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The Mothers and Fathers of Invention: A Meta-Analysis of Gender Differences in Creativity

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THE MOTHERS AND FATHERS OF INVENTION:

A META-ANALYSIS OF GENDER DIFFERENCES IN CREATIVITY

By

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Look, I don't know what's hidden within you. I have no way of knowing such a thing. You yourself may barely know, although I suspect you've caught glimpses. I don't know your capacities, your aspirations, your longings, your secret talents. But surely something wonderful is sheltered inside you. I say this with all confidence, because I happen to believe we are all walking repositories of buried treasure. I believe this is one of the oldest and most generous tricks the universe plays on us human beings, both for its own amusement and for ours: The universe buries strange jewels deep within us all, and then stands back to see if we can find them.

The hunt to uncover those jewels—*that's creative living* [emphasis added].

The courage to go on that hunt in the first place—that's what separates a mundane existence from a more enchanted one.

Elizabeth Gilbert, *Big Magic*
(2015)

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ABSTRACT

Relative to males, females have historically been underrepresented among recognized creators, inventors, and innovators. Despite vast strides toward female empowerment and gender equality in various social, political, and employment arenas, a trend of gender imbalance in many creative endeavors has persisted into the present day. Although real-world and anecdotal evidence present a clear disparity, the actual empirical literature regarding gender and creative capabilities presents a more muddled picture about gender differences. Some studies have suggested female superiority; some suggest male superiority; some suggest gender equality; and still others suggest that either gender can excel creatively depending on various measurement and contextual factors. The purpose of the current study was 1) to systematically investigate the accumulated evidence on gender differences in creativity and 2) to explore the conceptual factors and potential moderators that may account for past discrepancies in the literature. Specifically, a meta-analysis was conducted to address the question of whether females and males tend to differ in mean level of creativity across the empirical literature and also whether a variety of moderating variables (i.e., creativity construct, domain specificity of measure, measure format, sample age, study era) affect the relationship between creativity and gender.

In order to collect a pool of primary studies to address these questions, a systematic literature search was conducted, pulling for studies across the lifespan and throughout historical eras. All studies relating gender to an individual-level, quantitative measure of creative ability or achievement were eligible for inclusion, resulting in a variety of assessment instruments (e.g., divergent thinking performance tests, evaluation of creative products, self-report inventories, other-report inventories). The literature search returned 271 eligible studies, yielding 480 independent effect sizes and a total *N* of 137,247 participants across all studies.

Analyses showed a significant relationship between creativity and gender overall ($\bar{g} =$ .056, $p < .05$), such that females showed slightly higher creativity than males across all studies. Creativity construct and age were found to be marginally significant in moderating the association between gender and creativity, and creativity test format was significant at $p < .05$ as a moderator. However, in a multiple regression combining the predictive power of these three variables, age was no longer found to be a significant moderator. Domain specificity and study era were also not found to be significant moderators. Results of the study were discussed in terms of the strengths and limitations of the design, suggestions for future research, and practical implications for males and females in pursuing their creative passions.

CHAPTER 1

INTRODUCTION

Of the many controversies in modern psychology, the importance of creativity for human survival and actualization does not seem to be one of them. Few would disagree that creative thinking is a ubiquitous necessity in all levels of cognitive pursuit—from a teenager trying to deal with being locked out of his car to a music composer considering how best to convey the thematic elements in her symphony-in-progress. Though the whiplash speed of technological advancements may have some believing we have it all figured out, creativity has not suddenly become optional. "[I]n the creative age, memorization of facts and procedures is not enough for success" (Sawyer, 2010, p. 176). Industrialization and automatization have made many erstwhile human vocations obsolete, and creativity is rising as a last unique use of people in the workplace (Guilford, 1950).

Problem Statement

At a time of nearly universal consensus over the increasing importance of innovative thought, it is perhaps ironic that human creativity may (or may not) be on the decline. Recent creativity test score evidence has engendered debate that a "creativity crisis" may be burgeoning among the current cohort of children in the United States (Kim, 2011). It is likely premature to have a call to arms over such preliminary evidence, but there are other ways we could conceptualize a creativity crisis based on the broader creativity literature. Who is most affected if we are in crisis? A quick literature search reveals that a different, very large population may be in a state of creativity emergency of their own type, and one that is hardly new. This struggling population—a staggering 50% of all people on the planet—is females, and their crisis is one of creative production. One need to look no further than the titles of the literature in this area to get

a sense of puzzlement over the issue of women and creativity: “Why have there been no great women artists?” asks Nochlin (1971/2005). “Why are there so few [creative women: visual artists, mathematicians, musicians]?” asks Piirto (1991). “Why doesn’t Jane run?” asks Eccles (1985). “Why do women opt out?” ask Good and colleagues (2012). Stated simply, to date, women are responsible for relatively few creative accomplishments across all fields, and the current study seeks to quantitatively synthesize past evidence on creativity and gender to bring clarity to the often contradictory data.

In an effort to illustrate the magnitude of the gender problem, Reis (2001) summarized statistics from a variety of sources highlighting women’s underrepresentation across powerful creative fields. She noted that, in the 21 most prominent orchestras in the U.S., less than 1% of the works performed were written by women, and there were no female conductors. In the 2012-2013 year, this number has risen to one female conductor (Levintova, 2013). Reis (2001) further indicated that in 1978, only two (0.002%) Fortune 1,000 companies had female CEOs. An update of her statistic shows that, as of 2013, only 21 (4.2%) Fortune 500 firms had a female head (Vagianos, 2012). In 2001 (Reis), women held only 10% of U.S. Senate seats; this number was still only 20% as of 2016 (United States Senate, 2016). In 2001, Reis noted that only 22% of mathematics doctorates, 22% of physical science doctorates, and 11% of engineering doctorates went to women. According to the National Science Foundation (2014), these numbers today stand at 28% (math), 32% (physical sciences), and 22% (engineering). As the reader may have noticed, there is good news in the fact that most of these numbers are rising. However, considering that these percentages of women’s representation hypothetically should be 50%, the numbers remain relatively low.

Beyond Reis' analysis, holding up the magnifying glass to nearly any field powered by creative achievement, one finds a similar token status for women. In the 88-year history of the Academy Awards, there has been one award taken home by a woman for directing—Katherine Bigelow in 2009 for *The Hurt Locker* (Academy of Motion Picture Arts and Sciences, 2016). As of 2011, in over a hundred years of awarding Nobel Prizes, only 2% of those recognized in the sciences have been women (Charyton, Elliot, Rahman, Woodard, & DeDios, 2011), and historically, fewer than 1% of famous scientists have been female (Simonton, 1994). The Missing 32% Project reports that, despite equal gender representation in graduate programs, only 18% of licensed architects are female (The Missing 32% Project, n.d.). According to the National Center for Women and Information Technology (2015), only 26% of the IT workforce is female. The Women's National Basketball Association is not only significantly smaller than the men's NBA, but the maximum combined salary of an entire women's team ($878,000) is less than the median salary of a single NBA player ($2,000,000; Woods, 2012). Even in the realm of literature, an area in which females are often reputed to have parity, only 10% of eminent authors have been female (Simonton, 1999). Overall, in the course of recorded history, Simonton (1994) estimates that less than 3% of notable figures have been female. Regardless of the cause of such numerical disparities, each statistic adds to the critical mass of evidence suggesting that women are struggling to be recognized as creators and innovators.

Men, likewise, experience their own creative struggles. Males themselves are a minority in some creative fields and may be actively discouraged from pursuing careers in the arts and humanities (Kerr, Vuyk, & Rea, 2012). It is still not uncommon for a young man to be the token boy at an audition, class, or recital for the School of American Ballet (Goodwin, 2007). Creation—the act of exposing one's unconventional ideas, products, attitudes, and sides of

oneself—can be an intimidating and anxiety-provoking experiences for anyone, regardless of gender (Russ & Fiorelli, 2010). Moreover, men and boys often experience less social acceptance in deviating from gender norms to pursue creative interests than do women, who enjoy more flexibility (Runco, Cramond, & Pagnani, 2010). One imagines that the gender currently carrying the higher expectations for such a vulnerable process with a high chance for rejection (Bandura, 1997) would be experiencing some struggles and pressures of their own, even if the repercussions are more covert. Overall then, innovation and creation, while crucial to societal advancement, seem to involve challenges and pitfalls for both women and men.

Summary of the Literature

In turning to review the psychological literature on creativity and gender, we learn that creativity is typically defined as the formation of products and ideas that are original and useful (Sternberg & Lubart, 1999). Subcomponents of the construct include creative ability (potential) and creative achievement (activities, ideas, products, etc.) (Ivcevic, 2009; Jauk, Benedek, & Neubauer, 2014). While there is often variation in the literature in terms of what constitutes creativity, gender is usually defined narrowly as a female-male dichotomy. Regardless of conceptual shortcomings, explicit definitions of both creativity and gender were important to the current study for setting limits on what subset of studies were of interest.

Beyond basic definitions, more in-depth creativity theories take on many forms: person theories, process theories, product theories, place theories, or comprehensive theories (Kaufman, 2009). These focus on individual differences, creative methods, creative outputs, environmental variables, or a combination of these other elements, respectively. Theories may also be divided into those involving creative abilities (often aligning with person theories) and those focusing on creative achievement (aligning with product theories) (Eysenck; 1993). Person and product

theories were most relevant to the current study given that personal qualities, differing levels of creative production, and disparities between ability and achievement are often implicated in explaining observed gender differences in creativity. However, all types of theories provide potential explanatory power for any observed gender differences. For instance, women may tend to utilize a different creative process or encounter different environmental (place) pressures than men do, which may account for their unique patterns of creative expression. Thus, all four types of theories were vital to framing the current study.

Creativity is typically operationalized and assessed via divergent thinking performance tests, expert evaluation of products, self-report, or other-report. Other tests also indirectly assess creativity through measures of attitudes, interests, or personality (Hocevar, 1981). Almost all creativity measures have evidence both for and against their psychometric soundness (Pfeiffer, 2015; Plucker & Makel, 2010). In general, the Consensual Assessment Technique (CAT) may receive the least criticism and DT tests the most, with newer self- and other-report measures falling in between. Such measurement issues are relevant to the current study because different types of assessments may lead to different conclusions (Ai, 1999; Bender, Nibbelink, Towner-Thyrum, & Vredenburg, 2013) regarding creativity and gender. Overall, review of the creativity measurement literature led to the following implications for the current study: 1) diverse creativity measures were included to be representative of a diverse literature; 2) indirect measures of creativity (e.g., personality) were not included because they do not explicitly represent the creativity construct; and 3) measurement variables were included as covariates in analyses exploring creativity and gender.

In turning to the actual empirical investigations of men and women and creativity, past reviews of the subject suggest several possible conclusions (Baer and Kaufman, 2008; Kogan,

1974; Rejskind, Rapagna, & Gold, 1992; Runco, Cramond, et al., 2010). Males are sometimes reported to have greater creativity, and females are sometimes reported to be more creative. Still other studies find no advantage for either males or females. General patterns in the evidence favor the interpretation that gender differences may vary based on the type of creativity construct under discussion: the majority of studies suggest that the genders do not differ in creative ability, but females are underrepresented in creative accomplishment relative to males. Actual empirical work on creative achievement shows a mix of support for interpretations that males do, in fact, exceed females in achievement or that neither gender exceeds the other. Systematic, quantitative review of the available studies seemed warranted to substantiate evidence regarding creative ability and clarify evidence on creative achievement.

Given the incongruity in findings across different studies, it was also important to examine logistical factors varying amongst investigations that may give rise to the different outcomes. For instance, as mentioned above, creativity is measured in a plurality of ways (Kaufman, Plucker, & Russell, 2012). Some evidence suggests that gender differences vary depending on certain characteristics of measures, such as their domain specificity or their format. Evidence suggests that females may exceed males on measures of verbal creative domains, and males may exceed females in nonverbal domains (Abra & Valentine-French, 1991; Maccoby & Jacklin, 1974). Whereas DT tests tend to show no gender gaps in creative ability (Baer & Kaufman, 2008), self-reports in particular tend to show a male advantage (e.g., Mathisen, 2011). Another explanation for mixed findings may be a developmental one. Several scholars (Baer & Kaufman, 2008; Piirto, 1991) suggest that children do not initially differ by gender in terms of creativity, but that they certainly seem to by adulthood. It is possible that an insidious developmental process may be at work in the lives of females as they age. Finally, a variety of

scholars and empirical works over the past several decades have suggested that gender differences in cognitive variables have been decreasing over time, likely due to cultural changes (Hyde & Linn, 1988; Runco, Cramond, et al., 2010). As such, it was important to track study publication date in reviewing associations between creativity and gender. Overall, given that each of these study elements—domain specificity, creativity measure, sample age, and era of study publication—had the potential to systematically alter results, they were considered sub-variables of interest in the current study.

In order to synthesize and make sense of each of the above discussed patterns (or lack thereof) in the creativity literature, a meta-analysis was conducted. In the past, relatively few meta-analyses have focused on creativity, and no analysis has treated the subject of creative gender differences in-depth (Baer, 2012). Several scholars have conducted narrative reviews (Baer & Kaufman, 2008; Kogan, 1974; 1976; a dissertation reported in Rejskind et al., 1992; Runco, Cramond, et al., 2010), employing "vote-counting" to draw conclusions (Card, 2012). Another researcher did include gender as a cursory variable in much larger creativity meta-analysis (Ma, 2009), but the study evidenced methodological concerns and a lack of focus on the gender variable per se. In general, a thorough meta-analysis of creativity and gender was beneficial in several ways: it allowed for a more systematic literature search, a greater emphasis on the magnitude of any gender gap over its mere existence, the analysis of moderators, a larger overall sample size to minimize sampling error (Card, 2012), and for firmer conclusions to be drawn (Chan & Arvey, 2012).

The Current Study

In light of the above reviewed evidence, the purpose of the current study was 1) to systematically investigate the accumulated evidence on gender differences in creativity and 2) to

explore the conceptual factors and potential moderators that may account for past discrepancies in the literature. To this end, the following research questions were proposed:

1) Question 1: Do females and males tend to differ in overall creativity?
2) Question 2: Does the relationship between creativity and gender change when creative ability and creative achievement are considered separately?
3) Question 3: Does the relationship between creativity and gender change when domain general and domain specific measures are considered separately?
4) Question 4: Does the relationship between creativity and gender change depending on the format of the creativity measure?
5) Question 5: Do associations between gender and creativity depend on a person's age?
6) Question 6: Have associations between gender and creativity changed over time according to study era (i.e., do associations vary by study publication date)?

