular context. Consequently, something that is original (O = 1) but does not meet contextually defined task constraints (TC = 0) could be called original but not creative (C = 0). Consider, for instance, a student taking a calculus exam who produces a vivid and quite stunning pencil drawing of mathematical symbols transforming into doves (instead of solving the problem presented on the exam). Such a response is clearly original, but it would not be considered creative in the context of the exam. In order for a student's response on a calculus exam to be considered creative, it would need to represent a novel solution to the problem at hand (i.e., meet the task constraints).

In the context of academic learning, creativity can be thought of as occurring at both a subjective (creativity as part of the act of learning) and an intersubjective (learning as a creative act) level (Beghetto, 2016a). At the subjective level, students exercise their creativity by developing new and personally meaningful ideas, insights, and understandings within the context of particular academic constraints (Beghetto, 2007; Beghetto & Kaufman, 2007). At the intersubjective level, students who share their unique and academically accurate insights and interpretations can also contribute to the learning and understanding of others (Beghetto, 2016a).

In this way, creativity is more than originality (Beghetto, 2010), divergent thinking (Baer, 1993; Beghetto, 2013; Guilford, 1967; Runco, 1991), or vividness of imagination (Dziedziewicz & Karwowski, 2015; Jankowska & Karwowski, 2015). It also involves deductive and inductive thinking (Dunbar, 1997; Vartanian, Martindale, & Kwiatkowski, 2003; Weisberg, 2006), as well as the ability to use specific problem-solving strategies to generate novel solutions to complex and ill-defined problems (Beghetto, 2016b; Finke, Ward, & Smith, 1992; Sternberg, 1998). All these characteristics are important for the acquisition of new knowledge and learning (Greiff et al., 2013). In this way, creativity and learning work hand-in-hand (e.g., Beghetto, 2016a; Guilford, 1967; Piaget, 1981; Vygotsky, 1967/2004). It therefore seems reasonable to suggest that creativity would be related to academic achievement, which is conceptualized as the outcome of learning.

Academic Achievement

Academic achievement is an outcome of learning, which is typically measured by classroom grades, classroom assessments, and external achievement tests. Researchers who have examined correlates of academic achievement have identified a wide array of factors, including individual, social, and sociocultural influences (see Hattie, 2009, for a review). Of these, student characteristics play one of the broadest and most influential roles in explaining variations in academic achievement. Student characteristics represent a highly heterogeneous dimension, which includes personality (Chamorro-Premuzic & Furnham, 2003; Poropat, 2009), cognitive abilities (e.g., Chamorro-Premuzic & Furnham, 2008; Deary, Strand, Smith, & Fernandes, 2007), intensity and type of motivation (Di Domenico & Fournier, 2015), self-esteem and academic self-concept (Marsh & Hau, 2004), and socioeconomic factors (Johnson, McGue, & Iacono, 2007; Sackett, Kuncel, Arneson, Cooper, & Waters, 2009).

Creativity is yet another student characteristic that shares a conceptual, albeit equivocal, link with academic achievement. As we have discussed, researchers have reported associations that are relatively strong (e.g., $r = .41$, Marjoribanks, 1976 or $r = .66$, Yeh, 2004), modest (e.g., $r = .20$, McCabe, 1991), null (e.g., $r = .03$, Tatlah, Aslam, Ali, & Iqbal, 2012), and, in some cases, negative (e.g., $r = -.03$, Anderson et al., 1969). The aim of the present study is to help clarify the empirical ambiguity surrounding the link between creativity and academic achievement by providing a stable estimate of the association and also examine whether and how potential moderators might influence that association.

Potential Moderators

What might account for variations in the relationship between creativity and academic achievement? Researchers who have addressed this question (e.g., Freund & Holling, 2008; Gralewski & Karwowski, 2012; Vijetha & Jangaiah, 2010) have identified several moderating factors (see Figure 1). As illustrated in Figure 1, those factors include (a) the type of measurement used, (b) grade level of participants, (c) the decade the study was conducted, and (d) the geographic region of the study. In the sections that follow, we briefly describe each of these potential moderators.

Type of Measurement

The type of measurement represents one of the most clearly identifiable moderators of the empirical relationship between cre-

[1] An anonymous reviewer brought to our attention an unpublished report (Halliburton-Beatty & Simms, 2013) that reanalyzed meta-analytic data testing the impact of creativity training programs on school achievement (presented in the meta-synthesis by Hattie, 2009). This report, however, has different scope and focus than our present study. As previously described, our analysis focuses on the relationship between creative ability/self-concepts and academic achievement (rather than the impact of creative training programs), and we analyze effects reported in primary source material (rather than a reanalysis).

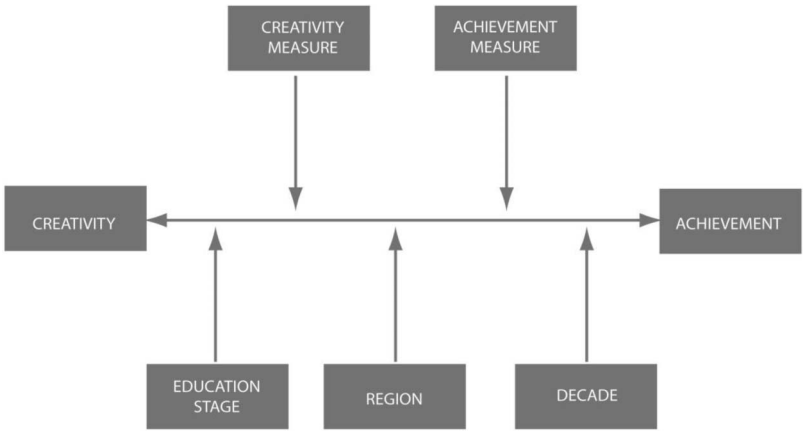

Figure 1. Potential factors influencing creativity and achievement relationship.

ativity and academic achievement. Put simply, regardless of the conceptual overlap between creativity and academic achievement, the degree of the observed relationship between creativity and academic achievement will, in large part, be determined by the amount of overlap in how each construct is measured. Moreover, there is a wide array of methods measures that can and have been used to measure both constructs (Freund & Holling, 2008; Gralewski & Karwowski, 2012). With respect to creativity, this includes everything from self-report measures to more objective creativity tests. To further compound this issue, there is little consensus in the field of how to best measure creativity (see Freund & Holling, 2008; Kaufman, Plucker, & Baer, 2008).

The kinds of creativity measures typically used to examine the relationship between creativity and achievement can be classified into two types: self-report and more objective creativity tests. Self-report measures tend to focus on beliefs about one's creative ability (e.g., Karwowski & Lebuda, 2015; Skager, Klein, & Schultz, 1967), creative activity or achievement (mainly inventories measuring the intensity of declared creative behaviors and activities or observable creative accomplishments, e.g., Carson, Peterson, & Higgins, 2005; Jauk, Benedek, & Neubauer, 2014), and indicators of creative personality (e.g., Naderi, Abdullah, Aizan, Sharir, & Kumar, 2009). More objective creativity tests tend to focus on divergent thinking skills (i.e., the ability to generate original ideas). These include tests based on Guilford's theory (e.g., Toll, 1985), the Test of Creative Thinking–Drawing Production (TCT-DP) by Urban and Jellen (Urban, 1991; Karwowski & Gralewski, 2013), the Torrance Test of Creative Thinking (TTCT; Clapham, 2004; Torrance, 1968), and other instruments (e.g., the Remote Associates Test, Mednick, 1963, or the Sternberg Triarchic Abilities Test, Chooi, Long, & Thompson, 2014).

Creativity tests can be further distinguished by modality: verbal tests (i.e., requiring participants to provide verbal answers to the problems provided; e.g., the TTCT verbal, Hansenne & Legrand, 2012, or the Verbaler Kreativity-Test, Rindermann & Neubauer, 2004) and figural tests (i.e., requiring participants to draw the solution; e.g., the TCT-DP, Gralewski & Karwowski, 2012, or the Test of Creative Imagery Ability, Jankowska & Karwowski, 2015). The most popular divergent thinking tests (e.g., TTCT) can be further divided into dimensions of divergent thinking (i.e., fluency, flexibility, originality, or elaboration). Previous studies have demonstrated that aspects of divergent thinking vary in their association with academic achievement (e.g., Auzmendi, Villa, & Abedi, 1996; Feldhusen, Treffinger, Van Mondfrans, & Ferris, 1971). We therefore explore whether these different dimensions influence the relationship between creativity and academic achievement but, given the limited work in this area, have no prediction as to the specific strength of this influence (e.g., nonexistent, weak, moderate, strong).

With respect to academic achievement, researchers have also used a wide array of methods and measures to examine the relationship with creativity. Similar to creativity measures, academic achievement measures can be classified into two types: subjective assessments and objective tests. Grade point averages (GPAs) represent the most common type of subjective measure used in studies that have examined the link with creativity (e.g., Chamorro-Premuzic, 2006; Freund & Holling, 2008; Gralewski & Karwowski, 2012). More objective tests refer to any externally constructed tests of academic subject matter knowledge or achievement (e.g., Tan, Mourgues, Bolden, & Grigorenko, 2014).

Taken together, the measures of creativity and academic achievement typically used in studies that have examined their relationship tend to include both subjective and more objective types of measurement. Moreover, creativity measures tend to focus more on assessing divergent thinking skills and abilities (e.g., generating original ideas), whereas academic tests tend to focus more on whether students can meet predetermined task expectations (e.g., accurately solving a problem in mathematics). Figure 2 provides a visual representation of where creativity and academic achievement tests tend to place their emphasis.

As depicted in Figure 2, these areas of emphasis map onto the conceptual definition of creativity ($C = O \times TC$), with creativity tests tending to focus on the originality (O) aspect of creativity and measures of academic achievement tending to focus on meeting predetermined task constraints (TC). The area of empirical overlap between these measures is therefore restricted to the narrow intersection between O and TC. We therefore might expect that the empirical relationship between creativity and academic achievement is constrained by the types of measures used to assess these

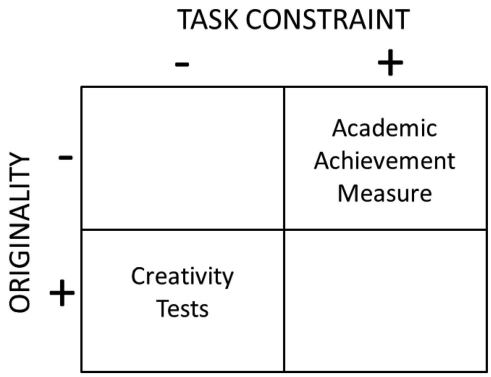

Figure 2. A visual representation of where creativity and academic achievement tests place emphasis.

constructs. It is unclear, however, how various types of measurement used in previous studies affect the average relationship between creativity and academic achievement. We therefore endeavor to shed light on this moderating factor.

Education Stage

Education stage is another potentially moderating factor in the relationship between creativity and academic achievement. Some of the earliest creativity research in classrooms was conducted by Torrance (1968), who documented what he called a fourth-grade slump (i.e., declines in creativity in the transition from third to fourth grade). Since that time, researchers have demonstrated variability in creativity scores across stages of education. The relationship between the imagination of children starting school and their achievements, for instance, hardly exists at all, $r = .02$ (Karwowski & Dziedziewicz, 2012). However, as early as the fifth grade, that relationship has been found to be more substantial, $r = .23$ (Jankowska, Gajda, & Karwowski, 2015; Karwowski, 2015). In yet other studies, the relationship between creativity and achievement in elementary school students has been found to range between $r = .08$ (Gajda, 2008) and $r = .39$ (Awamleh, Al Farah, & El-Zraigat, 2012). Variations have also been found in middle grades, $r = .18$ (Rindermann & Neubauer, 2004) and high school, ranging from $r = .12$ (Kim & Michael, 1995) to $r = .21$ (Karwowski, 2005).

Although education stage seems to moderate the relationship between creativity and achievement, there is no clear pattern or direction that can be expected from previous findings. As such, the present study aims to provide a more stable estimate of the influence of grade level on the relationship between creativity and academic achievement.

Decade

As with education stage, there is prior empirical work suggesting that decade may influence the relationship between creativity and academic achievement. Kim (2011) conducted one of the largest cross-sectional studies ($N = 279{,}599$) that examined the pattern of creativity scores over six time periods (from 1966–2008). Kim summarized her findings by stating that creativity scores, measured by the TTCT, are "declining overtime among Americans of all ages, especially kindergarten through third grade, the decline is steady and persistent, from 1990 to present, and ranges across various components tested by the TTCT" (p. 293). When taking the full range of decades into account, the patterns demonstrate more variability (including periods of gain, stagnation, and decline). Moreover, the changes from one sampled time period to the next are often (but not always) statistically significant, and the magnitude of the effect varies from small to large (depending on the particular component of the TTCT examined and the time period tested).

Consequently, we expect that time period likely will have some influence on the relationship between creativity and academic achievement, but it is difficult to predict the direction or magnitude of that difference. Our analysis will, however, allow us to examine whether studies conducted across different time periods moderate the relationship between creativity and academic achievement.

Culture

Finally, we expect culture to play a moderating role in the relationship between creativity and academic achievement. The direction and magnitude of that difference, however, are once again difficult to predict. Researchers have noted that conceptualizations of creativity can and do differ across cultures (Kaufman & Sternberg, 2006; Rudowicz, 2003). Given that there is so much variation within cultures (Freund & Holling, 2008; Gralewski & Karwowski, 2012), it is difficult to untangle the within variation from the between variation in previous work. As such, the present study aims to help clarify whether and to what extent culture moderates the relationship between creativity and academic achievement.

Method

Search Strategies

We followed a three-step procedure to select the studies included in our meta-analysis. The first step was a review of articles and research papers in English. We searched EBSCO, PsycExtra, Academic Search Complete, PsycInfo, PsycArticles, and ERIC databases and used the resources of JSTOR, Science Direct, SAGE Journals, Taylor & Francis, and ProQuest. In the next step, we analyzed book publications using three electronic libraries: Wiley Online Library and Questia, as well as Google Books.

We used the following search parameters to collect articles (keywords, abstracts, titles, and full text): *academic achievement** or *school grades** or *school achievement** or *scholastic achievement** or *grade point average* and *creative ability** or *creativity** or *divergent thinking**. Finally, in the third step of our search procedure, we explored whether any additional studies could be found by conducting a review of Polish-language periodicals devoted to psychology and education. We chose Polish-language periodicals because the first two authors had access to this literature and are fluent in the language.

Inclusion and Exclusion Criteria

Our search yielded a total of 148 studies. We then applied the following selection criteria to those studies. First, we only consid-

ered studies that presented a quantitative measure of the strength of the relationship between creativity and academic achievement, even if the relationship between creativity and academic achievement was not the primary goal of the study. A total of 18 studies[2] did not meet this first selection criterion and were eliminated from the analysis.

Next, we only included studies if they used more objective measures of creativity (e.g., TTCT) or self-report scales that demonstrated adequate reliability, such as measures of creative personality (e.g., Naderi et al., 2009) or creative self-confidence beliefs (e.g., Skager et al., 1967). This resulted in the elimination of four studies.[3] With respect to academic achievement, we included studies that used GPA (e.g., Chamorro-Premuzic, 2006), external examinations (e.g., Tan et al., 2014), and achievement tests created by researchers for the purpose of their study (e.g., Dobrołowicz, 2002; Sethi, 2012). This resulted in the elimination of one study that used students' self-assessments of academic achievement (Kaltsounis, 1974).

We also excluded two studies that used data presented in other publications, one study that used data previously published by a different author, and two studies that used multilevel models. The two studies that used multilevel models were excluded because they provided unstandardized regression coefficients that were inflated by the control of nesting students into classes and schools. Although β values are sometimes translated into *r* values (Peterson & Brown, 2005), there is no widely accepted or robust procedure for translating coefficients from multilevel models into standardized effect size for use in meta-analysis.

A total of 120 of the original 148 studies met our selection criteria and were included in the analysis. Taken together, the included studies had 782 effects with over 50,000 participants ($N = 52{,}578$). Participants had a mean age of 13.8 years ($SD = 2.43$) and attended elementary, middle, and high schools as well as colleges or universities. The studies were conducted between 1962 and 2015, in various countries (including the United States, European countries, Asia, and Africa). Table 1 provides a detailed overview of the studies included in the meta-analysis.

Coding Procedures

The first two authors independently coded each article for relevant information, including sample size, sample selection, effect size, and information necessary for the moderator analyses (i.e., measures of creativity and academic achievement, participants' age and stage of education, date and location of publication). Next, we reviewed the coded data and articles, as well as discussed and resolved any discrepancies to help eliminate errors in coding.

Moderators

For each study included in our analysis, we coded for the key moderators of interest. With respect to type of measurement, we coded the type of creativity measure used in the study (i.e., creative ability test or self-report questionnaire). We distinguished between different types of creativity tests, including tests based on Guilford's theory, the TCT-DP by Urban and Jellen, the TTCT, and other instruments (e.g., Remote Associates Test; Mednick, 1963). We also coded the different dimensions of creative ability measured by tests used in the studies (i.e., overall indices of creative ability, fluency, flexibility, originality of thinking, and elaboration). With respect to academic achievement, we coded for how achievement was measured (i.e., GPA or achievement test) and type of achievement measured (i.e., humanities, science, overall performance, sports).

Finally, we coded (a) education stage (i.e., elementary, middle school, high school, college/university), (b) study year (i.e., the year the study was conducted), and location (i.e., the country or continent where the study was conducted). We also included two dichotomously coded control variables that might influence the relationship between creativity and academic achievement. Those control variables included (a) goal of the study (i.e., primary purpose was examining the relationship between creativity and academic achievement vs. another goal) and (b) publication status (i.e., published or unpublished study).

Statistical Methods

When possible, we computed effect size using the values of correlation coefficients (*r*) and sample size (*N*). In a few studies, however, we converted the effect value provided (e.g., β, *F*, or χ^2) to the value of the *r* correlation coefficient. To analyze main effects, we used multilevel meta-analysis (Cheung, 2014, 2015; Konstantopoulos, 2011; Lebuda, Zabelina, & Karwowski, 2015), because individual correlations were clustered within studies. We carried out a three-level meta-analysis. Level 1 related to the participants in individual studies, Level 2 to interdependent effects within independent studies, and Level 3 to the studies themselves.

Three-level meta-analysis made it possible to obtain robust estimates of effect size, specifically unbiased estimates of standard errors, Level 2 (within-study) variance, and Level 3 (between-study) variance. Three-level meta-analysis was required because averaging the effects of individual studies would have significantly weakened the power of the entire analysis (we had 782 effects, but these were drawn from 120 studies) and would not have allowed us to estimate the influence of various moderators (as these were attributed to specific effects rather than studies).

[2] Those 18 studies focused on analyzing the theory of positive disintegration (Gallagher, 1985); the effectiveness of training influences (Blumen-Pardo, 2002; Cheung, Roskams, & Fisher, 2006; Malekian & Fathi, 2012; Yorke-Viney, 2007); the analysis of success in teaching (Hodder, 1972); the analysis of the relationship of sibling structure with creativity, intelligence, and academic achievement (Cicirelli, 1967); investigating the predictors of entrepreneurship (Farzaneh et al., 2010); seeking various predictors of academic achievement (Childs, 1978; Muhich, 1972; Owen, Feldhusen, & Thurston, 1970; Richards & Casey, 1975; Yamamoto, 1964); analyzing the relationship between parenting style, perfectionism, and creativity in talented individuals with high academic achievement (Miller, Lambert, & Speirs Neumeister, 2012); the teacher's perception of creativity, intelligence, and academic achievement (Mayfield, 1979); the measurement of creativity, intelligence, and academic achievement (Eisenman, Platt, & Darbes, 1968); analyzing the reliability and validity of ideational originality (Runco & Albert, 1985); and creativity in exact sciences (Son, 2009).

[3] Those four studies included a single self-report question from a questionnaire as a measure of creativity (Unal & Demir, 2009), judges' rating of participants with low-reliability products (Hasirci & Demirkan, 2007; Priest, 2006), and a questionnaire completed by the teacher concerning students' creativity level (Baltzer, 1988).