Social Significance

In an American economy driven by the marketability of innovation and entrepreneurship, women often wrestle unsuccessfully to find a niche. Many women are working in low-paying, part-time jobs (Reis, 2001), still earning only 77 cents per each dollar that men earn (National Women's Law Center, 2012). Women over age 60, as a demographic, constitute the largest single poverty group in the country (Reis, 2001). As Eccles (1985) described, getting married is no longer tantamount to financial security for women, so they need to look to cultivate their own agency and talents to thrive in a society more and more sustained by creative activity.

Without women's full participation, society—men included— may suffer both financially and culturally. One of the key components to creativity is diversity. Multicultural experiences (i.e., exposure to a different racial, ethnic, gender, or sexual orientation group) have been

routinely found to increase individuals' and groups' creativity (Díaz-García, González-Moreno, & Sáez-Martínez, 2013; Leung & Chiu, 2010; Leung, Maddux, Galinsky, & Chiu, 2006; K. W. Phillips, 2014). Alternatively, a lack of diversity can be expensive. In their study of the 1,500 S&P companies, Dezsö and Ross (2012) found that employing females in upper management added $42 million in "firm value." Such gains were particularly attributed to females' capacity for innovation. In other words, those companies without women in creative leadership rolls seemed to be experiencing a diversity penalty of millions of dollars in lost profits. Beyond the strictly monetary, Leung and colleagues suggest that civilizations progress creatively only when they become involved in an exchange of ideas with "outside influences" (2006, p. 173). The longer we allow creative fields to remain homogenous in gender composition, the longer we fail to fully mine our most renewable resource: creativity. Thus, discerning the true magnitude of gender disparities in creative ability and creative achievement is a matter for urgent study. The more intricate an understanding we have of the problem, the better equipped we will be to correct it.

The current study addresses such serious social issues in a meaningful way. Its focus on summarizing a complex and conflicting literature may help bring clearer answers to pressing questions regarding gender and innovation. Estimating the presence and magnitude of overall gender differences helps us to determine how best to treat gender issues in further creativity research. Discerning whether gender differences are stronger in creative ability or achievement helps us understand how best to intervene (i.e., helping girls better develop basic creative skills or simply encouraging their creative productivity). Detecting any differential gender gaps based on the types of measures used (e.g., domain-general vs. domain-specific, DT tests vs. teacher reports) better enables us to design valid and unbiased creativity assessment batteries for use in

research and practice settings. Pinpointing any timeframes in development where creative discrepancies tend to appear between girls and boys helps us learn about critical periods for intervention. Finally, finding whether gender disparities have increased or decreased over time, historically, informs our thinking about gender gaps as either a thing of the past or a point of intervention in the present to ensure equal access to creation and innovation opportunities. Zooming in on these types of issues, one by one, has the potential to direct the attention of researchers, clinicians, teachers, parents, and even creators themselves toward improving the often invisible gender politics of the creative process.

CHAPTER 2

LITERATURE REVIEW

In order to establish a common language for discussion, this chapter will begin with working definitions of constructs and concepts to be used in the study: creativity, creative ability, creative achievement, and gender. Creativity theory and measurement will next be summarized to provide a basic foundation in the literature. Following the foundational material, empirical studies on gender differences in creativity will be narratively reviewed, with an emphasis on highlighting the discrepancies between previous studies in order to justify the need for quantitative review in the current study. Given the disagreements in previous literature, studies regarding the specific creativity construct (e.g., ability vs. achievement) will be presented in detail, as a main moderator of interest. Literature relevant to other factors that may influence gender differences in creativity—including measure domain specificity, measure format, age of the sample, and era of the study—will also be explored, suggesting other potential moderators. Finally, the current study, research questions, and hypotheses will be reiterated in the context of all literature reviewed.

Definitions

Creativity. Relative to some aspects of psychology, the formal study of creativity is new and has proved to be a complex endeavor, so scholars are still in the process of defining what creativity looks like and what it means to be creative. One handy, parsimonious description of the creativity construct is provided by Sternberg and Lubart (1999, p. 3): “Creativity is the ability to produce work that is both novel (i.e., original, unexpected) and appropriate (i.e., useful, adaptive concerning task constraints)." According to a meta-analysis of the variables most central to creativity, Ma (2009) created an empirically-based definition: “the ability to reorganize

the available knowledge, information, cues, facts and/or skills in a person's reservoir to generate new ideas or useful solutions" (p.39). Generally, the juxtaposition of the novelty and usefulness of ideas is common to most current definitions. Like most important psychology constructs, creativity has been re-named and re-imagined multiple times and may fall under many currently used terms in the literature: "imagination, ingenuity, innovation, inspiration, inventiveness, muse, novelty, originality, serendipity, talent, unique[ness]" (Plucker & Makel, 2010, p. 48), "divergent thinking," "flexible thinking," "remote associations," "insight," (Baas, De Dreu, & Nijstad, 2008), and "ideational fluency" (Chan, Cheung, Lau, Wu, Kwong, & Li, 2001). For a comprehensive review of creativity definitions and terminology, see Kaufman (2009) or Piirto (2004).

Creative ability. Creative ability is an individual's capacity or aptitude for originality. As defined by Jauk and colleagues, it is "an individual's cognitive ability to generate something novel and useful" (2014; p. 95). Other synonymous terms in the literature have included "originality" (Eysenck, 1993), "creative potential" (Ivcevic, 2009; Jauk et al., 2014; Runco, Cramond, et al., 2010), "creative competency" (Epstein & Phan, 2012), and "creative thinking" (Milgram & Hong, 1993; Hong & Milgram, 2010). Eysenck (1993) described creative ability as an individual differences trait, similar to general cognitive ability, or *g*, in theories of intelligence (Kaufman, 2012). However, creativity is seen as distinct from intelligence or general cognitive ability (Eysenck, 1993; Sternberg, 2003). Whereas *g* is thought to be the central, innate quality of a person from which intelligent behavior arises, creative ability is the central innate quality of a person from which creative behavior arises. Nevertheless, as with intelligence, a variety of detrimental factors may intervene to inhibit creative activity, regardless of true ability. Thus, one

cannot assume creative abilities (potential) and creative achievements (products) will always be congruent.

Creative achievement. According to Eysenck (1993), "it is possible to be original (i.e., to present unusual solutions, associations, etc.) without being creative in the achievement sense" (p. 153). Ivcevic (2009) defines creative achievement (behavior) as "observable behavior, communicated ideas, or products that result from the interaction between individual potential and situational or cultural influences" (p. 17). Simonton (1994) gives examples of the contributions of eminent creators: "decisions, treaties, elections, revolutions, battles, conquests, reforms, laws, theories, discoveries, inventions, systems, monographs, novels, poems, plays, paintings, designs, compositions, products, songs, movies, shows, competitions, championships, trophies…" (p. 181). Beyond single products, Carson and colleagues (2005) go a step further in defining creative *achievement* as "the sum of creative products generated by an individual in the course of his or her lifetime" (p. 37). However, this conception is somewhat rare in the actual literature and is certainly a challenge to measure; thus, a less comprehensive definition of creative achievement was used in the current study, ranging from a single product to more cumulative reports of achievement. In the literature, other like terms to creative achievement include "real-life creativity" (Jauk et al., 2014; Kim, 2008), "creative accomplishment" (Jauk et al., 2014; Kim, 2008; Milgram & Hong, 1993), "creative productivity" (Baer & Kaufman, 2008), "creative activity" (Jauk et al., 2014; Kim, 2008), "creative behavior" (Ivcevic, 2009); "creative expression" (Epstein & Phan, 2012), and "creative performance" (Milgram & Hong, 1993; Pretz & McCollum, 2014; Runco, Cramond, et al., 2010).

Gender. *Gender* typically refers to the socially constructed "behavioral, social, and psychological characteristics of men and women" (Pryzgoda & Chrisler, 2000, p. 554). It is often

contrasted with *sex*, which alludes more concretely to the primary and secondary biological characteristics that separate males and females. However, as Pryzgoda and Chrisler (2000) note, these two terms have often (incorrectly) been used interchangeably in the psychological literature. As a result, despite the focus of the current study being on gender, research on both "gender differences" and "sex differences" was addressed.

Notably, the majority of the creativity literature considers gender as a dichotomous construct, mostly self-reported through demographic questionnaires. While those of variant gender orientations (e.g., transgender, bigender, gender neutral, androgyne, third gender, pan-gendered, gender queer; Bockting, 2008) may be present in such research samples, they may be forced to categorize themselves according to study parameters, and the full gender diversity of the population may not be truly represented. Interestingly, some evidence suggests that those who identify their gender more fluidly (i.e., androgynously) may be more creative than those who conform to typical gender roles and definitions (Norlander, Erixon, & Archer, 2000). Nevertheless, the current study considered gender as a binary (i.e., male-female) construct to best accommodate the precedent set in the majority of the past literature and maintain a clear operational definition of the gender variable.

Implications for the current study. In this section, creativity has been defined as generating products and ideas that are novel and purposeful. Additionally, global creativity can be parsed into sub-constructs, such as creative ability (the potential to be creative) and creative achievement (actualized ideas and products). Even those who provide definitions of creativity and its different constructs admit that these are nebulous concepts with multiple meanings and mysteries (Kaufman, 2009; Pfeiffer, 2013; Piirto, 2004), and some suggest that the research on creativity, gender, and achievement could head in a more productive direction with a better

working definition of creativity itself (Reis, 1991). The same is likely true of providing a more modern, fluid working definition (and categorization scheme) of gender. Although it is not within the scope of the current study to critique or refine past definitions, it is important to keep in mind the various definitions and sub-constructs underlying "creativity" and "gender" when dealing with such a literature. Researchers purporting to study these variables may mean different things depending on their own operational definitions, and many studies may examine constructs of interest in the current analysis but call them things other than creativity, creative ability, creative achievement, or gender. Also, as Plucker and Makel (2010) remark, many researchers in the creativity field fail to provide precise definitions of the concepts under study at all. Thus, in the current review and analysis, the researcher adhered strictly to pre-determined definitions of the different constructs in gathering a focused set of studies to examine.

Creativity Theory

Within the creativity realm, scholars (e.g., Kaufman, 2009) have tended to distinguish among four different classifications of creativity theory: those concerning the creative person, creative process, creative product, and creative press or environment. As Pfeiffer (2013) points out, in reality, these four categories overlap and support one another a great deal. However, the current paper will use this convenient category system to get a snapshot of general creativity theory—largely drawing on Kaufman's (2009) review. This review of theory is not intended to be all-inclusive, but it should provide a thorough enough overview to facilitate interpretation of the results and to place the eventual findings into a theoretical framework. In addition, such theories tend to imply different factors or mechanisms that may precipitate gender differences. These potential mechanisms will also be reviewed briefly below.

Process theories of creativity emphasize the ingredients, steps, and experiential qualities of creativity. For instance, Wallas' cognitive creative process theory includes five stages following the life cycle of an idea: preparation, incubation, intimation (the anticipation of a breakthrough), illumination (breakthrough), and verification (confirming the idea) (Kaufman, 2009). Other examples of process theories include Csikszentmihalyi's Flow theory, Rubenson and Runco's cost-benefit analysis of creativity, and Rothenburg's ideas about homospatial and Janusian thinking. Thus, one explanation for gender differences in creativity may be that males and females tend to utilize different creative processes, resulting in different outcomes. For instance, independence and the solitary incubation of ideas is often described as part of the traditional creative process (Kaufman, 2009; Piirto, 2010), but most agree that females find social relationships very important, perhaps more so than males do (Reis, 2002a). Hence, women and girls may more often prioritize relationships (sometimes at the expense of their creative work; Eccles 1985; Reis, 2001) or include others in their creative work (sometimes at the expense of getting full credit for their ideas; Charyton et al., 2011; O'Shea, Heilbronner, & Reis, 2010). Such variations in creative process may help account for gender differences in accomplishments.

Place theories of creativity, on the other hand, involve more focus on the environmental factors helping or hindering creativity than the process itself. A review of the literature reveals no popular formal theories of creative environments alone. However, Kaufman (2009) mentions the work of Teresa Amabile and colleagues, who describe factors conducive to creativity in the workplace (e.g., freedom, resources, diverse peers, recognition, cooperation, goal-directed conflict, being challenged, mentorship, institutional support) and those detrimental to creativity (e.g., time pressure, excessive evaluation, emphasis on status quo, organizational politics). Thus,

if females are producing fewer symphonies or scientific theories than males, one has to wonder whether females and males experience different environmental contingencies leading them down different paths. Several researchers suggest that boys are socialized along a track toward independence and achievement and girls toward interdependence and nurturing (Baron-Cohen, 2003; Simonton, 1994) based on the types of play, punishment, and even toys parents engage their children with (Baron-Cohen, 2003; Eccles, 2011; Lee, 2002; Reis, 2001). Likewise, throughout development, females generally find fewer female role models and more barriers imposed by male gatekeepers in creative fields (Abra & Valentine-French, 1991). Such environmental pressures and disadvantages may render a life of adventure and innovation a less attractive pathway for females than for males.

Person theories of creativity highlight the characteristics of individuals considered to be creative. Kaufman (2009) discusses one example, Amabile's (1983; Amabile & Pillemer, 2012) componential model of creativity, which proposes that four personal qualities give rise to creativity: domain-relevant skills (e.g., basic math knowledge), creativity-relevant skills (e.g., risk-taking), task motivation (intrinsic and extrinsic), and more recently, affective state. Sternberg's investment theory of creativity—urging innovators to "buy low" and "sell high" in terms of developing their ideas—enumerates a similar list of creator attributes: intellectual ability, knowledge, novel thinking style, personality (e.g., self-efficacy, risk-taking, overcoming, unconventionality), and motivation (Sternberg & Lubart, 1999). Kaufman (2009) also describes Joseph Renzulli's three-ring conception of giftedness, uniting the three components of high intellectual ability, creativity, and task commitment as the recipe for the successful use of talent. Within his conception of creativity, Renzulli incorporates such personal qualities as divergent thinking, openness to experiences, curiosity, risk-taking, and aesthetic sensitivity.