Table 1
The Subjects of the Studies Included in the Meta-Analysis

No.	Study	Aim of the study	Type of publication	Creativity measure	Achievement measure	*N*	*r*	No. of effects	School	Country	Year
1	Cline, Richards, & Abe, 1962	The reliability of creativity test batteries	Journal article	Guilford Tests of Divergent Thinking	GPA	161	.32	12	high school	United States	1962
2	Mednick, 1963	The creativity of psychology students	Journal article	Creativity Rating Scale Remote Associations Test	GPA	21	−.03	2	college/university	United States	1963
3	Cline, Richards, & Needham, 1963	Creativity and achievement tests in school education	Journal article	Guilford Tests of Divergent Thinking	GPA	119	.30	14	high school	United States	1963
4	DeBoer, 1964	The relationship of creativity with intelligence and academic achievement	Unpublished dissertation	Getzels, Jackson Creative Thinking Tasks	The Iowa Test of Basic Skills	277	.51	5	elementary, middle and high school	United States	1964
5	Karnes, Zehrbach, Studley, & Wright, 1965	The intellectual functioning of children with high potential from culturally threatened communities	Unpublished study	TTCT	SAT	203	.32	4	elementary	United States	1963
6	Ohnmacht, 1966	Academic achievement, anxiety, and creative thinking	Journal article	Getzels and Jackson Creative Thinking Tasks: 2. Uses for Things	SAT	204	.56	18	elementary	United States	1966
7	Yamamoto & Chimbidis, 1966	Academic achievement, intelligence, and creative thinking	Journal article	Minnesota Tests of Creative Thinking	SAT	790	.22	9	elementary	United States	1966
8	Bentley, 1966	Creativity and academic achievement	Journal article	Test of Imagination The-Ask-and-Guess Test	GPA	75	.34	1	college/university	United States	1966
9	Klein, Skager, & Erlebacher, 1966	Measures of artistic creativity and flexibility of thinking	Journal article	Hidden Figures Thurstone Complex Space Pitcher	GPA	92	.02	3	college/university	United States	1966
10	Dowd, 1966	The relationship between creative thinking and academic success	Unpublished study	Guilford Tests of Divergent Thinking	Scholastic Aptitude Test	417	.16	18	college/university	United States	1966
11	Yamamoto, 1967	Creativity and unpredictability as related to academic achievement	Journal article	Minnesota Tests of Creative Thinking	Iowa Tests of Educational Development	159	.04	18	high school	United States	1967
12	Skager, Klein, & Schultz, 1967	Predicting academic and artistic achievement	Journal article	Self-Ratings of Creativity Symbol Production Task Controlled Associations Task Alternate Uses Task	GPA	357	.27	7	college/university	United States	1967
13	Graves, Ingersoll, & Evans, 1967	The creative medicine student: a descriptive study	Journal article	Opinion, Attitude and Interest Survey	Medical College Admissions Test	150	.03	5	college/university	United States	1967
14	Mednick & Andrews, 1967	Creative thinking and the level of intelligence	Journal article	Remote Associations Test	Scholastic Aptitude Test	1,211	.32	2	college/university	United States	1967

Table 1 (*continued*)

No.	Study	Aim of the study	Type of publication	Creativity measure	Achievement measure	*N*	*r*	No. of effects	School	Country	Year
15	Hetrick, Lilly, & Merrifield, 1968	Figural creativity, intelligence, and children's personality	Journal article	Gulamerian Flexibility and Originality tests	Iowa Achievement Test GPA	196	.06	4	elementary	United States	1968
16	Wade, 1968	Differences between intelligence and creativity: suppositions concerning the role of the environment	Journal article	Guilford Tests of Divergent Thinking	GPA	105	.35	3	high school	United States	1968
17	Tibbetts, 1968	Socioeconomic status, race, gender, IQ, age, and GPA among adolescents	Unpublished dissertation	Getzels and Jackson Creativity Test	GPA	258	.42	2	high school	United States	1968
18	Bowers, 1969	Interactions between creativity and intelligence	Journal article	TTCT, verbal & figural	GPA Iowa Tests of Educational Development	278	.26	40	middle-school	United States	1969
19	Anderson, White, & Stevens, 1969	Creativity, intelligence, students' achievement, and behavior	Journal article	The Utility Test The Apparatus Test The Plot Titles Test	GPA Language Test CAT	197	−.03	2	high school	United States	1969
20	Kanderian, 1969	The relationship between academic achievement, creativity, and intelligence	Unpublished dissertation	Divergent Thinking Test	GPA	304	.05	3	elementary	Iraq	1969
21	Gluskinos, 1971	Types of students' creativity and their relationship with academic grades	Journal article	AC Test for Creative Ability The Purdue Creativity Test Guilford's Divergent production	GPA	314	.02	11	college/university	United States	1971
22	Feldhusen, Treffinger, Van Mondfrans, & Ferris, 1971	The relationship between school grades and the level of creative thinking	Journal article	TTCT, verbal & figural	GPA	356	.11	112	elementary and high school	United States	1971
23	Wagner, 1972	Time-bound and non-time-bound measures of creativity and their correlates	Unpublished dissertation	Wallach and Wing Test	GPA	131	.13	16	high school	United States	1972
24	Stallings & Gillmore, 1972	The relationship between nonverbal creativity and grades	Unpublished study	TTCT, figural	GPA ACT	292	.06	8	college/university	United States	1972
25	Kaltsounis & Stephens, 1973	Arithmetical achievement and creativity	Journal article	TCT, verbal & figural	Seeing Through Arithmetic Tests	196	.22	5	elementary	United States	1973
26	Porter, 1974	Race, socialization, and mobility in education and early professional achievement	Journal article	Getzels and Jackson Unusual Uses Creativity Test TTCT	GPA	15,326	.22	2	high school	United States	1974
27	Joesting, 1975	Creativity and school grades, school activities, and students' attendance	Journal article	Torrance's Creative Motivation Inventory Khatena-Torrance What Kind of Person Are You?	Achievement Test GPA	133	.16	10	college/university	United States	1975

(*table continues*)

Table 1 (*continued*)

No.	Study	Aim of the study	Type of publication	Creativity measure	Achievement measure	*N*	*r*	No. of effects	School	Country	Year
28	Marjoribanks, 1976	Regression analyses: academic achievement, intelligence, and creativity	Journal article	Adaptation of Torrance and Guilford Tests of Divergent Thinking	GPA	450	.41	18	middle-school	United States	1976
29	Rodriguez, 1980	The influence of creativity training on academic achievement and creative thinking	Unpublished dissertation	Divergent Thinking–Structure of Intellect Learning Abilities Test (SOILAT)	Comprehensive Test of Basic Skills	188	−.05	4	elementary	United States	1980
30	Wódz, 1981	Students' creative talents and their academic achievement	Journal article	Wallach Kogan Creativity Test	GPA	60	.24	1	elementary	Poland	1981
31	Stiles, 1982	Correlates of creativity among students	Unpublished dissertation	TTCT, verbal & figural	GPA	68	.14	8	college/university	United States	1982
32	Jackson, 1982	The relationship of cognitive abilities with intelligence and academic achievement	Unpublished dissertation	TTCT	Comprehensive Test of Basic Skills Prescriptive Reading Test Prescriptive Mathematics Test	76	.30	4	elementary	United States	1982
33	Westcott, 1983	Signature humor as an alternative in the identification of creative and talented students	Unpublished dissertation	TTCT, figural	The Iowa Tests of Basic Skills GPA	62	.43	6	high school	United States	1983
34	Toll, 1985	The relationship between Guilford's tests and reading comprehension	Unpublished dissertation	New Uses Test Seeing Different Meanings Test Judging Object Adaptations Test	Gates-Mac Ginitie Reading Test scores	105	.24	3	elementary	United States	1985
35	Janes, 1988	The relationship between creativity test scores and receiving awards and school grades	Unpublished dissertation	TTCT, figural	GPA	209	.09	4	high school	United States	1988
36	Orieux, 1989	Correlates of creative abilities and achievement in high schools	Unpublished dissertation	The Creative Activities Checklist Guilford Tests of Divergent Thinking	GPA	157	.40	4	high school	United States	1989
37	McCabe, 1991	The influence of creativity and unpredictability on academic achievement	Journal article	TTCT, verbal & figural	GPA	210	.20	21	middle-school	United States	1991
38	Guastello, Bzdawka, Guastello, & Rieke, 1992	Cognitive abilities and creative behavior	Journal article	CAB 5 The Remote Consequences Test	GPA	144	.18	5	college/university	United States	1992
39	Popov, 1992	Creativity and reading comprehension	Journal article	Guilford Tests of Divergent Thinking	Reading Comprehension Test	63	.38	10	college/university	Russia	1992
40	Kim & Michael, 1995	The relationship of creativity with academic achievement and the preferred style of thinking	Journal article	TTCT, verbal & figural	GPA	193	.12	5	high school	Korea	1995

Table 1 (*continued*)

No.	Study	Aim of the study	Type of publication	Creativity measure	Achievement measure	*N*	*r*	No. of effects	School	Country	Year
41	Auzmendi, Villa, & Abedi, 1996	The validity and reliability of an instrument for measuring creativity	Journal article	Abedi-Schumacher Creativity Test	GPA	2,264	.14	24	no data	Spain	1996
42	Johns & Morse, 1997	Divergent thinking	Journal article	The Alternative Uses Test (Based on Guilford and Wallach, Kogan tests)	GPA	79	.28	3	college/university	United States	1997
43	Simpson, 1998	The relationship of academic achievement with intelligence, creativity, motivation, and gender identification	Unpublished dissertation	TTCT, figural	The Texas Learning Index The Texas Assessment of Academic Skills	71	.14	2	elementary	United States	1998
44	Niaz, Núñez, & Pineda, 2000	Students' academic achievement as an effect of mental abilities, cognitive style, fixation vs. mobility dimensions, and creativity	Journal article	TTCT, figural	GPA	141	.16	32	high school	Venezuela	2000
45	Diakidoy & Constantinou, 2001	Creativity in physics: the fluency of answers and the specificity of tasks	Journal article	Three Open Tasks	GPA	54	.11	4	college/university	Greece	2000
46	Gollmar, 2000	Attention-deficit hyperactivity disorder, creativity, and cognitive styles: interactions and effect on school success	Unpublished dissertation	TTCT	GPA Iowa Test of Basic Skills	179	.08	20	elementary	United States	2000
47	Clapham, 2001	The effect of information manipulation and exposure on divergent thinking	Journal article	TTCT	GPA	148	.14	1	college/university	United States	2001
48	Dobrołowicz, 2002	Students' creativity and their academic achievement	Book	Modified Guilford Tests of Divergent Thinking	School Achievement Tests	445	.28	9	elementary	Poland	2002
49	Grzelak, 2003	Creative and imitative attitudes and academic achievement in third-grade high school students	Unpublished thesis	Creative Behavior Questionnaire	GPA	200	.06	1	high school	Poland	2003
50	Chamorro-Premuzic & Furnham, 2003	Personality and the prediction of academic achievement	Journal article	The Barron-Welsh Art Scale	GPA	70	.07	2	college/university	Great Britain	2003
51	Cheung, Rudowicz, Yue, & Kwan, 2003	The influence of the year of study on university students' creativity	Journal article	Alternate Uses Test Guilford	GPA	859	.09	6	college/university	China	2003

(*table continues*)

Table 1 (*continued*)

No.	Study	Aim of the study	Type of publication	Creativity measure	Achievement measure	*N*	*r*	No. of effects	School	Country	Year
52	Zhang, 2004	School performance prediction styles	Journal article	Sternberg Triarchic Abilities Test	GPA	250	.28	16	middle-school	Hong Kong	2004
53	Yeh, 2004	Academic achievement, creativity, and mind-mapping ability	Journal article	The Alternative Uses Test by WU	GPA	69	.66	3	middle-school	Taiwan	2004
54	Rindermann & Neubauer, 2004	Processing speed, intelligence, creativity, and school performance	Journal article	Verbaler Kreativity-Test Verwendungs Test	GPA	271	.18	8	middle and high school	Germany	2004
55	Clapham, 2004	The reliability of the TTCT test battery and self-report	Journal article	How Creative Are You? How Do You Think?	SAT ACT	145	.18	8	college/university	United States	2004
56	Karwowski, 2005	The school performance and creativity of students perceived by teachers as different in terms of abilities	Journal article	Urban, Jellen TCT-DP	GPA	194	.20	1	high school	Poland	2005
57	Uszyńska-Jarmoc, 2005	Types of thinking and the academic achievement of 7-year-olds	Journal article	Urban, Jellen TCT-DP	GPA	167	.10	2	elementary	Poland	2005
58	Al-Dhobaiban, 2005	The relationship between self-regulation and creativity	Unpublished dissertation	Test Your Creativity Level Scale Khatena Torrance Creativity Perception Inventory	GPA	219	.15	2	college/university	United States	2005
59	Stankiewicz, 2006	The talented student in the teacher's eyes	Unpublished thesis	Urban, Jellen TCT-DP	GPA	79	.19	1	high school	Poland	2006
60	Chamorro-Premuzic, 2006	Creativity and conscientiousness: which of the variables is a better predictor of a student's achievement?	Journal article	Christensen Alternate Uses Test	GPA	307	.19	3	college/university	Great Britain	2006
61	Sternberg, 2006	Enhancing the SAT through assessments of analytical, practical, and creative skills	Journal article	Sternberg Triarchic Abilities Test	GPA	777	.40	2	college/university	United States	2006
62	Arseniuk, 2007	Creativity differences and disability	Unpublished thesis	Urban, Jellen TCT-DP	GPA	130	.24	1	high school	Poland	2007
63	Freund, Holling, & Preckel, 2007	The relationship between cognitive abilities and academic achievement	Journal article	Berlin Structure of Intelligence Test for Youth: Assessment of Talent and Giftedness	GPA	1,135	.38	3	middle-school	Germany	2007
64	Wang, 2007	Teaching, learning, and creativity in Taiwan and the United States	Unpublished dissertation	Abbreviated Torrance Test for Adults	Entrance Examinations CBEST	216	.27	3	college/university	United States	2007

Table 1 (*continued*)

No.	Study	Aim of the study	Type of publication	Creativity measure	Achievement measure	*N*	*r*	No. of effects	School	Country	Year
65	Wasil, 2008	The student's creativity as related to his or her grades and position in the teacher's eyes	Unpublished thesis	Urban, Jellen TCT-DP	GPA	30	.20	2	high school	Poland	2008
66	Dąbrowska, 2008	Creative abilities, school performance, and motivation type as related to interpersonal attractiveness	Unpublished thesis	Urban, Jellen TCT-DP	GPA	75	.10	1	middle-school	Poland	2008
67	Gajda, 2008	The accuracy of teachers' nominations and the actual level of students' creative abilities	Unpublished thesis	Urban, Jellen TCT-DP	GPA	90	.08	1	elementary	Poland	2008
68	Hirsh & Peterson, 2008	The prediction of creativity using an instrument connected with personality traits	Journal article	Creative Achievement Questionnaire	GPA	98	.01	1	college/university	Canada	2008
69	Palaniappan & Persekutuan, 2008	The influence of intelligence on the relationship between creativity and academic achievement	Journal article	TTCT, figural	GPA	72	.17	8	high school	Malaysia	2008
70	Sternberg, 2007	Improving school-related skills by diversifying the goals to be achieved	Journal article	Sternberg Triarchic Abilities Test	GPA Scholastic Assessment Test (Writing and Math) SAT	793	.50	4	college/university	United States	2008
71	Silvia, 2008	Creativity and intelligence: a latent variable analysis by Wallach and Kogan	Journal article	Guilford Tests of Divergent Thinking	School and College Ability Test Sequential Tests of Educational Progress	151	.25	1	elementary	United States	2008
72	Zielińska, 2009	The significant others of young people with different levels of creativity	Unpublished thesis	Urban, Jellen TCT-DP	GPA	115	.07	1	high school	Poland	2009
73	Tkaczyk, 2009	Conflict resolution styles and selected aspects of middle school students' creativity	Unpublished thesis	Urban, Jellen TCT-DP	GPA	209	.18	1	middle-school	Poland	2009
74	Karwowski, Lebuda, & Wiśniewska, 2008–2009	Creative abilities and styles as predictors of school success	Journal article	Urban, Jellen TCT-DP	GPA	1,316	.11	2	middle and high school	Poland	2009
75	Naderi, Abdullah, Aizan, Sharir, & Kumar, 2009	Creativity, age, and gender as predictors of students' academic achievement	Journal article	Khatena-Torrance Creative Perception Inventory	GPA	153	.16	1	college/university	Iran	2009

(*table continues*)

Table 1 (*continued*)

No.	Study	Aim of the study	Type of publication	Creativity measure	Achievement measure	*N*	*r*	No. of effects	School	Country	Year
76	Karwowski, Ciak, & Grubek, 2009	The accuracy of teachers' nominations in recognizing students' creativity	Book chapter	Urban, Jellen TCT-DP Creative Behavior Questionnaire	GPA	94	.12	3	high school	Poland	2009
77	Mann, 2009	The identification of creative potential in middle school students	Journal article	Creative Abilities in Mathematics Test	Connecticut Mastery Tests	89	.48	1	middle-school	United States	2009
78	Bierly, Kolodinsky, & Charette, 2009	The relationship between creativity and ethical ideologies	Journal article	Creativity Scale based on Kirton and Robinson theories	GPA	899	.04	1	college/university	United States	2009
79	Olatoye, Akintunde, & Yakasai, 2010	Emotional intelligence, creativity, and students' academic achievement	Journal article	Nicola Holt Creativity Test: The Creative Cognition Inventory	GPA	235	.00	1	college/university	Nigeria	2010
80	Day, Hanson, Maltby, Proctor, & Wood, 2010	Hope as a predictor of academic personality and academic achievement	Journal article	Gilford Tests of Divergent Thinking	GPA	129	.31	1	college/university	Great Britain	2010
81	Vijetha & Jangaiah, 2010	Intelligence, creative thinking, and academic achievement in children with hearing disorders	Journal article	Baqer Mehdi Nonverbal Test of Creativity	GPA	50	−.07	4	elementary	India	2010
82	Kousoulas, 2010	The interrelations between creative behavior, divergent thinking, and knowledge during students' creative expression at the time of learning	Journal article	Two Open Tasks	Achievement Test GPA	115	.26	12	elementary	Greece	2010
83	Sak & Maker, 2006	The developmental differentiation of mathematical creative thinking in children depending on age, education, and the level of knowledge	Journal article	DISCOVER (based on Guilford Divergent Thinking Tests)	Mathematical Knowledge DISCOVER	297	.38	2	elementary	United States	2010
84	Dhatrak & Wanjari, 2011	The relations between school attitude, creativity, and academic achievement	Journal article	Verbal Test of Creative Thinking Baqer Mehdi	GPA	500	.05	1	high school	India	2011
85	Pishghadam, Khodadady, & Zabihi, 2011	Creativity and learning foreign languages	Journal article	Arjomand Creativity Questionnaire	GPA	272	.36	1	college/university	Iran	2011
86	Dollinger, 2011	Recruitment tests and creativity	Journal article	Hocevar Creative Behavior Inventory	ACT	433	.17	4	college/university	United States	2011

Table 1 (*continued*)

No.	Study	Aim of the study	Type of publication	Creativity measure	Achievement measure	*N*	*r*	No. of effects	School	Country	Year
87	Dziedziewicz & Gajda, 2011	Creativity and academic achievement in middle school	Unpublished study	Urban, Jellen TCT-DP	GPA 3-grade and 6-grade Achievement Tests	362	.29	2	middle-school	Poland	2011
88	Petrulyte, 2011	Creativity and academic achievement in students of arts	Journal article	TTCT Asmenybes Kurybiskumo Klausimynas	GPA	140	.24	1	high school	Lithuania	2011
89	Vock, Preckel, & Holling, 2011	Intellectual abilities and academic achievement: analysis of mediators	Journal article	Berlin Structure of Intelligence Test for Youth: Assessment of Talent and Giftedness	GPA	1,135	.38	3	high school	Germany	2011
90	Ofili, 2011	Do multicultural experiences and biculturalism enhance students' creativity?	Unpublished thesis	Creative Achievement Questionnaire	GPA	122	.16	1	college/university	United States	2011
91	Hansenne & Legrand, 2012	Creativity, emotional intelligence, and academic achievement in students	Journal article	TTCT	GPA	73	.20	14	elementary	Belgium	2012
92	Piórkowska, 2012	The dynamics of strategic behaviors in learning and their associations with creative abilities	Unpublished thesis	Urban, Jellen TCT-DP	GPA	107	.17	1	high school	Poland	2012
93	Sethi, 2012	Investigating performance in math in relation to the creativity of high school students	Journal article	Verbal Test of Creative Thinking Baqer Mehdi	Mathematics Achievement Test for 9th Class	700	.26	3	high school	India	2012
94	Anwar, Aness, Khizar, Naseer, & Muhammad, 2012	The relationship between creative thinking and students' academic achievement	Journal article	TTCT	GPA	256	.46	4	high school	Pakistan	2012
95	Awamleh, Al Farah, & El-Zraigat, 2012	Creativity level measured using the TTCT	Journal article	TTCT	GPA	63	.39	4	elementary	Jordan	2012
96	Putwain, Kearsley, & Symes, 2012	Creative self-awareness as related to literary achievement and motivation	Journal article	Abedi Test of Creativity	Achievement Test	122	.23	4	middle-school	Great Britain	2012
97	Karwowski & Dziedziewicz, 2012	Correlations between creative imagination and skills at the beginning of school	Book	Creative Imagery Abilities Test	Test of Skills at School Beginning	1,096	.02	12	nursery and elementary	Poland	2012
98	Walia, 2012	The relationship between achievement and mathematical creativity	Journal article	Balka Creative Ability in Mathematics Test	Sessional Assessment in Mathematics Test	180	.66	3	middle-school	India	2012

(*table continues*)

Table 1 (*continued*)