Overall then, person theories usually incorporate some combination of general creative skill and talent, domain-specific skills and knowledge, motivation, and personality. Person theories are helpful in understanding ideas about creative ability (versus creative achievement), and they are also helpful in understanding interpretations of gender and creativity based on individual (or group) differences. For instance, there is evidence that differences between the average personal qualities of men and women—males' greater self-efficacy, higher penchant for risk-taking, higher need for achievement, and better response to evaluation/competition (Amabile, 1982a; Baer, 1998b; Browne, 2006; Eccles, 2011; Reis, 2002a)—make the act of creation more tractable for them than for females. As such, any gender differences in creativity may be at least partially explained by some of the personality features, habits, and preferences of the genders.

Creative achievement is best explained in the context of product theories. Product theories of creativity place the spotlight on creative output (e.g., a painting, a poem, a scientific theory, a business plan; Kaufman, 2009). Such output is typically categorized either as "everyday" creativity or "eminent" creativity (Carson, Peterson, & Higgins, 2005; Jauk et al., 2014; Pretz & McCollum. 2014; von Stumm, Chung, & Furnham, 2011). As an elaboration of this distinction, the Four-C model of creative potential (Kaufman & Beghetto, 2009) delineates different levels of creative accomplishment, including Mini-c (new personal insight), Little-c (everyday creative ideas and products), Pro-C (professional-level creative inputs), and Big-C (eminent, paradigm-altering contributions). Likewise, Kaufman (2009) highlights Sternberg's Propulsion Theory of eight levels of creative contribution, ranging from replication (e.g., a sequel) to advance forward incrementation (pushing one's creative work ahead of its time). Finally, focusing more on the evaluation of creative products, Csikszentmihalyi's Systems

Model (as described by Kaufman, 2009) involves the interaction between a domain's gatekeeper and a creative person in determining the success of creative products.

Product theories offer one final potential milieu for explaining gender disparities. There is some evidence that females may place less emphasis on creative products and derive more enjoyment from the process of creativity alone; for males, the opposite appears to be true (Piirto, 1991; Torrance, 1963). Thus, interpretations such as, "men may strive more for Big-C achievement than do women," or "women produce privately for their own enjoyment more so than for the evaluation or recognition of gatekeepers," may help us to place findings of gender differences into context.

Finally, a growing group of theories attempts to be comprehensive in integrating multiple of the previously discussed elements—process, press, person, and/or product. One excellent example is Piirto's (2010) formidable Theory of Creative Processes, which is a 360° look at the creative person, process, and environment. Piirto names five core attitudes of the creator: naïveté, self-discipline, risk-taking, trust of others, and tolerance for ambiguity. She envisions "seven I's" (of the creative process): inspiration, imagery, imagination, intuition, insight, incubation, and improvisation. She also describes some other general aspects of the creative process (and environment): a need for solitude, creativity rituals, meditation, cultural lenses of creativity, and creativity as an ongoing life process. Regrettably, it is not within the scope of this review to go in-depth with examples of this rich theory or other comprehensive theories, but this last set of theories is important in that they most fully convey the scope of creativity as a complex, multifarious, and global construct.

There are many different ways to parse creativity, such as Guilford's creativity components (i.e., fluency, flexibility, originality, and elaboration; Guilford, 1975), creative

ability versus creative achievement (Eysenck, 1993), or creativity broken down into different domains (Baer & Kaufman, 2005). However, seminal creativity theorists, as well as modern studies, have employed general creativity as a useful construct (Plucker, 1998). Thus, it is useful to retain the global concept, as well as exploring the newer, more specific theories and constructs, some of which will be reviewed next.

Theories of ability vs. achievement. As mentioned, one way to deconstruct creativity is to draw a distinction between creative ability and creative achievement (Ivcevic, 2009; Runco, Cramond, et al., 2010). Similar to the "four-p's" distinction made above, Eysenck (1993) explains that researchers and theorists discussing "creativity" often use the word to mean two different things: creativity as a trait of creative people (e.g., Newton and Hannibal were "creative") or creativity as various finished products (e.g., Newton's *Principia Mathematica* and Hannibal's Battle of Cannae were "creative"). To differentiate between the two, Eysenck labels trait creativity as "originality" and product creativity as "achievement." He describes originality as a normally distributed trait, measured by early divergent thinking and fluency tests. Creative achievement is evident in products and shows a more skewed distribution (Eysenck, 1993; Silvia, Wigert, Reiter-Palmon, & Kaufman, 2012). Creatively-able people are much more plentiful than creative achievements, with most people creating few (if any) products, and only a select number of eminent creators (e.g., scientists, composers, authors) responsible for the majority of contributions. Others present evidence that everyday creativity is more normally distributed (Richards, Kinney, Benet, & Merzel, 1988), suggesting that possibly only eminent creativity has a more skewed distribution. Regardless, disconnects between originality and achievement can arise due to a variety of intermediary factors (e.g., intelligence, other cognitive qualities, environmental variables, or personality traits) (Eysenck, 1993; Jauk et al., 2014).

Eysenck (1993) hypothesized the correlation between creative ability and achievement to be low. A validation study of several creativity instruments found correlations in the .20s between a divergent thinking test and creative products; however, this study failed to find a significant association between the DT test and a biographical scale of past creative accomplishments (Dollinger, Klaus, & James, 2004). A longitudinal study of divergent thinking in adolescents predicting adult creative accomplishment showed the constructs to correlate at r = .37 (Milgram & Hong, 1993), a low to modest relationship. In 2008, Kim conducted a meta-analysis showing the relationship between DT tests (ability) and achievement to be r = .19, a low relationship. (Notably, she found that the ability-achievement relationship was stronger for males than females.) However, another meta-analysis found an overall medium effect size (0.56) for the relationship of DT tests to later achievement (Ma, 2009). Recent latent class analysis and latent variable modeling suggest that creative ability and creative achievement are largely unrelated (Jauk et al., 2014; von Stumm et al., 2011). Overall then, since past literature seems mixed on whether these two constructs tend to correlate (Kim, 2008; Pretz & McCollum, 2014), it was wise to consider them separately.

Implications for the current study. As explained, there are a diverse variety of general theories attempting to describe and explain creativity. The majority of these conceptions can be sorted into person theories, process theories, product theories, place theories, or comprehensive theories incorporating multiple of these other elements (Kaufman, 2009). Theories and studies may also be separated into those focusing on creative abilities (which tend to overlap with person conceptions) and those focusing on creative achievement (which overlap more with product theories) (Eysenck; 1993). Given that the chief interest of the current study was gender, an individual differences variable, person theories (e.g., Amabile's componential theory) were

crucial to forming hypotheses and interpreting the results. Under such models, personal qualities (e.g., skills, motivation, risk-taking, cognitive qualities) are supposed to differ systematically between females and males and give rise to differences in creativity.

Product theories were also relevant to the current study, not only because creativity is often measured by evaluating creative products (discussed further in "Measurement"), but also because such theories provide systems for discussing different levels of creative accomplishment (e.g., the Four-C model of creative potential; Kaufman & Beghetto, 2009). In terms of product theory, females and males could be supposed to show different amounts, levels, or quality of creative output. Furthermore, product theories give researchers a complementary framework for considering products against potential—important because the gender gap in creativity is often more apparent when looking at products than potential. Although it is conceivable that females and males also differ in terms of their creative processes or the creative environments (places) they encounter, these distinctions are more rarely explored in the empirical literature. However, process and place theories may be equally as important as person and product theories in generating potential explanations for the *why* in the discussion of observed gender trends.

Creativity Measurement

Many studies purport to examine "creativity," but most capture only one or two narrow aspects (e.g., performance on creativity tests, subjective reports of creativity, performance or self-efficacy in a certain domain) and generalize to the larger construct. No known measure individually would be sufficient for capturing global creativity: "[…] any single psychometric test will inevitably fail to adequately operationalize creativity and its true scope" (von Stumm et al., 2011, p. 113). Pfeiffer (2015) recommends the use of at least three psychometrically sound measures in assessing creativity, particularly in high-stakes situations (e.g., gifted program

admissions). Indeed, recent scholarship has begun to reflect such standards, incorporating multiple types of measures in single studies (e.g., Ai, 1999; Bender et al., 2013; Charyton & Snelbecker, 2007; Dollinger et al., 2004; Gralewski & Karwowski, 2013; Jauk et al, 2014; Silvia et al., 2012). Multi-method assessment of this type is likely the way of future best practices in creativity assessment (Plucker & Makel, 2010; Silvia et al., 2012), and it is also most thorough in capturing the full breadth of what we colloquially call "creativity."

That said, practically speaking, the most common ways to measure creativity are individual performance on singular creative performance tests, evaluations of products, self-report inventories, and others' ratings (Baer & Kaufman, 2008). Creativity performance tests typically measure ability; evaluation of products typically measures achievement (Plucker, 1998); and rating scales are available to measure both. Other peripheral lines of inquiry have also looked into assessment of creative attitudes, interests, or personality, but these may be considered indirect correlates of creativity more so than direct measures (Hocevar, 1981). Therefore, the current review and study focused more on performance tests, product evaluations, self-report, and other-report. In the following sections, each type of measure will be reviewed, drawing largely from several very helpful summaries of creativity assessment (Carson et al., 2005; Hocevar, 1981; Kaufman et al., 2012; Pfeiffer, 2015; Plucker & Makel, 2010; Silvia et al., 2012; von Stumm et al., 2011). It should be noted that the current overview was not intended to be exhaustive of all possible measures, but to provide explanations and examples of the types of creativity assessment that were relevant to assessing creativity gender differences.

Measurement of creative ability. Throughout the history of formal creativity research, the most popular way to measure creative ability has been divergent thinking tests (Hocevar, 1981; Plucker & Makel, 2010), and creativity testing may often be considered synonymous with

divergent thinking (DT) tests (Piirto, 2004). Divergent thinking is the capability to provide novel and useful responses to questions or problems (Kaufman et al., 2012). Such tests tend to focus on fluency of ideas, differing from most standardized ability tests because they require multiple responses to each item (Hocevar, 1981). An example activity typical of such tests is the alternative uses (AU) task, during which an examinee is prompted to generate as many uses for an object (e.g., a brick) as possible (Jauk et al., 2014). The most widely-used DT test—Torrance's Test of Creative Thinking (TTCT)—includes sections on figural and verbal creativity and is scored according to the fluency, elaboration, originality, openness (i.e., resistance to premature closure), and abstractedness of the responses (Kaufman et al., 2012). Other examples of DT tests include Guilford's Structure of the Intellect divergent productions tests, Wallach and Kogan's divergent production test, and Getzels and Jackson's divergent production test. DT tests are often used in both research and in the schools to evaluate creative potential, and they have typically shown evidence of strong reliability (Plucker & Makel, 2010). Still, modern scholarship questions whether divergent thinking fully captures creativity, and studies show mixed evidence on DT tests' predictive validity (Kaufman et al., 2012; Sawyer, 2010). Some suggest test scores are completely unrelated to real-world creative achievement (Baer, 1993), and others suggest that they account for up to half of the variance in creative achievement (Plucker, 1999).

To some extent in response to criticisms of DT tests, other methods of testing creative potential have been developed, such as self-reports. These tend to involve checklists or rating scales of creative abilities, behaviors, and characteristics (Kaufman et al., 2012). As such, an example of a self-report ability measure would be the Runco Ideational Behavior Scale (Runco, Plucker, & Lim, 2001), a 23-item measure asking examinees to rate the frequency of behaviors

related to creative ideas (e.g., “Sometimes I get so interested in a new idea that I forget about other things that I should be doing.”).

Other types of self-reports ask individuals to estimate their own level of creativity, measuring constructs such as “self-rated creativity,” “creative self-efficacy,” or “creative metacognition” (Karwowski, 2011; Pretz & McCollum, 2014). An example of this type of measure is the Kaufman Domains of Creativity Scale (K-DOCS; Kaufman, 2006), consisting of 50 items (e.g., “Acting in a play”) on which participants are asked to rate their own creativity. Regardless of the exact self-report creativity construct being measured, this group of assessments generally have shown empirical overlap (Choi, 2004; Karwowski, 2011; Lim & Choi, 2009). However, there is still some contention over the psychometric soundness of the self-report of creativity (Baer, 1998a; Kaufman, Evans, & Baer, 2010; Pfeiffer, 2015; Reiter-Palmon, Robinson-Morral, Kaufman, & Santo, 2012), and some meta-analysts have chosen to exclude such measures from past quantitative syntheses of creativity (Baas et al., 2008; Davis, 2009; Ma, 2009). Nevertheless, most researchers consider self-reported creativity and self-efficacy invaluable data sources (Carson et al., 2005; Kaufman, 2012; Silvia et al., 2012), and evidence suggests that laypeople have a valid understanding of what it means to be creative and to rate themselves and others on the trait (V. K. Phillips, 1973; Sternberg, 1985).

Other-report measures of ability are similar to self-report measures, involving ratings or nominations of creative individuals, except that the respondent is typically a parent, teacher, peer, supervisor, or expert (Hocevar, 1981). The most popular rating measure currently used in educational settings is the Renzulli Scales for Rating Behavioral Characteristics of Superior Students, which asks teachers to rate the frequency of a variety of creative behaviors in students (e.g., “The student demonstrates…the ability to adapt, improve, or modify objects or ideas”)

(Plucker & Makel, 2010). Additional examples of other-report measures would be the Creativity scale of the Gifted Rating Scales (GRS; Pfeiffer & Jarosewich, 2007) and the Creativity Checklist (as reviewed in Kaufman et al., 2012). In the case of both other-report and the self-report type of measures mentioned above, other less formal measures have also been developed and used in research (see Plucker & Makel, 2010 for review). In general, self- and other- report checklists are still new and in the process of acquiring empirical evidence for validity; however, they are used in practical settings (e.g., gifted evaluation) in concert with other established indicators (Kaufman et al., 2012).

Measurement of creative achievement. The tests of creative potential just discussed focus primarily on abstract skill, with no real product resulting. Turning toward measures of creative achievements, the focus shifts to creative outputs. The most commonly used assessments of achievement in the literature have been ratings by others, self-report inventories, and markers of eminence (Carson et al., 2005; von Stumm et al., 2011). In addition, more recently, evaluation of products created in experimental settings has emerged as a popular and psychometrically sound option for measuring creative production. Each of these will briefly be discussed in turn.