No.	Study	Aim of the study	Type of publication	Creativity measure	Achievement measure	*N*	*r*	No. of effects	School	Country	Year
99	Tatlah, Aslam, Ali, & Iqbal, 2012	The role of intelligence and creativity in academic achievement	Journal article	Nicola Holt Creativity Test: The Creative Cognition Inventory	GPA	235	.03	1	college/university	Pakistan	2012
100	Dai et al., 2012	The influence of social environment and education conditions on creativity in adolescence	Journal article	Four-item creativity test	GPA	229	.35	2	middle-school	United States	2012
101	Ibrahim, 2012	The relationship between creativity, engineering, knowledge, and design	Unpublished dissertation	TTCT	GPA	85	.03	7	college/university	United States	2012
102	Gajda, 2013	Creativity and academic achievement, elementary schools	Unpublished dissertation	Urban, Jellen TCT-DP	GPA	384	.16	1	elementary	Poland	2013
103	Karwowski, 2013a	Creativity and academic achievement	Unpublished study	Urban, Jellen TCT-DP	GPA	392	.14	1	no data	Poland	2013
104	Karwowski, 2013b	Creativity and academic achievement	Unpublished study	Urban, Jellen TCT-DP	GPA	113	.03	1	no data	Poland	2013
105	Dziedziewicz, 2013	Creativity and learning styles	Unpublished study	Creative Imagery Abilities Test	GPA	238	.14	1	college/university	Poland	2013
106	Mitrofanow, 2013	Creative imagination and academic achievement	Unpublished thesis	Creative Imagination Test by Kujawski	GPA	140	.12	3	college/university	Poland	2013
107	Ritchie, Luciano, Hansell, Wright, & Bates, 2013	The relationship between reading-related skills and creativity	Journal article	Queensland Core Skills Test: "create and present" scores	Reading and Spelling Test Core	855	.32	1	no data	Australia	2013
108	Gralewski & Karwowski, 2013	Students' gender and the accuracy of teachers' creativity nominations	Journal article	Creative Activity in Science Creative Activity in Arts Urban Jellen TCT-DP Creative Behavior Questionnaire	GPA	589	.05	5	high school	Poland	2013
109	Lovelace & Hunter, 2013	The influence of charismatic ideological and pragmatic leaders on the creative process and the products of creativity	Journal article	Divergent Thinking Test of Fluency (Baer, 1993)	SAT	336	.03	4	college/university	United States	2013
110	Matthew & Stemler, 2013	The assessment of the flexibility of thinking based on a new word recognition test	Journal article	Abbreviated Torrance Test for Adults	SAT	299	.17	5	college/university	United States	2013
111	Tan, Mourgues, Bolden, & Grigorenko, 2014	Two methods of scoring creativity in the Aurora test	Journal article	Cartoon Numbers is a subtest of the Aurora Battery	Key Stage 2 Exam Tests MidYIS (Middle Years Information System)	205	.66	2	elementary	Great Britain	2013

Table 1 (*continued*)

No.	Study	Aim of the study	Type of publication	Creativity measure	Achievement measure	*N*	*r*	No. of effects	School	Country	Year
112	Zabelina, Condon, & Beeman, 2014	The relationship of psychopathology with creative achievement and creative thinking	Journal article	Abbreviated Torrance Test for Adults Creative Achievement Questionnaire	ACT SAT	100	.11	2	college/university	United States	2014
113	Chooi, Long, & Thompson, 2014	Sternberg Triarchic Abilities Test as an instrument for measuring intelligence	Journal article	Sternberg Triarchic Abilities Test	GPA	260	.37	3	college/university	United States	2014
114	Szumski & Karwowski, 2014	Investigating the influence of students with special educational needs on the functioning of their healthy peers	Unpublished study	Divergent Thinking Tests	Achievement Tests (Mathematics and Language)	1,611	.25	2	middle-school	Poland	2014
115	Karwowski & Szumski, 2014	Effects of intraclass comparisons	Unpublished study	Guilford Tests of Divergent Thinking	Achievement Tests (Mathematics and Language)	3,312	.24	4	middle-school	Poland	2014
116	Hunter & Cushenbery, 2015	Examining the role of disagreeableness in the sharing and utilization of original ideas	Journal article	Guilford Tests of Divergent Thinking	GPA Scholastic Assessment Test (Writing and Math) SAT	201	.06	6	college/university	United States	2015
117	Wallace & Russ, 2015	Pretended play, divergent thinking, and mathematical achievement	Journal article	Wallach, Kogan Test of Creative Thinking	AIMS Web Achievement Scores Test	24	.54	5	elementary	United States	2015
118	Pretz & Kaufman, in press	University admission criteria and applicants' creativity	Journal article	Creative Self-Efficacy Guilford Tests of Divergent Thinking	Scholastic Assessment Test (Writing and Math) SAT	363	.04	12	college/university	United States	2015
119	Jankowska, Gajda, & Karwowski, 2015	The determinants of education efficiency	Journal article	Creative Imagery Abilities Test	Mathematic Achievement Test Language Achievement Test	5,174	.21	4	elementary	Poland	2015
120	Roķe & Kālis, 2015	The relationship between academic achievement and creativity	Journal article	Urban, Jellen TCT-DP	GPA	180	.27	15	middle-school	Lithuania	2015

Note. GPA = grade point average; TTCT = Torrance Test of Creative Thinking; SAT = Stanford Achievement Tests; ACT = American College Testing; CAB 5 = Comprehensive Ability Battery; TCT-DP = Test of Creative Thinking–Drawing Production; CBEST = California Basic Educational Skills Test.

The multilevel meta-analysis was conducted using the meta-SEM package (Cheung, 2014, 2015) in the R statistical environment (R Development Core Team, 2013). When analyzing the effect of publication bias, we also used the Comprehensive Meta-Analysis package (Biostat, 2008), the metafor package in R (Viechtbauer, 2010), and *p*-curve (Simonsohn, Nelson, & Simmons, 2014).

Results

We present the results of the meta-analysis in three steps. First, we present a general estimation of the effect size obtained in the multilevel model and in the random-effects model. Next, we analyze the potential influence of publication bias, which helps determine the robustness of the obtained effect size. Finally, in further multilevel models, we present the results of our moderator analyses.

Overall Effect

Table 2 presents the overall effect of the relationship between creativity and academic achievement. The obtained mean effect size was consistent with our expectations. More specifically, there was a positive and statistically significant, albeit modest, relationship: $r = .22$, 95% CI [.19, .24].[4] As expected, this effect was also heterogeneous, $Q(df = 781) = 9{,}481.65$, $p < .001$. Both within-study variance (between particular effects) and between-study variance were statistically significant, with most of the variance being between ($I^2 = .62$) rather than within studies ($I^2 = .30$).[5] Prior to examining the influence of moderators, however, we examined to what extent the obtained effect may be influenced by publication bias.

Publication Bias

We analyzed the robustness of the obtained effect size by examining whether it was influenced by publication bias. We used a four-step process that included both classic and more recent methods of analysis. First, we used a funnel plot (Duval & Tweedie, 2000) with several nonparametric techniques to estimate possible bias. We next used a *p*-curve analysis (Simonsohn et al., 2014) and then estimated the effect of using PET-PEESE[6] (Stanley & Doucouliagos, 2014). Finally, we compared effect sizes obtained in published versus unpublished studies.

An inspection of the funnel plot (see Figure 3) does not suggest asymmetry (i.e., correlations on one side of the funnel do not seem to be regularly suppressed by the effects on the other side). This pattern suggests a lack of publication bias (although such an interpretation is based more on a qualitative judgment, rather than strict statistical rules).

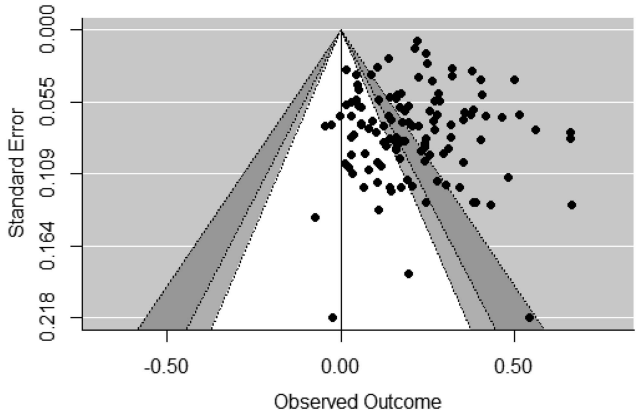

Figure 3. A funnel plot assessing the possible publication bias.

To assist with the interpretation of the funnel plot, researchers conducting meta-analyses often include statistical analysis. We used Egger's regression intercept test (Egger, Davey Smith, Schneider, & Minder, 1997). Based on the random effects model, assessing funnel plot asymmetry, and Begg and Mazumdar (1994) rank correlation test (nonsignificant *p*s = .42 and .30, respectively), we concluded there was no evidence of publication bias.

We next performed a *p*-curve analysis[7] (Simonsohn et al., 2014) to examine the credibility of the estimate using the online application available at http://www.p-curve.com/. The results of the *p*-curve analysis (see Figure 4) provided no evidence of a "file-

Table 2
Overall Effect Size Obtained Using Three-Level Meta-Analysis

Effects	Estimate	*SE*	95% CI *LL*	95% CI *UL*	*p*
Fixed effect					
Overall effect	.215	.015	.187	.244	<.001
Random effects					
Within-study variance	.010	.001	.008	.011	<.001
Between-study variance	.020	.003	.013	.026	<.001

Note. Number of studies = 120, number of effects = 782, total N = 52,578. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

[4] Robustness check performed using Comprehensive Meta-Analysis software (Biostat, 2008) on averaged effects for studies revealed the existence of an identical relationship. Due to high heterogeneity (Q = 892.61, df = 119, $p < .001$, I^2 = 86.67%), we performed analyses using the random-effects model, in which we obtained a mean correlation of r = .22, 95% CI [.19, .24], and a high degree of heterogeneity, $\tau^2 = .015$, τ = .12.

[5] The relatively low within-study variance compared to between-study variance suggests that an equally good analytic choice could have been meta-analysis using the random-effects method on data aggregated to the level of individual studies. However, we chose multilevel analysis performed at the level of individual correlations (with correlation grouping in studies controlled for), because some of the possible moderators clearly had a within-study character (e.g., the operationalization of creative abilities as the fluency, flexibility, and originality of thinking).

[6] This method fits a meta-regression model predicting effect sizes in studies by their variances (the precision effect test, called PET) or their standard errors (the precision effect estimate with standard errors, called PEESE). If the intercept is statistically significant in the PET model, the PEESE model should be taken into account as the publication bias–free effect size.

[7] The *p*-curve analysis focuses only on statistically significant studies (i.e., all effects below significance level are excluded) and checks whether "just significant effects" (i.e., slightly lower than $p = .05$ or between p = .04 and $p = .05$) are not overrepresented in the analyzed studies. Such overrepresentation may be caused not only by publication bias but also by "cherry-picking," "*p*-hacking," or other questionable research practices (Simonsohn et al., 2014).

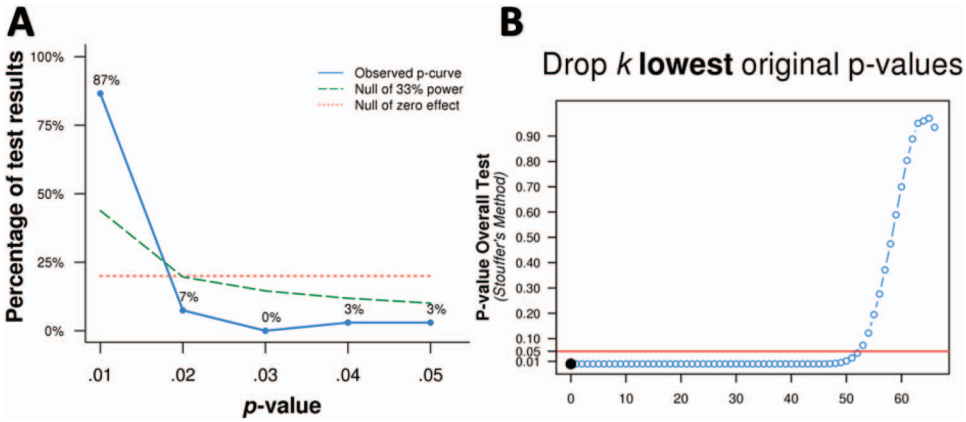

Figure 4. The *p*-curve analysis of publication bias. (A) The *p*-curve analysis and (B) its robustness. See the online article for the color version of this figure.

drawer effect" (i.e., most studies provided highly significant results) and there was also no overrepresentation of "just significant effects" (i.e., slightly lower than $p = .05$ or between $p = .04$ and $p = .05$; Figure 4A). Even more important, *p*-curve analysis demonstrated that the obtained effects were quite robust and insensitive to the exclusion of subsequent studies with the highest *p* values (Figure 4B).