Self-report inventories typically ask individuals to report their own past creative achievements (e.g., producing a website, designing and planting a garden, selling writing to a publisher) often via checklists, such as the Creative Achievement Questionnaire (Carson et al., 2005), the Biographical Inventory of Creative Behaviours (BICB; Batey & Furnham, 2008), or the revised Creative Behavior Inventory (Dollinger, 2003). Scholars tend to distinguish between everyday and eminent creativity (Carson et al., 2005; Jauk et al., 2014; Pretz & McCollum. 2014; von Stumm et al, 2011). For instance, in their Inventory of Creative Activities and Achievements (ICAA), Jauk and colleagues (2014) created separate scales for creative "activities" and

"achievement," the former reflecting everyday creativity (e.g., writing a poem) and the latter reflecting a hierarchy of more eminent achievement (e.g., "I have already sold some of my work in this domain"). Others have also used separate self-report measures for younger versus older individuals, with extra-curricular/leisure activities as indicators of creative performance in younger populations and higher-level accomplishments for adult indicators (Milgram & Milgram, 1976; Milgram & Hong, 1993). However, empirically, everyday creativity and higher creative achievement still appear to be "complementary concepts" (Jauk et al., 2014) with sizable overlap; thus, they may both still be considered under the umbrella of creative achievement as defined in the current literature review. Regardless of the level of achievement, it has been argued that self-reports of past creative activities and achievements are the "most easily defensible" form of creativity assessment, given that past creative behavior is the best objective behavioral indicator in predicting future creative behavior (Hocevar, 1981).

Ratings by others have typically involved either experts or non-experts nominating outstanding creative individuals or otherwise rating the level of creativity of both historically eminent individuals' and the general population's achievements. For instance, Ludwig's Creative Achievement Scale (CAS; Ludwig, 1992) focuses on the achievements of eminent historical figures, while the Lifetime Creativity Scales (LCS) by Richards and colleagues (1988) measures the creativity of everyday people. It should be noted that such ratings are not immune to bias. For instance, in a study by Lebuda and Karwowski (2013), they found that adults rated creative products (i.e., musical compositions, scientific models) attributed to males as more creative than identical products attributed to females. However, such rating bias has not always been found, with other studies showing hypothetical males and females rated as equally creative (Sternberg, 1985).

Nomination systems also involve others' impressions of creativity but focus more holistically on identifying the most (or least) creative individuals. In relation to gender differences, these measures are typically used to compare how many males versus females are identified. For example, Charyton and colleagues asked co-ed college students to list 10 eminent creative people and found that the top ten most selected individuals were all male (Charyton, Basham, & Elliott, 2008). While nominations of famous creators or creative peers are interesting and informative, such measures were not considered in the current study because they speak more to group-level gender ratios than individual-level measurement of creativity, which was the target of the study.

As a measure of achievement, markers of eminence have typically included objective indicators of past accomplishments. As summarized by Carson et al., (2005), examples of such markers used in past research have included entries in a national biography book of notable people, number of patents acquired, and number of recordings of pieces of music. However, such measures as these are more relevant to creatively producing adults and less so to children, whose innovative potential may not have manifest in full products yet (DeMoss, Milich, & DeMers, 1993).

Nowadays expert evaluation of products is often considered best practice (Kaufman et al., 2012) or "the gold standard" (Pfeiffer, 2015; Plucker & Makel, 2010) in creativity evaluation. Amabile's consensual assessment technique (CAT; 1982a; 1982b) is the most established expert procedure. It calls for the composition of creative products (e.g., poem, story, collage), which are then rated on originality by multiple experts. This method operates on the presumption that "a product or response is creative to the extent that appropriate observers independently agree it is creative" (Amabile, 1982b, p. 1001). Although not formally part of the CAT, self-ratings of

one's own creativity have also been used as a method to evaluate the creativity of products (e.g., Satterfield & Muehlenhard, 1997). The CAT and its variations are often used in research, especially on children, but not as commonly as a clinical measure (Kaufman, Beghetto, Baer, & Ivcevic, 2010; Pfeiffer, 2015).

Implications for the current study. As discussed, creativity measurement is a multimodal affair, involving DT tests, expert evaluation of products, self-estimates, and others' ratings of creative abilities, accomplishments, and products. Other tests also assess creative attitudes, interests, or personality, but these represent indirect markers of creativity (Hocevar, 1981) that were not central to the current study. Nomination measures were also excluded, being more focused on group-level differences than individual differences. There was, however, a sufficient body of studies using direct measurements that were available for synthesis. Although some of these studies have begun to incorporate multiple measures (e.g., Silvia et al., 2012), the majority used one or two to operationalize creativity, and there is little integration of traditional creativity testing with newer evaluation methods (Plucker & Makel, 2010). Almost all creativity measures have advocates and critics, evidence both for and against their psychometric soundness (Pfeiffer, 2015; Plucker & Makel, 2010). In general, the Consensual Assessment Technique may receive the least criticism and DT tests the most. Both self- and other-report measures tend to be relatively new and still in the process of being validated. However, general statements about reliability and validity are difficult to assert with confidence given that psychometric studies of creativity measures are relatively rare (Plucker & Makel, 2010).

Although it was not within the scope of this review to provide a full critique of the strengths and weaknesses of different measurement strategies, the nuances of measurement were relevant to the extent that different creativity assessments have contributed to some of the

disagreement in findings of studies of creativity and gender (Ai, 1999; Bender et al., 2013). There is a variety of evidence suggesting that different creativity assessments fail to demonstrate convergent validity (Hocevar, 1981), and as will be discussed further later in the review, there is some evidence that gender differences in creativity do look different depending on the type of assessment used. As such, the present quantitative synthesis 1) included diverse measures in order to be thoroughly representative of the literature and 2) considered measurement type as a variable to explore whether differing methodologies captured the creativity-gender gap in different ways.

Gender Differences in Creativity: The Empirical Evidence

Now that a foundation in the language, theory, and definitions of the creativity literature has been established, this review may shift focus to the main topic of interest: the relationship between creativity and gender. What exactly are the specific differences between men and women, boys and girls, in terms of creativity? If they do in fact differ, what do these differences look like, and how do they affect people at the individual level? Interest in creativity research blossomed in the 1950s, largely due to the encouragement of Guilford (1950), and since this time, gender investigations have revealed consistently inconsistent findings (Baer & Kaufman, 2008; Stoltzfus, Nibbelink, Vredenburg, & Thyrum, 2011). Delving into the hustle and bustle of the actual literature, one hears conflicting voices: “Boys are better!” “Girls are better!” “It depends!” “They are no different from each other!” Here, the paper will review each one of these propositions in turn, evaluating the credibility of each.

Gender differences in creative ability. Some evidence indicates that boys surpass girls in general creative potential. A fairly straightforward example, in a test of 100 college men and 100 college women, men scored higher on Guilford’s cognitive flexibility task than women did

(Carter, 1985). Similarly, male adolescents and adults have been found to report higher general creative self-efficacy (Beghetto, 2006; Bender et al., 2013; Karwowski, 2011) and to perform better on creative problem-solving tasks (Lin, Hsu, Chen, & Wang, 2012). In his early work in reviewing the subject of creativity, Kogan (1974; 1976) found evidence of a male creativity advantage in 1-2 studies. In their review of 78 studies exploring gender and creativity, Baer and Kaufman (2008) found four such studies where males were found to outscore females on creativity. In a similar review by Runco, Cramond, and colleagues (2010), they likewise found a small group of studies in which boys outperformed girls. Sometimes used in explanation for such data about the superiority of male ability is a concept called the Greater Male Variability hypothesis (Abra & Valentine-French, 1991; Baer & Kaufman, 2008; He & Wong, 2011; Simonton, 1994), which posits that men show a "flatter" normal curve of ability than do women. This idea would suggest that more men would be present in the higher (and lower) ends of ability than women, who tend to cluster toward the middle. Overall then, it seems that there are both theoretical and empirical works suggesting a male advantage in creative ability.

Alternatively, there is competing evidence from a variety of sources that girls are the true victors in terms of potential. Girls from elementary through college age have, on average, received significantly higher scores on tests like the TTCT and Wallach-Kogan Creativity Tests (Cheung & Lau, 2010; Lin et al., 2012; Mullineaux & Dilalla, 2009; Stephens, Karnes, & Whorton, 2001), excelling in many areas: verbal fluency, figural fluency, figural flexibility, figural uniqueness, and figural unusualness. In addition, some studies have shown females to rate themselves higher in creative self-efficacy (Hill, Tan, & Kikuchi, 2008) and to be rated higher by their teachers in creative potential (Beghetto, Kaufman, & Baxter, 2011; Pfeiffer & Jarosewich, 2007). In Kogan's reviews (1974; 1976), females outperformed males in 2-3 studies, causing him

to conclude at one point that females excelled relative to males (1976). In Baer and Kaufman's summary (2008), females were found to exceed males in 9 of 78 studies, and in their review Runco, Cramond, and colleagues (2010) reported that approximately one-third of studies showed an advantage for girls on divergent thinking tests. In Bramwell Rejskind's review of 41 studies of children's DT test performance, differences were found rarely, but when they were found, girls outperformed boys in both figural and verbal tasks (as reported in Rejskind et al., 1992). Thus, there is a competing hypothesis that girls may be the more creative gender.

A final perspective with the potential to trump the others is that boys and girls, in fact, do not differ in terms of creative ability at all. Simonton (2002) argues that many aspects of the creative process are "the same whether you are scientist or artist, man or woman, Black or White" (p. 279). The Gender Similarities Hypothesis posits that females and males are more the same than different on a variety of psychological variables (Hyde, 2005), reminiscent of that well-worn mantra of the study of individual differences: there is often more within-group than between-group variability. Some have long argued that cognitive gender differences have never existed (Hollingworth, 1918), and a recent review of 46 meta-analyses of gender differences in psychological variables reveals that effect sizes are small at best and often close to zero (Hyde, 2005).

As applied specifically to studies of creativity, the Gender Similarities Hypothesis seems plausible. Across samples and measures, males and females have not tended to differ in performance on either traditional DT tests or newer real-world divergent problem solving tasks (e.g., Gralewski & Karwowski, 2013; He & Wong, 2011; King, Walker, & Broyles, 1996; Lee, 2002). Even with more specific measures, no gender differences have been found in more narrow areas, such as creative music and creative engineering potential (Charyton & Snelbecker, 2007).

Similarly, females and males have been found to rate themselves evenly in terms of self-perceived creative ability and personality in diverse samples (e.g., for college sample see Charyton, Basham, et al., 2008; for corporate sample see Jaussi, Randel, & Dionne, 2007). Beyond self-ratings, other reporters, including teachers and coworkers, have been found to rate their pupils and peers similarly regardless of gender (Gralewski & Karwowski, 2013; Jaussi et al., 2007; Kousoulas & Mega, 2009). Overall, the preponderance of synthetic evidence does seem to support the Gender Similarities Hypothesis. In the reviews by Kogan (1974), Bramwell Rejskind (as reported in Rejskind et al., 1992), Baer and Kaufman (2008), and Runco, Cramond, and colleagues (2010), the majority of studies showed no statistically significant gender differences. Considering all perspectives presented, the strongest case at the current time appears to be that of gender similarities in basic, global creative ability.

Gender differences in creative achievement. Now, it is time to move from the abstract to the concrete and practical: how do these gender differences (or lack of gender differences) in abilities play out in males' and females' actual creative achievements? As alluded to in the introduction to this paper, most history accounts, statistics, anecdotes, and common knowledge suggest that males clearly exceed females in real-world innovation and productivity. However, the true state of empirical results tells a more muddled story. For creative achievement, the variety of conflicting opinions amongst studies is similar to that found for creative ability: some research shows differences in favor of one gender or the other and some show more similarities than differences.

As mentioned, majority opinion seems to support the idea that males show more productivity in terms of ideas and innovation across the board. Eysenck (1993) noted the discrepancies between males and females in creative achievement, primarily relying on historical

evidence of creative eminence (e.g., a lack of eminent female scientists, sculptors, painters, dramatists, composers). He even reviewed evidence suggesting that female psychologists publish at a rate lower than males, and that this disparity was increasing. Other research has corroborated that female scientists, in general, have historically published at a rate lower than males, which could not be accounted for by controlling for marriage or motherhood (Cole & Zuckerman, 1987). Moreover, most review papers on the subject state incontrovertibly that males dominate real-world achievements and recognition relative to females. One of the small sample of studies reviewed by Kogan (1976) revealed gender differences in creative productivity among academics. In their review of gender studies, Runco, Cramond, and colleagues (2010) draw a stark contrast between studies of potential and performance, suggesting that creative potential tends to be even between the genders, but that men tend to dominate real-world participation. Abra and Valentine-French (1991) make similar assertions at the outset of their paper, outlining explanations for creative gender differences. Interestingly, such scholars cite few traditional, large-scale empirical studies, instead mostly noting statistics, case studies, and historical figures to support their conclusions.

There is a set of studies that finds girls and women to excel in creative achievement relative to males. In samples of both Israeli (Milgram & Milgram, 1976) and Sudanese adolescents (Khaleefa, Erdos, & Ashria, 1996), females have outscored males on tests of self-reported creative accomplishments and activities. Similarly, in a study of 205 American young adults, Kaufman, Niu, and colleagues (2010) used the consensual assessment technique and found that female participants' poems were evaluated as more creative than males participants'. In the review by Baer and Kaufman (2008), of the eight creative achievement studies they summarized, only one indicated mixed findings slightly suggestive of female advantage. Despite

such findings favoring females, as is apparent, these studies are few in number and difficult to replicate relative to the majority of studies showing other types of results.

Finally, as with creative ability, there is a proportion of studies suggesting no gender differences in creative achievements. For example, King and colleagues (1996) found no differences in self-reported creative accomplishments between females and males. In fact, as far back as Torrance (1972), there have been null findings for gender differences based on a variety of achievement indicators (i.e., quantity of creative achievement, quality of creative achievement, or creativeness of aspirations). Similarly, some of Amabile's classic work on the consensual assessment technique showed no differences between the judged creativity of the collages of elementary-aged students (Amabile, 1982b). More recently, Kaufman, Niu, and colleagues (2010) used the CAT with an older college student sample and found no gender differences in creative stories. Baer and Kaufman (2008) assert that the majority of studies using the CAT have shown no gender differences across the lifespan. In their review, six of the eight creative achievement studies using various measures found little to no evidence of gender differences. Similarly, one of the studies reviewed by Kogan (1974; 1976) showed no gender differences in adult creative accomplishments in academia. Even very sophisticated modern studies, such as that by Batey, Furnham, and Safiullina (2010), find no gender discrepancies based on a variety of methods combined in a single study—DT tests, the consensual assessment technique, self-rating of creative achievement, self-rating of general creativity, and a total creativity score combining all measures.