Moreover, the continuous test for a right-skewed curve (i.e., examining whether studies contain evidential value) was statistically significant ($z = -30.78$, $p < .0001$), whereas testing for left-skewed studies (i.e., those that exhibit evidence of *p*-hacking) did not yield significant results ($p > .999$). Taken together, the results of our *p*-curve analysis provided further evidence that there was not an influence of publication bias.

The third step in the analysis of publication bias was the creation of a model based on the PET-PEESE method. Because the intercept obtained using PET was statistically significant ($r = .219$, $SE = .016$, $p < .001$), we adopted the intercept obtained based on PEESE as a measure of effect size not affected by publication bias, as recommended by Stanley and Doucouliagos (2014). The obtained effect was nearly the same as the results reported before (i.e., $r = .215$, 95% CI [.192, .239], $p < .001$), which also suggests no evidence of publication bias.

Finally, the results of comparing the effects obtained in published, $r = .23$, 95% CI [.20, .27], versus unpublished studies, $r = .19$, 95% CI [.15, .22], revealed a marginal difference in favor of published studies ($Q = 3.86$; $df = 1$, $p = .05$), but the similar size of the estimated effects and the overlapping confidence intervals make it legitimate to conclude that publication bias did not substantively influence our estimations.

Moderator Analysis

We analyzed the role of moderators in a sequence of multilevel regression models and used the measures of the baseline model's fit ($-2LL = -794.92$, $df = 3$) obtained in our analysis of the overall effect to compare models with moderators included as predictors. This approach allowed us to control for the mutual associations between predictors. At the end of this section, we also present estimations obtained using the analysis of variance (ANOVA) analog (Wilson, 2014), performed at the study level. Although not as statistically robust as multilevel models, the ANOVA analog analysis provides estimated effects for different groups of studies in a more convenient and easier to interpret fashion.

Types of measurement and study year. In the first step, we entered three moderators representing the measurement of creativity (0 = *self-report,* 1 = *test*), academic achievement (0 = *test,* 1 = *GPA*), and study year (grand centered). We also included two control variables in Step 1: research objective (0 = *other*, 1 = *creativity*—achievement) and publication status (0 = *unpublished*, 1 = *published*).

This model demonstrated better fit to the data ($-2LL = -813.61$, $df = 8$, Δ–$2LL = 18.69$, $\Delta df = 5$, $p = .002$) compared to our baseline model. The results are presented in Table 3.

As displayed in Table 3, the predictors entered in the model explained 11% of between-study variance and 2.2% of within-study variance. The obtained effects were stronger when creativity was measured using tests compared to when it was measured using self-report scales, as well as stronger for academic achievement measured using standardized tests compared to using GPA. With respect to study year, there was no significant influence on the obtained effect size, suggesting that the correlations were stable across time (see Figure 5). Finally, the two control variables (i.e., research objective and publication status) were not significantly related to effect size.

In the second step, we removed nonsignificant predictors from the model (research objective, publication status, study year) and added variables specifying the location of study (with Europe as the reference value) and type of achievement measured (i.e., performance in the humanities, in sciences, and overall performance, with sport as the reference value). This model did not fit the data significantly better than the previous model ($-2LL = -819.37$, $df = 13$, Δ–$2LL = 5.76$, $\Delta df = 5$, $p = .33$). Given that these additional moderators did not influence the obtained effects, our results indicate that the relationship between creativity and achievement was stable regardless

Table 3
Moderator Analysis: Types of Measurement and Study Year

Effects	Estimate	*SE*	95% CI *LL*	95% CI *UL*	*p*
Fixed effects					
Intercept	.119	.040	.041	.198	.003
Creativity measurement (0 = self-report, 1 = test)	.097	.028	.042	.153	.001
Academic achievement measurement (0 = test, 1 = GPA)	−.039	.018	−.074	−.004	.03
Study year (grand centered)	.0002	.001	−.001	.002	.76
Goal (0 = other, 1 = creativity × achievement)	−.003	.029	−.060	.054	.91
Published? (0 = no, 1 = yes)	.054	.030	−.005	.114	.07
Random effects					
Within-study variance	.009	.001	.008	.011	<.001
Between-study variance	.018	.003	.012	.023	<.001

Note. Number of studies = 120, number of effects = 782, total N = 52,578. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; GPA = grade point average.

of location[8] where the study was conducted and regardless of domain of achievement examined. Moreover, given that these additional moderators were not significant, we do not provide detailed results of Step 2 of the analysis (but interested readers can find those results in the online supplemental material Table S1).

Education stage. The next step took into account the possibility of effects being influenced by the participants' education stage. We used a different model for examining this moderator because eight studies (and 154 correlations) used samples that combined participants from elementary and middle, elementary and high, or middle and high schools. Thus, we removed those eight studies from this step and conducted our analysis using a model that included a total of 628 effects from 112 studies (see Table 4).

The results of multilevel regression, using elementary school students as the reference category, indicated that the effect observed for middle school students was significantly higher than the effect for elementary students (B = 0.12, SE = 0.05; p = .015). The effect sizes obtained for high school and university/college students did not differ significantly from the effect obtained for elementary school students.

Aspects of creativity tests. Given that we found consistently stronger associations between creativity and academic achievement obtained in studies where creativity was measured using tests compared to self-report, we conducted a more focused analysis on studies that used creativity tests (i.e., 106 studies, 700 effects). The overall effect obtained only in those studies was r = .23, SE = .016, 95% CI [.20, .26], with a significant level of heterogeneity, $Q(df = 699) = 8{,}145.81$, $p < .001$, situated mainly between studies, I^2 = .60, rather than within them, I^2 = .31, $-2LL = -676.70$, df = 3.

Therefore, in the next model, in addition to the method of measuring academic achievement, we included four more specific moderators in the group of creativity test predictors—namely, fluency, flexibility, originality of thinking, elaboration, and overall creative ability (e.g., the sum of TTCT or TCT-DP scores) and other measures (e.g., imagination as measured by Jankowska & Karwowski, 2015). We used a combination of overall indices of creative ability and other measures as the reference category for our analysis. This model did not fit the data better than the previously tested model ($-2LL = -681.35$, df = 8; Δ–$2LL$ = 4.65, Δdf = 5; p = .46). Moreover, the various aspects of creative ability (fluency, flexibility, originality, elaboration) did not differ from the reference category in terms of the effect size generated (see the online supplemental material Table S3).

Next, we examined whether the verbal or figural characteristics of the creativity test resulted in different obtained effects. For this analysis, from the total pool of studies using creativity tests (106 studies, 700 effects), we excluded 16 studies whose authors did not provide separate results for verbal and figural tests (e.g., Anwar, Aness, Khizar, Naseer, & Muhammad, 2012; Porter, 1974; Zabelina, Condon, & Beeman, 2014). The observed effect was therefore estimated on a total of 90 studies. The results of this model are presented in Table 5.

As depicted in Table 5, the average effect size estimated on 617 correlations did not differ significantly from the overall effect previously reported: r = .228, SE = .017, 95% CI [.194, .262], $p < .001$; $Q(df = 616) = 7{,}520.86$, $p < .001$; I^2 between studies = .595; I^2 within studies = .322 ($-2LL = -577.52$, df = 3). This model—which examined test type (0 = *figural,* 1 = *verbal*), in addition to the previously examined moderators and controls—fit the data better than the previously tested model ($-2LL = -685.00$, df = 15; Δ–$2LL$ = 107.48, Δdf = 12; $p <$ .001). Moreover, the results of this analysis indicate that verbal tests of creativity generated significantly higher effects than figural tests.

[8] An anonymous reviewer questioned our decision to include studies published in languages other than English (especially Polish but also Lithuanian). Specifically, the reviewer recommended that we exclude these studies as they may cause difficulty for those who want to replicate our study. Ultimately, we decided to keep these non-English studies in our analysis for three reasons. First, eliminating them would reduce the statistical power of our meta-analysis to 88 studies. Second, our additional analyses (see the online supplemental material Table S2) showed that although studies published in Polish and Lithuanian yielded significantly lower effect size, r = .14, 95% CI [.10, .18], than studies published in English, r = .24, 95% CI [.21, .27], this effect was caused by the fact that nonverbal tests were more often used in Poland and Lithuania, not by the country itself. When we controlled for the type of the test, the effect of country was no longer significant (p = .44). Hence, we decided to analyze all obtained effects. Finally, we are making available the raw data and R scripts to researchers interested in replicating our analyses, available here: https://osf.io/zhr8v/.

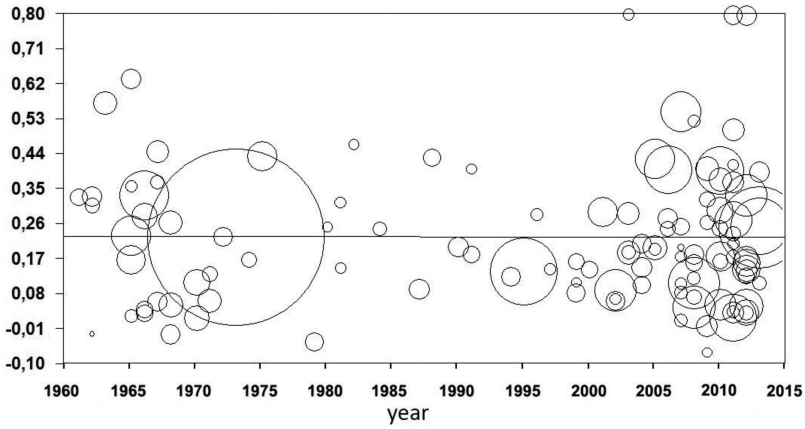

Figure 5. The relations between study year and effect size.

Finally, in an effort to provide a summary of estimated effects of the moderators, we conducted a meta-analysis analog of ANOVA[9] using the estimations obtained at the study level. Results of that analysis are presented in Table 6. As with our previously reported findings, the results of this analysis indicate that the observed effect was stable across time (similar in concurrent decades) but moderated by the type of creative test used. More specifically, verbal tests developed in the Guilford tradition (e.g., unusual uses or consequences tasks; see Guilford, 1967) resulted in more than two times higher correlations ($r = .30$) with academic achievement than did figural (e.g., TCT-DP, see Urban, 1991) tests ($r = .14$). Moreover, the use of standardized academic achievement tests resulted in higher correlations with creativity ($r = .28$) compared to the use of GPA ($r = .19$). In addition, the academic stage of middle school ($r = .33$) resulted in higher correlations between creativity and academic achievement compared to elementary schools ($r = .23$), high schools ($r = .21$), and universities ($r = .17$).