Overall then, despite the seeming general consensus amongst scholars of the dominance of males in creative achievement, there does also seem to be an equally convincing argument for gender similarities in creative achievement based strictly on documented empirical evidence thus

far. Though perhaps not as clear-cut as the evidence for similarities in ability, similarities in achievement does provide a strong competing hypothesis. Nevertheless, given the striking picture drawn by real-world indicators (e.g., the statistics about female representation across creative fields in the introduction to this paper), it is still likely that gender differences in creative achievement exceed those in creative ability.

Implications for the current study. Creativity has been a growing area of empirical study over the last fifty years; however, this research boom has given rise to a cluttered patchwork of results on gender. In terms of ability, some studies suggest that boys surpass girls in creative potential based on DT tests and self-reported creative ability. Other researchers have found that females are the victors on DT tests, creative self-efficacy, and ratings by others. Finally, based on a large preponderance of study results, a convincing argument can be made that the genders, in fact, show no mean differences in overall levels of creativity. Thus, small to null gender differences (when compared with creative achievement) was the working hypothesis for ability in the current study.

As with ability, a similarly conflicted literature exists on gender and creative achievement—perhaps, even more so. Based on creative products, markers of real-world contributions, self-report, and other-report, there is evidence of male superiority, female superiority, and also gender equality in achievements. However, unlike with ability, the studies on achievement do not tend to cluster together mostly supporting one conclusion. While the evidence for female superiority is somewhat scant, equally compelling bodies of evidence exist to support the ideas of either a male creative achievement advantage or no creative achievement advantage for either gender. Overall, given the substantial real-world evidence that females

struggle with creative achievement, it was hypothesized that gender differences in creative achievement would exceed those for creative ability, favoring males.

Other Potential Moderators

Even after reviewing an organized narrative summary of the evidence, one can see that there is considerable variability in the conclusions about creativity and gender. There are trends among the studies; however, even after conducting a meta-analysis of this body of work, there was likely to be residual unexplained variability among different studies. As such, it was wise to consider what differences existed between studies to bring about different results. Distinctions between creativity constructs (creative ability vs. creative achievement) has already been discussed as one main moderator. Data and theory from past scholarly work also suggest that the domain specificity of the creativity measure, the format of the creativity measure, the age of the sample, and the era of study publication are important factors in the question of creativity and gender. As such, each of these variables will be reviewed in turn as a potential moderator.

Domain specificity. In contrast to a global conception of creativity, much of the current work on creativity discusses the construct as "domain specific" (Baer, 1998a) or "content specific" (Plucker, 1998). The idea of the "domain-specificity" suggests that people may show skills and talents, but only in a certain domain (Kaufman, Beghetto, et al., 2010; Piirto, 2004; Russ & Fiorelli, 2010). This idea is contrasted with the notion of domain generality, the idea that there is a single ability at the core of all creative thought and behavior, regardless of the domain (Plucker, 1998). Past scholarly debate and study have delivered competing evidence of both domain generality and domain specificity. Some theoretical work supports that creativity extends to only one or two domains within the individual (Feist, 2004), and empirical studies using both self-ratings (Kaufman, Evans et al., 2010; Kaufman, 2012) and products (e.g., writing a story,

making a collage, doing math puzzle; Baer, 1991, 1998a) provide evidence that people neither tend to rate themselves nor perform similarly across creative domains. As such, if a student were creative in poem-writing, he should not automatically be assumed to be creative in math-equation writing.

Yet, as mentioned, some theorists still support domain general conceptions (Plucker, 1998). Empirical work has also substantiated the existence of general creativity, or an over-arching *c* factor (similar to *g* in intelligence; Kaufman, 2012), via factor analysis and structural equation modeling (Kaufman, Cole, and Baer, 2009; Hong & Milgram, 2010). In an attempt to incorporate both viewpoints and sets of evidence, most modern theories tend to be less black-and-white on the issue of generality vs. specificity, and many theories incorporate both levels (e.g., Amabile, 1983; Baer & Kaufman, 2005; Kerr & McKay, 2013; Milgram & Hong, 1993).

Such distinctions between domain general and domain specific creativity raise interesting questions when it comes to the gender issue. Do males and females tend to show different sets of talents across different creative domains? Empirically, females have been shown to outperform males on verbal/interpersonal creativity using the CAT (Amabile, 1996), DT tests (DeMoss et al., 1993), creative problem-solving tasks (Hong & Milgram, 2010), and self-report (Kaufman, 2006). Males, accordingly, have been found to outperform females on figural/spatial DT tests (Alpaugh and Birren, 1975) and self-report of creative ability and activity in nonverbal/spatial domains (Gralewski & Karwowski, 2013; Kaufman, 2006). However, it should be noted that these general patterns are not universal across studies. Sometimes the genders have been shown to be equal in the verbal domain (Hyde & Linn, 1988; Kaufman, Baer, & Gentile, 2004), and reverse gender patterns have also been seen on DT tests, with males excelling in verbal creativity and females in nonverbal (Gupta, 1981). Furthermore, the artistic domain, which can include

both verbal and nonverbal features, has tended to be split in its evidence over male or female superiority (e.g., Amabile, 1996; Gralewski & Karwowski, 2013; Kaufman, 2006). However, general consensus shows that males are thought to evidence greater creativity in mathematical and spatial domains and women in verbal (Abra & Valentine-French, 1991).

In real-world research and practical settings, domain distinctions are rarely as simple as verbal versus nonverbal. Studies of general ability show relatively consistent gender divides along a variety of domains. When individuals ranging from age seven to young adult rate their own ability, boys tend to rate themselves as more competent in math, science, social studies, sports, logic tasks, and spatial tasks (Abra & Valentine-French, 1991; Eccles, Wigfield, & Harold, 1993; Furnham, 2001; Kaufman, 2006; Siegle & Reis, 1998; Tirri & Nokelainen, 2008; Wigfield et al., 1997). Girls, on the other hand, rate themselves as more competent in language, reading, music, and interpersonal skills. A longitudinal study of 615 students shows that this pattern begins as early as the first grade and remains relatively stable throughout early development (Wigfield et al., 1997).

Thus, one way to potentially unravel past inconsistencies on the question of creativity and gender would be to consider whether measures are accounting for the potentially different aptitudes of boys and girls for different creative domains. Directly testing creative performance on the multitude of different creative activities in experimental conditions is time-consuming and impractical (Kaufman, 2012); thus, most work attempting to derive a domain structure for creativity has been theoretical, based on self-reported creativity, or based on a sample performance of creative tasks (e.g., CAT products). Unfortunately, there is a lack of consensus in terms of the domains comprising creative achievement, with different studies and measures using very different domain structures. For instance, the Kaufman Domains of Creativity Scale (K-

DOCS; Kaufman, 2012) asks individuals to rate their perceptions of their creativity in five major domains: Mechanical/Scientific, Artistic, Performance (writing and music), Self/Everyday, and Scholarly. By contrast, the Tel-Aviv Activities Inventory (Milgram & Milgram, 1976), a different self-report measure, includes domains, such as Music, Science, Fine Arts, Social Leadership, Writing, Community Service, Drama, Sports, and Dance. While it would have been ideal to compare gender differences by specific domains across studies (e.g., males vs. females in the area of dance creativity), the lack of similarity of domain structures across studies made this method problematic. Thus, in order to capture this important variable as a moderator, the current study made an overall discrimination between domain general and domain specific measures. Based on the above discussion, it was hypothesized that domain-specific measures (relative to domain-general measures) would show less magnitude of gender differences due to their greater sensitivity in detecting respective strengths and weaknesses of each gender across domains.

Creativity measure format. Past work has also suggested that using different creativity measure formats across studies may produce varying results (Plucker, 1998). While some studies show impressive coherence of results regardless of the type of measure (e.g., Batey et al., 2010), others show important discrepancies. For instance, in a study of 2,264 Spanish high school-level students, teacher ratings, students' self-ratings, and creative performance did not seem to unite in a coherent picture of creativity at the individual level (Ai, 1999). Scores on such measures were uncorrelated with each other. Recent analysis has shown that self-ratings and performance measures of creative ability do not necessarily show consistent associations with others' ratings of creativity or creative products (Gralewski & Karwowski, 2013; Kaufman, Evans, et al., 2010; Lim & Choi, 2009). Interestingly, teachers' perceptions may be more accurate for males than for females (Gralewski & Karwowski, 2013).

Delving specifically into the literature by different test formats, past reviewers have tended to conclude that there are no gender differences based on DT test scores alone (e.g., Baer & Kaufman, 2008). If they concede to any type of advantage, it usually favors females. The current researcher perused the literature, seeking to update and expand past reviews, and came to a similar conclusion. The majority of studies using DT tasks showed no significant gender results (e.g., Abraham, Thybusch, & Pieritz, 2014; Gralewski & Karwowski, 2013; Gupta, 1981; He & Wong, 2011; Karwowski, 2011; King et al., 1996; Lee, 2002; Saeki, Fan, & Van Dusen, 2001; Torrance, 1972). However, there are smaller groups of DT studies showing at least some male advantage (e.g., Alpaugh & Birren, 1975; Stoltzfus et al., 2011), some female advantage (e.g., Cheung & Lau, 2010; Kousoulas & Mega, 2009; Mullineaux & Dilalla, 2009; Stephens et al., 2001), or mixed results (e.g., Lin et al., 2012; Oral, Kaufman, & Agars, 2007). Similarly, the majority of studies using evaluation of creative products have also shown no male-female distinctions (Baer & Kaufman, 2008). There are some studies showing that females create more original products (e.g., Kaufman, Niu, et al., 2010) or that males do (e.g., Bender et al., 2013). However, historically-focused studies based on real-world accomplishment tend to side with the idea of male superiority (Cole & Zuckerman, 1987; Eysenck, 1993).

Regarding self-report, some evidence suggests that, on self-report measures of many characteristics—not just creativity—males tend to report higher ability than females regardless of actual ability level (Correll, 2001). Evidence from the creativity field suggests strongly that males tend to evaluate their abilities and achievements more highly than do females, or alternatively, that females tend to rate their creativity as lesser than males'. For instance, in a multi-national study of children ages 7-13, Stetsenko and colleagues (2000) found that girls' tendency to minimize their own abilities relative to boys' own self-estimations persists even

when girls are the superior in ability, an effect found around the world (e.g., Germany, Russia, Japan, Switzerland, the Czech Republic, and the United States). A large proportion of other studies have replicated such findings (Beghetto, 2006; Bender et al., 2013; Karwowski, 2011; Karwowski, Lebuda, Wisniewska, & Gralewski, 2013; Kaufman & Baer, 2004; Mathisen, 2011; Miller, Lambert, & Speirs Neumeister, 2012; Walton & Kemmelmeier, 2012). However, not all studies find such differences in self-report or creative efficacy (e.g., Charyton, Basham, et al., 2008; Chong & Ma, 2010; Jaussi et al., 2007; King et al., 1996; Tan, Ho, & Yong, 2007). Sometimes women are even found to self-report higher creativity than men (Epstein & Phan, 2012; Hill et al., 2008; Khaleefa et al., 1996; Milgram & Milgram, 1976), particularly in international samples. Interestingly, following up on study results, Karwowski (2011) generally found that males tended to overestimate and females tended to underestimate relative to actual creative ability as objectively evaluated by a DT test.

The field of other-report studies shows a fairly even mix of results, with some studies showing that females tend to be rated more favorably (Beghetto et al., 2011), others that males are (Jaussi et al., 2007), and still others that neither is (Gralewski & Karwowski, 2013; Kousoulas & Mega, 2009). In experimental studies of other-reports, researchers have also manipulated the supposed gender of the creator, randomly assigning hypothetical genders to similar artifacts, to interesting result. Study participants have rated creative products (i.e., musical compositions, scientific theories) attributed to males as more creative than identical products attributed to females (Lebuda & Karwowski, 2013), poems written by females higher (Kaufman, Baer, Agars, & Loomis, 2010), and overall creativity of neither gender higher in a study based on letters of recommendation (Sternberg, 1985). Thus overall, based on standard and experimental other-rater studies, no clear-cut pattern emerges. Baer and Kaufman (2008) found a

relatively similar variety of results in terms of other-report studies. However, both their review and the current review cover relatively few studies addressing other-reporters of creativity. Thus, the above results were best viewed as mixed and tentative, pending review of more results.

Combining across studies and measures, it did appear that different types of creativity assessments possibly rendered different results. Specifically, based on the current evidence, DT tasks seemed to show smaller or even zero effect sizes for gender, while self-report tended to show larger effect sizes favoring males. Few studies have been reviewed on creative products and other-report measures; however, those that do exist tended to show a mix of results. Overall then, creativity measure format was an important variable to include as a moderator in the current study.

Age of the creator. Do boys and girls look the same in terms of creativity at the age of 5 as men and women do at the age of 50? Some researchers have suggested that the various ages of samples might account for conflicting results in past research (Lee, 2002). Generally, empirical work has been mixed as to the general course of creativity development (Lau & Cheung, 2010; Ma, 2009; Russ & Fiorelli, 2010), but there are some points of consensus vital to the current gender conversation. First, most agree that the path to creative achievement begins early in life (Pfeiffer & Thompson, 2013; Stokes, 2010). Second, there appear to be some periods of waxing and waning, with late elementary school (e.g., the well-documented "fourth-grade slump") and adolescence being difficult times for nonconformity (Csikszentmihalyi, 1996; Russ & Fiorelli, 2010). Also, the 20s and 30s seem to be the peak of creative productivity, with declines starting in the 40s (Abra & Valentine-French, 1991; Simonton, 1994). While some studies suggest creativity declines in old age (Zhang & Niu, 2013), older adults are not shown to differ in actual creative ability from younger people when typical cognitive declines are accounted for (Foos &

Boone, 2008; Roskos-Ewoldsen, Black, & McCown, 2008; Jaquish & Ripple, 1981). There is potential for creative productivity and "swan songs" into old age (Simonton, 1994).

Such key points are important in comparing the developmental trajectories of creative girls and boys. The question becomes, how do creativity development and gender identity development intertwine to reveal the patterns of gender differences we see across the lifespan? By age 3, children can reliably label their own gender (Thompson, 1975; Weinraub, Clemens, Sockloff, Ethridge, Gracely, & Myers, 1984). They become socially and cognitively susceptible to gender stereotypes around age 11-12, a susceptibility which seems to peak during adolescence (Aronson & Good, 2002). Interestingly, Baer and Kaufman (2008) and Piirto (1991) suggest that gender differences in creative accomplishment are virtually non-existent in younger ages, per both objective evidence and subjective report, and only surface later in development. In their review, Baer and Kaufman (2008) found a modest handful of mixed results based on age.

Reviewing the literature briefly, this author found an interesting story about creativity and gender moving through the lifespan. The majority of evidence from the elementary school years favors higher creativity in girls, using various DT tasks (Kousoulas & Mega, 2009; Mullineaux & Dilalla, 2009; Stephens et al., 2001) and teacher ratings (Beghetto et al., 2011). Baer (2012) conducted a narrative review of creativity and gender by age and came to essentially the same conclusion for the preschool/elementary age range as the studies discussed above. However, some studies do suggest gender equality at this age range (Urban, 1991; Kousoulas & Mega, 2009). Interestingly, in a set of studies (1998b), Baer found evidence of gender equality in creative products during second grade, but he found female underperformance at the middle school-level—the implication being that girls in second grade are not yet susceptible to sociological factors that may undermine their creativity later in adolescence.

Surveying the available evidence on the preadolescent/adolescent period, one finds truly inconclusive results: an equal mix of studies reporting female advantage (Cheung & Lau, 2010; Hill et al., 2008; Khaleefa et al., 1996; Milgram & Milgram, 1976), male advantage (Beghetto, 2006; Karwowski, 2011), gender equality (Gupta, 1981; Gralewski & Karwowski, 2013; He & Wong, 2011; Torrance, 1972), and mixed results based on various factors (Cheung and Lau, 2013; Lau & Cheung, 2010; Oral et al., 2007). Baer's narrative review (2012) suggested similarly mixed results for the adolescent period. The set of studies by Cheung and Lau (2013; Lau & Cheung, 2010) is particularly interesting because they demonstrate that both males and females tended to increase in divergent thinking scores from 4^{th}-9^{th} grade; however, males' scores tended to grow more quickly than females', whose growth tended to slow over time. Given that girls seemed to show creative excellence during the elementary school years, the mixed results and perhaps slowing development for them during this period may suggest a transitional limbo during which more adult creativity patterns begin to emerge for the genders. Perhaps, the creativity "slumps" noted above become more amplified for females during the teen years.

Indeed, based on this researcher's narrative review, the college years show a significant shift in the tides of creative gender differences. At this level, some studies show no gender differences in originality across measures (Abraham et al., 2014; Batey et al., 2010; Charyton, Basham, et al., 2008; Chong & Ma, 2010; King et al., 1996; Lee, 2002; Saeki et al., 2001). There is still some evidence of female superiority on DT tests in particular (Baer, 2012). However, in the college range, a growing set of studies show evidence of male superiority (Bender et al., 2013; Carter, 1985; Lin et al., 2012; Miller et al., 2012; Stoltzfus et al., 2011; Walton &

Kemmelmeier, 2012). It should be noted that college students represent a unique subset, and they may differ in important ways from the adult population.

Yet, such trends continue to strengthen in studies carried out in adulthood. There is a portion of studies suggesting no gender differences in adulthood (Jaussi et al., 2007; Zhang & Niu, 2013), and some biographical evidence suggests that females' creativity peaks later than males' (perhaps later than the 40s threshold suggested by Simonton [1994]) due to waning family responsibilities later in life (Csikszentmihalyi, 1996; Piirto, 1991; Reis, 1991; 2002a). Nevertheless, a greater portion of evidence emerges showing men outperforming or outscoring women, based on historical accounts, markers of success, self-ratings, and DT tests (Alpaugh and Birren, 1975; 1977; Cole & Zuckerman, 1987; Eysenck, 1993; Karwowski et al., 2013; Mathisen, 2011). Overall then, based solely on narrative review, there was fairly strong evidence that gender differences in creativity may change in important ways throughout development, such that females may be born with an advantage that diminishes and gives way to a male advantage by adulthood. This conclusion is similar to the hypothesis of Baer and Kaufman's review (2008) that gender differences only become apparent later in development. The fact that these type of gender differences do not seem to emerge until adolescence or later indicate the possible influence of environmental pressures (Hyde, 2005).

Era of the study. In 1972, Torrance expressed the following:

> It is commonly believed that women are less creative than men... It is also commonly acknowledged that the past decade has been characterized by increasing rates of change [in…] society's treatment of girls and women. If common beliefs about women were valid in the past, are they still valid? (p. 597)

Just as certain parts of development may press for conformity and discourage creativity, certain points in history may have encouraged conformity or innovation to different degrees (Ivcevic, 2009). Research has indeed shown historical trends in standardized creativity scores (Cheung & Lau, 2013; Kim, 2011; Torrance & Safter, 1986), finding increases or decreases in creativity based on different cohorts over time. Simonton (1992) has empirically demonstrated that female creative productivity and eminence has historically risen and fallen in Japan according to whether cultural dictates and practices have promoted or discouraged it. Cheung and Lau (2013) found increases in the overall creativity of children (grades 4 to 9) in Hong Kong from 1994-2002 at a time when educational reform had been specifically geared toward increasing creativity. Thus, based on the available evidence, creativity may not be stable based on the historical era.

Many societal changes have come about in recent years with potentially dramatic consequences for the genders. Women have more prerogative in managing their family versus career priorities with relatively new reproductive and birth control technologies (Cowen, 1996). In a turning of the tides, females are now enrolling in college at a rate greater than males, are less often aspiring to sex-typed careers, and, even from a young age, are aspiring to careers requiring a college or graduate education more often than males (Blackhurst & Auger, 2008). As discussed in the introduction to this paper, previously gendered areas (e.g., law, medicine, book editing) are becoming more neutral, but others are slower to integrate (e.g., science, blue collar work) (Browne, 2006; Lawrence, 2006). Narrative and quantitative reviews, alike, are showing that past gender gaps favoring men in various cognitive abilities and pursuits are closing as we move toward the present day (Becker & Hedges, 1984; Feingold, 1988; Hyde & Linn, 1988; Simonton, 1994).

Regarding creativity specifically, summarizing his own and others' early work in the area, Torrance (1972) argued that data demonstrated decreases in creative gender differences over the preceeding decades. More recently, Runco, Cramond, and colleagues (2010) reviewed several studies showing that increased modernization and shifting socioeconomic factors can be linked to decreasing gender gaps in creative participation around the world. In the sampling of studies reviewed for the current paper, however, a definite trend was difficult to discern. Equal evidence could be found for both gender differences and gender similarities, regardless of the decade of the study. From the 1970s onward, some studies have shown girls and women to outperform males (e.g., Khaleefa et al., 1996; Milgram & Milgram, 1976; Mullineaux & Dilalla, 2009); others showed the opposite (e.g., Beghetto, 2006; Carter, 1985; Stoltzfus et al., 2011). Still other studies have shown a lack of gender differences (e.g., Chong & Ma, 2010; King et al., 1996; Torrance, 1972). Looking at the collection of studies in Baer and Kaufman (2008), one could draw similar conclusions. There is evidence of all manner of inconsistent findings, regardless of the decade. Nevertheless, given the theoretical justification and empirical evidence from other cognitive areas, publication era of creativity appeared to be an important variable for the current study.

Excluded moderators. In addition to the five moderators discussed above (creativity construct, measure domain specificity, creativity measure format, creator age, and study era), other factors could conceivably affect the association between creativity and gender. However, for various reasons, not all moderators were appropriate for the current study. A review of each of these factors and the rationale for their exclusion will be discussed briefly below.

There is some evidence that creativity may vary by culture/nationality. For instance, Chong and Ma (2010) found that those from individualistic societies (e.g., New Zealander)

reported higher creativity than those from collectivistic societies (e.g., Indian). Furthermore, Torrance (1972) reviewed evidence that gender patterns in creativity, specifically, may vary by country and culture. Several reviews suggest that cultural socialization plays a large role in gender differences, with those societies providing equal opportunities for females and males showing less evidence of gender gaps (Baer, 2012; Runco, Cramond, et al., 2010). While cultural distinctions are likely an important factor in conceptualizing gender differences, it was not feasible to fully illustrate such cultural disparities based on the available sample of empirical studies. Prior to undertaking the meta-analysis, this researcher gauged that the sample of studies would be skewed toward American and European participants, with African, Middle Eastern, and South American samples underrepresented. This imbalance may stem both from the uneven research outputs of different global regions and also the pitfalls of language barriers in accessing research. As such, it was decided that it would be difficult to include nationality or even world region as a meaningful moderator in analyses.

Participant ethnicity is another factor that may influence gender patterns in creativity and innovation. The evidence is mixed as to whether creative expression varies by ethnicity. Kaufman (2006) uncovered differences in self-reported creativity: African Americans and Native Americans reported higher creativity than those of other ethnicities (i.e., European American, Hispanic American, Asian American, mixed ethnicity). However, Kaufman and colleagues (2004) found few differences among African American, Caucasian, Latino/a, and Asian participants in creative writing tasks. Specific to gender differences, Baer (2012) summarized evidence that Anglo-American females outperformed males on the Unusual Uses Test; however, the reverse was true for African-American youth. Furthermore, Kaufman (2006) found evidence that African Americans and Native Americans may be less likely to fall prone to gender self-

stereotyping by domains (e.g., females self-rating higher visual-artistic creativity or lower science-analytic creativity) than other ethnicities. However, aside from this mixed preliminary evidence, scant scholarly work has addressed issues of creativity, gender, and ethnicity concomitantly. Thus, little theoretical or empirical basis existed for justifying analyses or making hypotheses about interactions among the three variables for the current study, and the variable was not used as a moderator.

Other moderators considered involved additional ways to categorize creativity measures. Several scholars distinguish between measures involving "quantity" (i.e., frequency) versus "quality" (i.e., level of creativity in a product) of creative achievement (Kim, 2008; Plucker & Makel, 2010; Runco, 1987; Simonton, 1994). Torrance (1972) found no evidence of gender differences based either quantity of creative achievement or quality of achievement. However, given their historic lack of opportunity (Runco, Cramond, et al., 2010), it is conceivable that women may have tended to show lower quantity of achievement than men. Unfortunately, few researchers have made distinctions between quantity and quality in their measures. For instance, a self-report measure of creative achievement may not ask participants to distinguish between how many times they have completed a creative task (e.g., made a sculpture) and how high the quality was for such products (e.g., how good or creative were the sculptures?).

Also, as alluded to previously, several researchers and measures adraw a contrast between "everyday" creativity and higher ranges of creativity up through eminence (Carson et al., 2005; Pretz & McCollum, 2014; Silvia et al., 2012) or "publicly acknowledged achievements" (Jauk et al., 2014; Kaufman & Beghetto, 2009). Ivcevic and Mayer (2009) found that females exceeded males in everyday creative activity (e.g., scrapbooking, making a mixed CD), but not in formal artistic creativity (e.g., painting, sculpting). However, other studies have

found almost the reverse: no differences in everyday or personal achievement, but differences only in more formal public achievements, favoring males (Runco, Millar, Acar, & Cramond, 2010). Such discriminations in level of creativity are likely important, but as with quantity and quality, they are often lumped together in measures. Given that there was no reliable and objective way to determine whether measures in primary studies concern things like quantity vs. quality of creativity or everyday vs. eminent creativity, these variables were not appropriate for the current study.

Implications for the current study. Despite their diversity, creativity studies using various constructs, measures, age groups, and historical periods all tend to be discussed and synthesized together when addressing the topic of gender. Therefore, it is no wonder that the results tend to contradict one another from study to study. As such, several important moderator variables were suggested in considering the relationship between creativity and gender.

In terms of measurement, gender gaps in creativity may look different depending on the types of measures used. Indeed, past meta-analyses have demonstrated that results and effect sizes are dependent on the type of creativity outcome measures used (Hammond, Neff, Farr, & Schwall, 2011; Hunter, Bedell, & Mumford, 2007; Scott, Leritz, & Mumford, 2004). Regarding domain specificity, domain specific measures may show a reliable profile of strengths and weaknesses for females and males (e.g., verbal superiority for females and spatial superiority for males; Abra & Valentine-French, 1991), which are not evident in domain-general measures. Regarding creativity test format, primary studies have shown relatively few gender differences on DT tests, male advantage in self-report, and mixed findings for creative products and other-report. (It should be noted that, for domain-specific measures, creative products, and other-report

measures relatively few studies were reviewed, so it was important to watch for small cell sizes when comparing the measurement types against one another).

Despite the differences among instruments, most measurement theory suggests that including the largest sample of studies possible and a variety of assessment types provides the most robust results (Card, 2012), so including diverse measures increased the current study's generalizability. Overall then, based on precedent in meta-analysis and the results reviewed in primary studies, measure domain specificity and creativity measure format were important moderators in the current study. The past literature suggested the hypotheses that 1) gender differences would be smaller on domain specific than domain general measures, 2) gender differences based on DT tests would be smaller than those of other measure formats, and 3) that gender differences in self-report would be relatively larger, favoring males.

Additionally, very interesting trends emerged when breaking down reviewed studies by the age of participants. In the elementary years, young girls appeared to perform as well or better than their male counterparts. However, moving into the adolescent years studies become muddled, only to resurface in the college years with evidence of male superiority in innovation and creative contributions. Tracking such a reversal across the lifespan seemed vital to untangling the inconsistencies of results on gender in previous studies. One caveat to studies of gender, creativity, and aging: studies of creativity and development tend to be more populous in the childhood period, with studies less commonly focusing on adults and older adults (Claxton, Pannells, & Rhoads, 2005). Thus, in the current study, particular care was taken to seek out studies across the lifespan and to monitor potential age skew in the studies selected. Despite these challenges, age was an important moderator to include in the current study, with the hypothesis that gender differences increase with age.