Finally, the results of our ANOVA analog analysis also indicated significant differences in the strength of creativity and academic achievement between continents ($Q = 32.58$, $df = 5$, $p < .001$). This finding, however, suggests that it is an artifact caused by the lack of control for differences in the characteristics of studies. Indeed, as our previous analysis indicates (see the online supplemental material Table S1), when properly controlling for between-country differences in creativity and academic achievement measurement, continent does not significantly influence the obtained the effect size.

Discussion

The goal of this meta-analysis was to clarify the somewhat mixed findings of previous research that has examined the relationship between creativity and academic achievement. More specifically, we endeavored to obtain a stable estimate of the direction and magnitude of the relationship between creativity and academic achievement. In addition, we had the aim of examining the influence of potential moderators on this observed relationship.

What Is the Relationship Between Creativity and Academic Achievement?

With respect to the relationship between creativity and academic achievement, our results indicate that there is a modest but significantly positive association ($r = .22$) in the studies we analyzed. Moreover, our analyses indicate that this relationship was not influenced by publication bias. These findings align with longstanding assertions of scholars who have described creativity and learning as representing interrelated phenomena (e.g., Beghetto, 2016a; Guilford, 1967; Piaget, 1962, 1981; Sawyer, 2012; Vygotsky, 1967/2004). The modest magnitude of this relationship ($r = .22$), however, raises questions as to why the observed association was so low. Indeed, this relationship only explains 5% of the variance in creativity and academic achievement. With so much unaccounted for variance, it is important to consider what factors might be influencing this relationship. The results of our moderator analysis help shed some light on this issue. In the sections that follow, we discuss the results of our moderator analysis and conclude with a brief discussion of strengths, limitations, and future directions for this line of research.

What Is the Influence of Different Types of Measures?

Conceptually speaking, one of the clearest factors that can influence the observed relationship between creativity and academic achievement is how the constructs are measured. Our results indicate that the relationship between creativity and academic achievement was significantly stronger when creativity was measured with tests, $r = .23$, 95% CI [.20, .26]—particularly verbal tests, $r = .30$, 95% CI [.25, .34]—compared to when it was measured using self-report scales, $r = .12$, 95% CI [.07, .17]. That test-based measures would have a stronger influence on the relationship between creativity and academic achievement is not sur-

[9] Although this analytic technique does not control for the associations and shared variance between moderators (and is therefore less robust than previously reported multilevel regression models), it provides results (i.e., effects in terms of averaged correlations), which tend to be easier for readers to interpret.

Table 4
Moderator Analysis: Education Stage

Effects	Estimate	*SE*	95% CI *LL*	95% CI *UL*	*p*
Fixed effects					
Intercept	.17	.04	.08	.25	<.001
Creativity measurement (0 = self-report, 1 = test)	.08	.03	.02	.14	.01
Academic achievement measurement (0 = test, 1 = GPA)	−.03	.02	−.07	.004	.08
Education stage (elementary = reference category)					
Middle school	.12	.05	.02	.21	.015
High school	.004	.04	−.08	.08	.93
College/university	−.04	.04	−.11	.04	.36
Random effects					
Within-study variance	.01	.001	.008	.01	<.001
Between-study variance	.02	.003	.011	.022	<.001

Note. Estimated on 112 studies and 628 correlations. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; GPA = grade point average.

prising. Indeed, as we noted earlier, cognitive characteristics relevant to creative ability, such as the fluency, flexibility, and originality of thinking (Guilford, 1967); imagination (Jankowska & Karwowski, 2015); induction and deduction abilities (Weisberg, 2006); and the use of specific problem-solving strategies play a considerable role in the learning process (Chamot, Dale, O'Malley, & Spanos, 1992; Hmelo-Silver, 2004). As such, our results provide further evidence of the potentially positive role that creativity can play in the acquisition, consolidation, and processing of new knowledge—including school knowledge (Hennessey & Amabile, 1987).

We also found that obtained effect size differed depending on the type of academic achievement measure used. More specifically, when the criterion of achievement was GPA, the effect was significantly weaker, $r = .19$, 95% CI [.16, .22], compared to when achievement was measured using standardized achievement tests, $r = .28$, 95% CI [.22, .34]. This difference may be caused by various factors. It may reflect the lower reliability of school grades compared to standardized achievement tests (Elliott & Strenta, 1988). In a majority of the meta-analyzed studies (especially the early ones), data concerning the reliability of grades were not given, and therefore we were unable to estimate the corrected correlations.

It is also possible, however, that this difference has substantive meaning. One reason why the correlation between creativity and grades was lower than the correlation between creativity and more objective academic achievement tests (Organisation for Economic Co-operation and Development [OECD], 2014) is because the willingness to express one's creativity can be influenced by subtle environmental features of the classroom (Amabile, 1996; Beghetto

Table 5
Moderator Analysis: Figural vs. Verbal Creativity Tests

Effects	Estimate	*SE*	95% CI *LL*	95% CI *UL*	*p*
Fixed effects					
Intercept	−.040	.131	−.296	.216	.76
Year (grand centered)	.001	.001	−.001	.003	.36
Goal (0 = other, 1 = creativity × achievement)	.018	.033	−.048	.083	.59
Published? (0 = no, 1 = yes)	.004	.035	−.064	.073	.90
Academic achievement measurement (0 = test, 1 = GPA)	−.020	.020	−.060	.019	.31
Test type (figural = 0, verbal = 1)	.170	.017	.136	.203	<.001
School subjects (sport = reference category)					
Humanistic	.200	.124	−.043	.443	.11
Science	.189	.124	−.055	.432	.13
Overall	.164	.127	−.084	.413	.20
Creative abilities (other + general = reference)					
Fluency	−.038	.023	−.083	.007	.10
Flexibility	−.024	.025	−.073	.025	.35
Originality	−.029	.024	−.076	.018	.23
Elaboration	.018	.030	−.041	.077	.56
Random effects					
Within-study variance	.009	.001	.007	.011	<.001
Between-study variance	.017	.003	.011	.023	<.001

Note. Estimated on 90 studies and 617 correlations. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; GPA = grade point average.

Table 6
Meta-Analysis Analog of ANOVA: Summary of Moderators

Moderator	*k*	*N*	*r*	95% CI	Heterogeneity (*Q*)[a]
Decade ($Q = 8.83$, $df = 5$, $p = .12$)					
1960–1969	19	5,378	.25***	[.18, .32]	126.91***
1970–1979	8	17,198	.17***	[.09, .26]	46.37***
1980–1989	9	1,121	.20**	[.09, .31]	29.56***
1990–1999	7	3,024	.15***	[.11, .19]	6.25
2000–2009	35	10,239	.20***	[.15, .26]	273.57***
2010–2015	42	21,711	.23***	[.18, .27]	377.42***
Region ($Q = 32.58$, $df = 5$, $p < .001$)					
Africa	2	539	.03	[−.06, .11]	.39
South America	1	141	.16	[−.01, .32]	NA
North America	61	30,299	.22***	[.18, .26]	427.24***
Australia	1	855	.32***	[.26, .38]	NA
Asia	14	3,852	.27***	[.16, .38]	155.63***
Europe	41	22,985	.20***	[.16, .24]	272.55***
Type of creative ability mode ($Q = 26.94$, $df = 2$, $p < .001$)					
Verbal	42	18,929	.30***	[.25, .34]	438.16***
Nonverbal	28	10,451	.14***	[.10, .18]	62.93***
Creativity test ($Q = 10.44$, $df = 3$, $p = .02$)					
Guilford	30	11,125	.26***	[.21, .31]	205.19***
TCT-DP	15	3,929	.18***	[.14, .21]	13.78
TTCT	22	3,746	.20***	[.15, .25]	54.66***
Other	25	16,306	.27***	[.21, .34]	394.70***
Academic achievement measure ($Q = 6.27$, $df = 1$, $p = .01$)					
GPA	73	35,341	.19***	[.16, .22]	412.66***
Achievement tests	31	11,328	.28***	[.22, .34]	322.04***
Education stage ($Q = 16.44$, $df = 3$, $p = .001$)					
Elementary	26	10,906	.23***	[.17, .29]	204.21***
Middle school	15	8,511	.33***	[.27, .39]	204.73***
High school	28	21,559	.21***	[.16, .26]	148.82***
College/university	42	11,602	.17***	[.12, .22]	287.67***

Note. A meta-analysis analog of analysis of variance (ANOVA) was used with a study as a unit of analysis. *k* = the number of studies included in the analysis; *N* = sample size. CI = confidence interval; NA = Not Applicable; TCT-DP = Test of Creative Thinking–Drawing Production; TTCT = Torrance Test of Creative Thinking; GPA = grade point average.
[a] *df* for *Q* statistic is the number of studies (*k*) – 1.
*** $p < .001$.

& Kaufman, 2014; Hennessey, 2010). Teachers who, for instance, prioritize students' ability to meet predetermined task expectations (over originality) when assessing students' work send subtle messages to students that originality is not necessary or perhaps not wanted (Beghetto, 2013). Consequently, students may learn that it is not worth the risk or effort to try to be creative in their responses. It is also possible that teachers may downgrade more original or unexpected responses. Indeed, there is evidence that teachers sometimes hold negative views about student behaviors associated with creativity (Gralewski & Karwowski, 2013, 2016; Karwowski, 2007, 2010; Scott, 1999; Westby & Dawson, 1995). Regardless of the reason, it is important to note that the observed relationship was still positive (albeit, somewhat modest).

Taken together, these findings help illustrate the importance of the types of measures used to assess creativity and academic achievement. Indeed, given the theoretical links between creativity and learning, one might expect a stronger correlation than what we found. With respect to creativity, the most popular measures tend to focus on divergent thinking (i.e., the ability to produce original ideas) and less on convergent thinking (i.e., the ability to meet task constraints) (see Barbot, Besancon, & Lubart, 2015, for an exception). As such, commonly used creativity tests often fail to represent broader conceptions of creativity (Baer, 2014; Cropley, 2006), which include a combination of originality and task constraints (Beghetto, Kaufman, & Baer, 2015; Plucker et al., 2004; Simonton, 2012). Consequently, such measures are a bit too narrow in what they measure. The same can be said for self-assessments of creativity.

Indeed, it may be the case that self-assessments also suffer from a form of "originality bias" (Beghetto, 2010; Runco & Acar, 2010) wherein they emphasize the more divergent aspects of creativity at the expense of the more convergent aspects of creativity. Given that academic measures tend to focus more on convergence (i.e., meeting task constraints, providing expected results), the use of overly narrow measures of creativity may result in systematically suppressed estimates of the observed relationship between creativity and academic achievement. At this point, such assertions are somewhat speculative and therefore warrant attention in future studies. As such, future research should focus on developing and testing measures of creativity that more adequately represent the creative combination of divergent and convergent thinking (see Barbot et al., 2015; Lubart & Besançon, in press). Doing so may help clarify whether there is a stronger empirical relationship between creativity and academic achievement than what is otherwise represented in more traditional measures.