Finally, creativity scores have been shown to fluctuate based on historical era and cultural zeitgeists (e.g., Cheung & Lau, 2013; Simonton, 1992), and recent societal developments have produced many shifts toward gender equality by behavioral, education, and employment standards. Studies show that previous gender differences in cognitive abilities are diminishing (Hyde & Linn, 1988). Some reviews suggest decreasing gender differences in creativity in modern times (Torrance, 1972; Runco, Cramond, et al., 2010). However, both the large review by Baer and Kaufman (2008) and the review of studies conducted by this researchers suggested no definitive pattern by study publication date. In general, meta-analysts assert that all data on a topic of interest is valuable regardless of when historically it was collected (Allen, 2009), but the current researcher noted that an increasing number of studies have focused on gender and creativity, causing the potential for a sample of studies on the topic to skew towards the more recent. Regardless, analysts are wise to consider the date of publication for studies included to evaluate for possible historical trends (Card, 2012). Given this standard in meta-analysis, as well as theoretical and empirical justification, era of study publication was a moderator variable in the current study, with the hypothesis that effect sizes for gender differences in creativity would decrease over time.

Aside from considering moderators individually, there was a possibility that moderator variables might also interrelate with one another. For instance, it has been asserted that children are more often assessed via divergent thinking tests, and adults via creative achievements (Rejskind et al., 1992). Such a relationship would suggest an interaction between age and type of creativity test in predicting gender-creativity effect sizes. Given the possibility of such covariance, in addition to being tested separately, it was also determined to be helpful to consider

significant moderators concurrently in a single analysis to determine the relative importance of each.

One last point was relevant in discussing moderators. In the current study, there was the option for including a vast multitude of moderators—the potential moderators are as plentiful as are the number of variables included in primary studies. However, not all moderators were appropriate for the current study, and some were necessarily excluded. For instance, there is evidence that gender differences in creativity may depend somewhat on culture/nationality (Baer, 2012; Torrance, 1972) and ethnicity (Baer, 2012; Kaufman, 2006) factors. However, too few primary studies fully represented such issues for these variables to be included in a meta-analysis. Also, measurement variables, such as quantity vs. quality and everyday vs. eminent creativity, were considered. Some theoretical and empirical work suggests that females would be disproportionately disadvantaged in quantity of creativity and eminent achievement (relative to quality of creativity and everyday creativity) due to their historic lack of support and resources (Ivcevic & Mayer, 2009; Runco, Cramond, et al., 2010; Runco, Millar, et al., 2010). Unfortunately, most measures of creativity currently used in the literature do not make distinctions between quantity/quality or everyday/eminent creativity, and there is no reliable way to code such features based on the information typically provided in research reports. As such, these issues were not explored in the current study. Overall then, further investigation of each of these variables—culture, ethnicity, quantity/quality, and everyday/eminent—in primary studies would be an important step toward making them more tenable for future meta-analyses.

Creativity and Meta-analysis

As mentioned previously, interest in creativity research blossomed in the 1950s, largely due to the encouragement of Guilford (1950), and it is now conducted widely by scholars across

psychology, education, neuroscience, business, career counseling, gender studies, and sports psychology. Despite this intensive research tradition over 60 years old and its frequently contradictory results (Baer & Kaufman, 2008; Stoltzfus et al., 2011), relatively few meta-analyses have been conducted to attempt to synthesize the divergent findings.

Put simply, meta-analysis is a method for statistically summarizing the results of a large body of past empirical studies (Card, 2012). It has been used as an analysis strategy for a wide variety of disciplines since the late 1970s (Chan & Arvey, 2012; Hedges, 2007). Instead of individual participants being the unit of study, effect sizes from past studies are "the unit of currency" (Borenstein, Hedges, Higgins, & Rothstein, 2009, p. 3). An effect size is simply the direction and "strength of a relationship between two variables" (Borenstein et al., 2009, p. 3). The researcher aims to generalize from a representative sample of studies (or effect sizes) to a population of studies instead of from a sample of individuals to a population of people (Card, 2012). The two primary functions of the technique are to combine the results of past studies (i.e., finding a mean effect size for a relationship) and to examine moderators based on different study characteristics.

The main benefits of meta-analysis are that it allows the researcher to incorporate larger overall sample sizes (minimizing sampling error), to synthesize *p*-values across studies, to consider the consistency of effects across studies, to correct for artifacts and flaws in primary studies, and to place greater emphasis on the strength of an effect over the significance test only (Borenstein et al., 2009; Chan & Arvey, 2012; Lipsey & Wilson, 2001). Aside from statistical advantages, Lipsey and Wilson (2001) also assert that meta-analysis offers a more transparent, thorough, and organized literature search process over other review strategies. More broadly, Chan and Arvey (2012) argue that it is an important tool for arranging the literature into

digestible trends, building consensus in conclusions, redefining theory, and providing directions for future research.

Although common to most types of synthesis (Chan & Arvey, 2012), several criticisms of meta-analysis also exist. First, meta-analysis is limited only to empirical quantitative studies; thus, theory papers, case studies, research reviews, biographical data, and other qualitative methodologies are necessarily excluded (Lipsey & Wilson, 2001). Even within the valid range of studies, the "apples and oranges" problem highlights the issue of statistically combining studies that might be too disparate to combine conceptually (Card, 2012). The "apples and oranges" issue is pertinent to the creativity literature, with its profound diversity in definitions, methods, and samples used. Thus, Card (2012) and Lipsey and Wilson (2001) both caution researchers to be precise in the language they use in describing studies and conclusions. If one is interested in studying "divergent thinking," it might be inappropriate to include the studies using the Creative Achievement Questionnaire. However, if one is interested in the broad construct "creativity," which was the case in this study, measures of both would be appropriate.

Another common critique of meta-analysis is the so-called "file-drawer problem," the phenomenon whereby studies finding null results (in the current case, no gender differences) are more difficult to publish and often end up shelved and inaccessible. However, there are strategies for containing this issue (Card, 2012), which will be discussed further in the "Methods" section. Another concern is the mechanistic coding of studies without regard to subtleties in qualitative aspects of studies (e.g., social and theoretical context, nuances in methods and results, quality of methodology; Lipsey & Wilson, 2001). Relatedly, the "garbage-in, garbage-out" problem describes including poor quality studies, which taints the overall sample (Card, 2012). Fortunately, the advantage of meta-analysis is that, by combining or reorganizing past data, it

can help to alleviate flaws in past studies (e.g., heterogeneous samples, small sample size, low power, poor measurement, inappropriate analyses) that may have clouded the clarity of effects (Card, 2012).

Accusations of lack of rigor are, indeed, sometimes leveled at the field of creativity research (Plucker & Makel, 2010; Silvia et al., 2012). Meta-analysis serves as a helpful tool for shoring up flaws in primary studies and increasing overall power in the hopes of discerning the true trends in the creativity literature. Although infrequent, some past meta-analyses of the creativity literature do exist. There is one past methodological synthesis, comparing different rating measures of creativity (Ng & Feldman, 2012). A larger number have covered the topic of creativity as it relates to various individual difference variables: intelligence (Kim 2005; 2008), intrinsic motivation (de Jesus, Rus, Lens, & Imaginário, 2013), life stressors (Byron, Khazanchi, & Nazarian, 2010), mood (Baas et al., 2008; Davis, 2009), personality (Feist, 1998), schizotypy (Acar & Sen, 2013), and various other correlates and predictors (Hammond et al., 2011; Ma, 2009). Finally, there are also some past syntheses regarding creative environment (e.g., work climate variables; Hunter et al., 2007) and training efforts (Scott et al., 2004). These past analyses have varied considerably in size. For instance, the number of papers returned in searches on specific questions have ranged from 17 (Kim, 2008) to 112 (Ma, 2009) in the published literature. The number of derived effect sizes has ranged from 10 (Davis, 2009) to over 2,000 (Ma, 2009). The overall number of participants amalgamated on the low end has been around 4,000 (Scott et al., 2004) and has ballooned to over 40,000 in other studies (Kim, 2005). Overall then, past creativity meta-analyses have been diverse in topic and scope.

However, no existing quantitative reviews have addressed the topic of creativity and gender in-depth (Baer, 2012). As mentioned, some authors have conducted narrative reviews of

the body of research addressing creativity and gender (Baer & Kaufman, 2008; Kogan, 1974; 1976; a dissertation reported in Rejskind et al., 1992; Runco, Cramond et al., 2010). Such reviews typically employ only "vote-counting" in considering the results across studies. Vote-counting is the simple process of comparing the number of significant to non-significant results in drawing conclusions about a sample of studies, which is problematic given the pitfalls of relying on significance tests alone (Allen, 2009; Card, 2012). Solely because a finding is not significant does not guarantee that no effect exists; the correct conclusion is that the study failed to find an effect. Alternatively, very high-powered studies with large sample sizes may find statistically significant results in cases where effects are small and unimportant in a practical sense. To avoid the drawbacks of vote-counting, meta-analysis offers a more objective alternative, combining the samples of past individual studies, reducing Type II error, emphasizing the magnitude of effects, and ultimately better estimating the population parameter of interest (Allen, 2009).

Notably, one previous large-scale meta-analysis of a wide variety of correlates did include gender as a variable (Ma, 2009). Ma's analysis revealed an overall mean effect size of 0.14 (*SD* = .43) for creativity and gender, seemingly suggesting that females outperformed males slightly in creativity. However, there were several flaws to the study in terms of methods and scope. First, as Ma points out, the study included no quality controls to monitor the caliber of studies included, nor was the literature search exhaustive for any variables, least of all gender. Of the 2,013 effect sizes included in the overall study, only 104 pertained to gender. The analysis seemed to pull almost exclusively from educational resources (e.g., ERIC, the ProQuest Educational Journal) to the exclusion of the psychological and organizational/business literatures. The synthesis intentionally excluded self- and other-reports (known to be valid and

important measures of creativity; Carson et al., 2005; Kaufman, 2012; Silvia et al., 2012), and it also seemed to unintentionally exclude measures of real-world creative achievement, favoring DT tests and CAT assessments. Most important, the study did not treat gender as a main variable of interest, not explaining the procedure, interpreting the gender finding fully, or considering possible moderators. As such, it was difficult for the reader to even determine which gender surpassed the other, whether the effect size differed significantly from zero, or the practical relevance of the finding.

Implications for the current study. Based on the Ma (2009) study alone, the inconsistencies in the literature on creativity and gender remained perplexing. The current study sought to provide a thorough meta-analysis by conducting a more exhaustive literature review, including the full range of creativity measurement, fully interpreting the mean effect size, incorporating moderator analyses, and placing all findings in a broader context to inform future research. A well-designed synthesis of this nature reduced the subjectivity of previous narrative results (e.g., Baer & Kaufman, 2008) and placed more emphasis on the magnitude of any gender differences versus simple notation of whether they exist or not (Card, 2012). No previous work has capitalized on the many advantages provided by a comprehensive meta-analysis in this way.

Few previous meta-analyses of creativity exist, but those that do vary greatly in scope. The overall *N* in previous published analyses has ranged from 4,000 (Scott et al., 2004) to 40,000 (Kim, 2005). Such past analysis gave the present author an estimate of the size of the analysis she could conduct and helped her to place the eventual size of her sample in perspective. Regardless of the scope, an accumulation of inconsistent findings signaled that a quantitative synthesis of current evidence would be an ideal method for drawing more solid conclusions about a potential gender gap in creativity. Meta-analysis (like all statistical techniques) did have

some caveats. However, many of these drawbacks could be attended to and corrected for during the analysis process (see "Methods"), and the benefits outweighed the drawbacks.

Study Purpose & Research Questions

Various real-world indicators suggest a potential gendered crisis in creativity, innovation, and imagination. The purpose of the current study was 1) to systematically investigate the accumulated empirical evidence on gender differences in creativity and 2) to explore the conceptual factors and potential moderators that may account for past discrepancies in the literature. Given the many benefits of meta-analysis, such a methodology was ideal to confirm past hypotheses and to clarify the many inconsistencies related to creativity and gender. To this end and based on the previous review of the literature, the following research questions and accompanying hypotheses were proposed:

1) Research Question 1: Do females and males tend to differ in overall creativity?

   RQ1 Operational Definitions: The overall creativity variable was measured by scores on divergent thinking performance tests, expert evaluation of products and achievements, self-report rating scales, or other-report rating scales. The construct of gender was determined via participant self-report or researcher determination of dichotomous (i.e., male or female) gender in the primary study.

   RQ1 Hypothesis: Given the mixed nature of previous evidence on this topic, no hypothesis was provided for this question. This analysis was exploratory in an attempt to clarify the previous literature.

2) Research Question 2: Does the relationship between creativity and gender change when creative ability and creative achievement are considered separately?

RQ2 Operational Definitions: Creative ability was measured using divergent thinking tasks, self-report of creative capacity, or other-report of creative capacity. Creative achievement was measured by expert evaluation of products, self-report of past products/accomplishments, or other-reports of past products/accomplishments.

RQ2 Hypothesis: It was anticipated that gender differences in creative achievement would be significantly higher than differences in ability, favoring males.

3) Research Question 3: Does the relationship between creativity and gender change when domain general and domain specific measures are considered separately?

   RQ3 Operational Definitions: Domain general creativity was measured by DT tests, self-report of general creativity, and other-report of general creativity. Domain specific creativity was measured using expert evaluation of domain-specific products (e.g., poems, scientific theories), self-report of creativity across different domains, and other-report of creativity across different domains. If not explicitly stated by the study author, the domain specificity of a measure was assessed by this researcher according to the criteria for domain specificity discussed above.

   RQ3 Hypothesis: It was anticipated that domain general creativity measures would show significantly greater gender differences than domain specific measures.

4) Research Question 4: Does the relationship between creativity and gender change depending on the format of the creativity measure?

   RQ4 Operational Definition: Creativity measure format was assessed by this researcher based on the information reported about the measure in the original study. Measures were either classified as DT tests, product measures, self-report, or other-report.

RQ4 Hypothesis: It was anticipated that self-report measures would show stronger gender differences (favoring males) than other measurement formats, and DT tests were expected to show weaker gender differences. No other a priori hypotheses were provided for this question as remaining comparisons were exploratory.

5) Research Question 5: Do associations between gender and creativity depend on a person's age?

   RQ5 Operational Definition: Participant age for a study was operationalized as the mean age of the sample.

   RQ5 Hypothesis: Differences between the genders were expected to increase over the course of development, such that females fall behind males with age.

6) Research Question 6: Have associations between gender and creativity changed over time according to study era?

   RQ6 Operational Definition: Era of a study was operationalized as the year a study was published (i.e., made available in a print format).

   RQ6 Hypothesis: It was anticipated that any extant gender differences in creativity would have decreased over time historically.