With respect to academic achievement, future studies should also use more precise measures of academic achievement. In the case of GPA, it is frequently effort (Brookhart, 1997), progress (Nitko, 2001), or even the student's adjustment to the teacher's demands (Wortham, 2004) that are evaluated. Moreover, given that creative students sometimes approach learning tasks in unexpected and unorthodox ways (Beghetto, 2013, 2016a; Günçer & Oral, 1993; Karwowski & Jankowska, in press), their GPAs may be negatively influenced by failing to meet behavioral expectations (rather than a reflection of academic ability). Measures of academic achievement that more clearly focus on learning gains (rather than meeting teachers' expectations for obtaining those gains) might provide a more accurate assessment of student learning and thereby more accurately reflect the relationship between student creativity and academic achievement.

What Is the Effect of Education Stage?

Our results indicate that the influence of education stage on the relationship between creativity and academic achievement is similar across most stages, with the exception of middle school (r = .33). Why might this be the case? Classic (Torrance, 1968) and more contemporary (Krampen, 2012) analyses suggest that although there may be declines in creativity development in childhood, there seems to be rather systematic growth in creative ability from puberty onward (Claxton, Pannells, & Rhoads, 2005; Milgram & Hong, 1999). Even though there is some evidence of higher levels of creativity in elementary school students compared to middle school students (Yi, Hu, Plucker, & McWilliams, 2013), middle school students may, on average, experience a boost in creative ability. This assertion has a basis in developmental theory (Feldman, 2003) and in neuropsychology (Barbot & Tinio, 2014). The middle school years are, for instance, thought to be a key developmental period for thinking skills, which are then measured in students' skills assessment programs such as Programme for International Student Assessment (OECD, 2014). Although studies have demonstrated an increase in thinking skills starting in elementary school (Molnár, Greiff, & Csapó, 2013), the most pronounced development of these skills tends to be the middle school years (Csapó, 1997). This is not to say that middle school years are free from declines or creative suppression (Beghetto & Dilley, 2016), but prior work suggests that these years of development may serve as a key time of growth in creative abilities (Barbot, Lubart, & Besancon, 2016; Kleibeuker, De Dreu, & Crone, 2013). Such assertions, however, warrant further empirical exploration.

Our findings also indicate higher correlations in the middle school stage of education compared to high school and universities. This finding has less theoretical and empirical support than the observed difference between elementary and middle school. One possible explanation is that learning becomes increasingly more specialized at higher levels of education. The majority of the studies included in our meta-analysis used general rather than discipline-specific measures of creative potential, which tend to have lower levels of predictive validity when explaining more specialized academic achievement (see Baer, 2014, in press). The fact that we did not observe differences in the strength of the relationship between various dimensions of school functioning may also be an indication that domain-general measures of creative ability—which tended to be operationalized as a form of divergent thinking (i.e., fluency, flexibility, elaboration, and originality of thinking)—were not sensitive enough to provide differential estimations of academic achievement across disciplines.

Once again, these findings point to the importance of the sensitivity and scope of the measures used to assess creativity and academic achievement. Indeed, both creativity and learning researchers tend to be in agreement that creativity and learning are domain specific (Alexander, 1995; Baer, 2014, in press; Beghetto et al., 2015; Poitras & Lajoie, 2013). Future research should therefore use domain-specific measures to examine whether such measures influence the observed relationship between creativity and learning and whether there are potentially important differences across domains.

What Is the Influence of Time and Place?

Finally, we examined the potential influence of time (i.e., when the study was conducted) and place (i.e., what country or continent the study was conducted). Our findings indicate that the relationship between creativity and academic achievement was stable across time and place. This finding differs from the results of previous research, which have suggested that creativity may be declining over time (Kim, 2011) and that creativity is often conceptualized and experienced differently across cultures (Kaufman & Sternberg, 2006).

When interpreting these findings, it is important to point out that the analyses conducted here and in related studies (e.g., Kim, 2005) are cross-sectional. Without longitudinal data, it is difficult (if not impossible) to make any definitive claims about the relationship between creativity and academic achievement across time. Moreover, the studies we analyzed did not have the goal of providing direct comparisons across cultures, and as such, cultural differences that may influence creativity and academic achievement may not have been adequately assessed or represented in the studies we analyzed. Consequently, strong claims about the influence of time and culture are not appropriate until additional research is conducted, which focuses specifically on addressing the impact of time (measured longitudinally) and the impact of culture (using more direct cross-cultural comparisons). Our findings, however, do provide a starting point for researchers to examine whether and under what conditions the positive relationship between creativity and academic achievement is stable across time and place.

Strengths and Limitations of the Present Study

Strengths

A strong point of our meta-analysis is that it serves as the first study to provide a stable estimate of the relationship between creativity and academic achievement. Consequently, this study contributes much-needed clarification on this relationship. Another key strength is the scope of the study. More specifically, our results cover a wide range of temporal (1962–2015), territorial (studies from all over the world), and numerical (120 independent studies, 782 effects, and the total joint sample exceeding 52,000 participants) factors. In fact, this study represents one of the largest meta-analyses in the creativity literature to date. We also consider the analytic models applied (multilevel meta-analysis) to be an

advantage. Indeed, multilevel models enabled us to provide more robust estimations of the observed effects and the effects of key moderators.

Limitations

A disadvantage of this meta-analysis was the limited number of moderators we were able to include. There are several moderating factors (e.g., instructional approach, curriculum used, contextual influences of schools and classrooms, and measures of various individual differences, such as student and teacher beliefs) that may have shed additional light on factors that influence the relationship between creativity and academic achievement. Additional studies are therefore needed that take into account these additional individual and sociocultural factors.

The unavailability of relevant data at the level of individual studies was also a limitation (e.g., the reliability of academic achievement measures). The lack of these data prevented us from being able to make corrections to the obtained effects. Future researchers (and journal reviewers) are therefore well advised to report (and require the reporting of) relevant psychometric data on all measures so that such corrections can be made.

Perhaps the most severe limitation of this synthesis was our inability to properly control for a number of mediators and confounding variables at the level of individual studies. This is a limitation that plagues meta-analytic studies more generally. One way to help address this issue is for researchers to ensure that their studies include as many theoretically important predictors of academic achievement in one study as possible. In the case of creativity, this would include factors such as intelligence and personality (Chamorro-Premuzic & Furnham, 2008; Day, Hanson, Maltby, Proctor, & Wood, 2010), thinking styles (Zhang, 2004, 2010, 2012; Zhang & Sternberg, 2005), motivational factors (Bandura, 1997; Hill & Amabile, 1993; Karwowski, 2011, 2012, 2014; Kaufman & Beghetto, 2013), and contextual factors (Beghetto & Kaufman, 2014; Schacter, Thum, & Zifkin, 2006).

As already mentioned, longitudinal studies, using more precise measures, are particularly needed. Longitudinal studies, although costly in terms of time and resources, would pay out in the form of being able to provide needed insights into how creativity and academic achievement grow and develop over time. Such studies would also enable researchers to empirically test various proposed theoretical links between creativity and academic achievement (Beghetto, 2016a), including whether the relationship is best thought of as unidirectional (e.g., creativity → academic achievement; academic achievement → creativity) or reciprocal (e.g., creativity ←→ academic achievement).

A final limitation we feel important to highlight pertains to the possibility of a nonlinear relationship between creativity and academic achievement. Such a relationship cannot be fully captured in the types of data (correlation coefficients) and analyses used in this study. A nonlinear pattern should therefore not be ruled out. Indeed, there is evidence that such patterns exist between creativity and related constructs, such as creativity and intelligence (see Jauk, Benedek, Dunst, & Neubauer, 2013; Karwowski & Gralewski, 2013).[10] Consequently, subsequent work should explore possible nonlinear patterns in the relationship between creativity and academic achievement using analytic techniques such as segmented regression (Jauk et al., 2013) or a "necessary condition analysis" (Dul, 2016).

Concluding Thoughts

For more than six decades, the question of whether creativity and academic achievement are related has been a focus of theoretical and empirical work in educational psychology. This question has proven to be a thorny one, complicated by various types of measures and potentially intervening factors. Not surprisingly, the results of previous research have run the gamut from positively related, unrelated, and even negatively related. The upshot of a decade's worth of research on this question is that it provided numerous effects that we were able to analyze using robust meta-analytic techniques and thereby take an important step in the direction of addressing the longstanding question of whether creativity and academic achievement are related.

Indeed, prior to this study, the question of whether there is a relationship between creativity and academic achievement could best be answered with the equivocal response of, "It depends." Based on the findings from this meta-analysis, we can now more confidently respond, "Previous research has, on average, demonstrated a positive (albeit modest) relationship between creativity and academic achievement, which is significantly moderated by the types of measures used to assess creativity and academic achievement." This, of course, does not mean that the question is now closed. Rather, the results of the present study provide researchers with a baseline correlation that they can use in subsequent research for comparison and further exploration.

The next logical step is to continue to design studies that examine the stability of this estimate and more carefully examine what additional factors might influence this relationship. We have already pointed to several needed directions for future study. One of the most important future directions pertains to developing and examining the influence of more precise measures of creativity and academic achievement. Such work, however, is not purely empirical. Complementary theoretical work is also needed to help specify how and to what extent creativity and academic achievement are related phenomena. Educational psychologists can play a key role in this endeavor by working alongside creativity researchers to develop more detailed theoretical models that help specify the relationship between creativity and academic achievement and also help develop more sensitive measures that can test and further clarify these asserted relationships. Doing so will provide addi-

[10] The nonlinear relationship between creativity and cognitive abilities, such as intelligence, has been asserted by some of the earliest theorists (e.g., Guilford, 1967). Some theorists have posited a so-called threshold hypothesis (see Jauk et al., 2013; Karwowski & Gralewski, 2013; Preckel, Holling, & Wiese, 2006). This hypothesis asserts a positive relationship between creativity and intelligence only in the groups of individuals whose intelligence level is below an IQ of 120, whereas above this threshold, the correlation is expected to disappear or weaken significantly (Guilford, 1967). Consequently, the threshold hypothesis does not assume linear association but rather a curvilinear inverted J-shaped relationship between intelligence and creativity. Similar thresholds may exist in the relationship between creativity and academic achievement, such as high levels of academic achievement suppressing creativity (see Simonton, in press) or, conversely, high levels of creativity negatively influencing academic achievement (Kim, 2008). We thank an anonymous reviewer for highlighting this possibility.

tional insights into the longstanding question of how creativity and academic achievement are related.

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Received September 11, 2015
Revision received April 4, 2016
Accepted April 13, 2016 ■