CHAPTER 3

METHODS

This chapter elaborates on the methodology used in the current study, including (1) search procedures, (2) inclusion/exclusion criteria, (3) the coding of study characteristics, (4) the calculation of effect sizes, (5) coding reliability, (6) the data analytic strategy, and (7) steps taken to address publication bias.

Study Selection

Search procedures. The process of locating relevant studies began with gathering primary study citations from key narrative reviews on the subject of creativity and gender. Such reviews included the following: Baer (2012), Baer and Kaufman (2008), Barron and Harrington (1981), Helson (1978), Jarial (1980), Kaufman (2011), Kogan (1974), Kogan (1976), Maccoby and Jacklin (1974), and Runco, Cramond, and colleagues (2010). Next, the researcher conducted a thorough search of electronic databases. In meta-analysis, using multiple databases is recommended, including those outside of one's home discipline (Card, 2012; Lipsey & Wilson, 2001). Creativity is studied across many fields, so a variety of databases were used: PsycINFO, ERIC, ABI/INFORM, AgeLine, Web of Knowledge, and ProQuest Dissertations and Theses. The initial, large database search involved PsycINFO, ERIC, ABI/INFORM, and ProQuest Dissertations and Theses. The keywords for the search included a general search of "creativ*" + "gender differences" using the Boolean wildcard "*" symbol to return other possible iterations of creativ- (e.g., "creative," "creativity"). As mentioned, the literature tends to employ many other synonyms for these constructs, so the related concepts listed in Table 1 were each also used in the search. In addition to the main database search, two smaller follow-up searches were conducted with the AgeLine and Web of Knowledge databases using only the terms "creativity,"

Table 1

Search Terms

Main Term	Synonyms[†]
Creativity	Divergent thinking, Ideational fluency, Remote assoc*, Flexible thinking, Originality, Imagination, Innovation
Gender differences	Sex differences

[†]Notably, some of the terms originally proposed as synonyms (e.g., "novelty," "ingenuity," "invent*," "uniqueness," "Female/male") were dropped after pilot searches suggested that these terms returned few relevant results and/or a high rate of spurious results.

"divergent thinking," "gender differences," and "sex differences," as these keywords were determined to be the most productive in the initial, large search. Next, the researcher manually reviewed the tables of contents for the three most popular journals publishing mainly creativity research (i.e., *The Journal of Creative Behavior*, *Creativity Research Journal*, and *Psychology of Aesthetics, Creativity, and the Arts*) for the previous 12-month period (i.e., June 2014 to June 2015) to ensure breadth and current-ness of studies.

After gathering this tentative pool of studies, the researcher submitted a citation list to invited field experts in the creativity area for review of its appropriateness and comprehensiveness. An "expert" was defined as an individual who has published three or more first-author articles in peer-reviewed journals in the past five year period—a criterion that has been used in previous studies using expert opinion (Pfeiffer, 2003). The two experts who consulted on the current study were Dr. James C. Kaufman and Dr. Jonathan A. Plucker—both of whom have researched and published extensively in the creativity area. As a result of this consultation, additional manual searches of the following journal contents were added to the search strategy: *Thinking and Creativity Skills, Empirical Studies of the Arts, Roeper Review,*

Gifted Child Quarterly, Creativity and Innovation Management, and *Imagination, Cognition, & Personality.* Finally, throughout the coding process, the researcher performed backward searches (i.e., combing the references of sources acquired; Card, 2012) for further primary studies. It should be noted that the researcher originally also proposed forward searches (i.e., investigating additional sources citing a given source) during coding; however, this strategy is often low in precision (Card, 2012), resulting in a high rate of irrelevant studies identified. As such, forward searches were discontinued in the current study.

Inclusion/exclusion criteria. The goal in establishing criteria for selecting studies is to balance 1) maximizing the number and diversity of studies to increase power and generalizability and 2) keeping the study sample rigorous and focused tightly on variables of interest (Card, 2012; Lipsey & Wilson, 2001). Studies selected for inclusion were those that involved the variables of interest—the binary gender of participants and at least one individual-level, quantitative, continuous measure of creativity—in relation to each other. Most studies included were quasi-correlational in design. Acceptable creativity measures included divergent thinking tests, self-report of creative ability, other-report of creative ability, evaluation of creative products, markers of real-world creative contributions, self-report of creative achievement, or other-report of creative achievement. These different methods of measurement are often discussed and compared alongside each other in the literature (particularly in meta-analyses; e.g., Acar & Sen, 2013; Byron et al., 2010; Hunter et al., 2007; Ma, 2009; Scott et al., 2004), and different measurement strategies were statistically contrasted in the present study. Given that this was intended to be a study of general human creativity across the lifespan, no limitations were instated based on age, ethnicity, nationality, ability-level of the sample, setting (e.g., school,

university, corporate), discipline of the study, publication status, or era in which the study was conducted.

The main exclusion criterion was whether or not a study included sufficient statistical information to compute the desired effect sizes. Unfortunately, primary studies often fail to report the basic data necessary for a meta-analysis (Allen, 2009; Chan & Arvey, 2012; Lipsey & Wilson, 2001), which was the case for a number of dropped studies in the current search. Studies also were dropped if they only reported statistical information for significant results and withheld exact information on results that failed to reach significance. For instance, some studies utilized multiple subtests of a creativity measure but only reported full statistical details on those subtests showing significant gender differences. Given that an effect size could not be computed to accurately reflect both the significant and non-significant results, these studies were omitted in order to avoid inflating the overall meta-analytic results.

Additionally, studies were excluded if they did not define or operationalize gender and creativity in the manner described throughout this paper. As mentioned, a small portion of investigations have examined gender/gender identity as a continuous variable; however, these studies were excluded because they are in the minority and examine a related, but distinct issue from the one of interest in the current study. Similarly, studies measuring variables peripheral to individual differences in creative ability and achievement (e.g., creative processes, environments, interests, personality, group creativity) were excluded. It should also be noted that the intended target for the current synthesis was naturally occurring gender differences in creativity, so experimental studies manipulating variables known to differentially affect males' and females' creative performance (e.g., competition, motivation, training, group performance situations; Baer, 1997; Booker, 1981; Gallagher, 1966; Rodriguez, 1981; Sapp, 1991) were excluded.

Control and pre-test groups from such studies, however, were permitted. Due to practical constraints, studies were excluded if they were not written or translated into English, which is common practice in meta-analysis (Lipsey & Wilson, 2001), or if the researcher was unable to gain access to them after making reasonable efforts to do so. Finally, the screening procedures described in Wood (2008) were employed to attempt to detect duplicate study effects (i.e., the same sample effects being published in more than one study), and one out of each pair of suspected duplicates was discarded.

Study Coding

Coding of study characteristics. Each study was coded by this researcher between April and October of 2015. Given the relatively inclusive eligibility criteria employed in the current study, it was important to code a detailed variety of study characteristics by which to compare the diverse studies, if necessary (Lipsey & Wilson, 2001). For each study, this researcher coded the following study characteristics: study number, authors, publication status, publication type, study date, discipline, primacy of key variables, sample size, sample gender composition, sample age, sample grade (if applicable), sample nationality, sample race/ethnic composition, any special characteristics of the sample (e.g., gifted), creativity construct, measure domain specificity, creativity measure format, creativity measure name, creativity variable, original statistical procedures and results, effect size, standard error, inverse variance weight, and the direction of the effect. The researcher also initially attempted to code measure reliability for each primary study, but few studies reported this value, and those that did used various reliability forms (e.g., alpha, test-retest), which were not directly comparable. As such, the researcher discontinued coding of study reliability.

The current study did not code for a global study quality variable. Lipsey and Wilson (2001) assert that even experienced researchers often disagree on what constitutes rigor and quality in a study. Thus, it is often recommended to empirically examine study characteristics (e.g., design, sampling, measures) that contribute to greater or smaller effect sizes (Card, 2012) instead of analyzing a global study quality variable. This strategy was employed in the current study via the coding and investigation of a variety of moderators (i.e., ability vs. achievement measures, measure domain specificity, sample age, and study date).

For those studies excluded from the sample, a variable was coded briefly describing the reason for disqualification (e.g., "language": Study reported in a language other than English). For further description of the coding of variables for all included and excluded studies, please refer to Table 10 in the Appendix. All coding and reporting of coding in this study was informed by the reporting standards of the APA Publications and Communications Board Working Group on Journal Article Reporting Standards (2008).

Calculation of effect sizes. In primary studies, gender differences in creativity were typically represented either as a group contrast (i.e., mean differences between males and females) or an association between creativity and a coded gender variable (e.g., correlation coefficient). In order to compare and combine gender differences (or similarities) found across studies, a standardized effect size—Hedges' *g*—and standard error were computed in Microsoft Excel for each measured relationship between gender and creativity. Effect sizes were calculated from standard information provided in research reports (i.e., means, standard deviations, *t*-values, correlation coefficients, ANOVA data, *p*-values) according to Formulas 2.1-2.7 in Table 2. Effect sizes were calculated such that positive values indicated higher mean creativity scores for females (the mean for females minus the mean for males); negative effect sizes indicated

Table 2

Formulas for Effect Size Calculations

Formula #	Formula Name	Formula	Source
2.1	Hedges' *g*	$\frac{\bar{X}_1 - \bar{X}_2}{s_{pooled}}$	Lipsey & Wilson (2001)
2.2	s_{pooled}	$\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}}$	Lipsey & Wilson (2001)
2.3	*g* from *t*-statistic	$t\sqrt{\frac{n_1+n_2}{n_1 n_2}} \approx \frac{2t}{\sqrt{N}}$	Lipsey & Wilson (2001)/Card (2012)
2.4	*t*-statistic from *p*-value	$t = IDF$ (*p*-value, *df*)	Lipsey & Wilson (2001)
2.5	*g* from *F*-statistic (one-way ANOVA)	$\sqrt{\frac{F(n_1+n_2)}{n_1 n_2}}$	Lipsey & Wilson (2001)
2.6	s_{pooled} from factorial ANOVA	$\sqrt{\frac{SS_B + SS_{AB} + SS_w}{df_B + df_{AB} + df_w}}$	Lipsey & Wilson (2001)
2.7	*g* from correlation (*r*)	$\frac{r}{\sqrt{(1-r^2)\big(p(1-p)\big)}}$	Lipsey & Wilson (2001)
2.8	Correction for bias in *g* (*g'*)	$\left[1 - \frac{3}{4N-9}\right] g$	Lipsey & Wilson (2001)
2.9	Standard Error of *g'* (SE_i)	$\sqrt{\frac{n_1+n_2}{n_1 n_2} + \frac{(g')^2}{2(n_1+n_2)}}$	Lipsey & Wilson (2001)
2.10	Variance for study *i* (v_i)	SE_i^2	Borenstein et al. (2009)
2.11	Weight for study *i* (w_i)	$\frac{1}{SE_i^2}$	Card (2012)

Note. Some notation may have been changed from the original source notation to maintain uniformity across formulas. $\bar{X}$ represents sample group mean. *s* represents sample group standard deviation. *n* represents group sample size. *t* represents a t-statistic reflecting the relationship between gender and creativity. *IDF* is the inverse distribution function for a two-tailed Student's *t*-distribution, with specified *p*-value and *df* degrees of freedom. *F* represents an *F*-statistic reflecting the relationship between gender and creativity. *r* represents a point-biserial correlation between gender and creativity. *p* represents one group's proportion of the total sample. *g* represents Hedges' *g* or the standardized mean difference effect size for a given study.

male creativity superiority; and effect sizes approaching zero indicated a lack of gender differences.

In primary studies, gender was also sometimes included as an independent variable in a multivariate regression predicting creativity. In this case, it was not possible to meaningfully combine the regression coefficient for gender with standardized mean difference effect sizes. It was originally proposed that if a large number of studies employed multivariate regression, a secondary meta-analysis would be conducted, in which semi-partial correlation effect sizes (r_{sp}) would be calculated (according to the procedures described in Aloe & Becker, 2012) and compared against the main meta-analysis. However, too few studies were found having used this method to warrant the second analysis, so regression-only primary studies were omitted.

Another common issue in meta-analysis is the possibility that multiple effect sizes can be derived from a single study/sample, thus violating the assumption of statistical independence of the data (Card, 2012). Examples of dependent effect sizes in the creativity literature arise from associations between gender and multiple creativity measures, the relationships between gender and multiple creativity subscales/domains, or measurement across different time points. There are three typical ways to handle such scenarios (Hedges, 2007): 1) multi-level nested modeling of the effect sizes, 2) creating a mean effect size from all measures used in a sample, or 3) disregarding that effect sizes are not independent. The first solution is the most elegant, but it is rarely used because the information necessary to carry it out is often not reported in primary studies. The latter two methods are the most practical and commonly used, but Becker (2000) recommends against ignoring the dependence of effect sizes.

The current study handled the issue of dependence as follows: where possible, data were averaged such that a single, independent effect size represented each study, which has been done

in several published creativity meta-analyses (e.g., Byron et al., 2010; Davis, 2009; de Jesus et al., 2013; Ma, 2009). However, using a measure of central tendency is sometimes unhelpful because data relevant to the study (particularly moderators) are lost (Becker, 2000). Another way to deal with multiple measures is to choose one to represent the study and omit the others (e.g., Becker, 1989; Hyde and Linn, 1988). Thus, when moderator variables needed to be preserved, the researcher selected one measure to represent the study. The measure was selected in such a way that the meta-analysis remained most balanced on variables of interest (e.g., ability vs. achievement, creativity measure format). It should also be noted that, if data for multiple independent samples were reported in a single paper (e.g., separately conducted studies, multiple age groups), these were treated as independent samples (Borenstein et al., 2009). Thus, it was possible to derive multiple independent effect sizes from a single report or paper[1].

The final issue with regard to effect size is that of corrections. Several effect size corrections were made based on flaws in the data. Hedges' *g* is known to be a biased estimate of population effect sizes (Card, 2012; Lipsey & Wilson, 2001). Thus, a correction (see Formula 2.8) is routinely applied, particularly if small samples are used in primary studies (Hedges & Becker, 1986). This correction was made to all effect sizes. The other study artifact most commonly corrected for is that of outliers (Lipsey & Wilson, 2001). After gathering the sample of studies, the investigator examined effect sizes for outliers and dealt with them as is discussed further in the Results section.

Coding reliability. The reliability of study coding was established via intracoder agreement. Intracoder agreement is considered to be a viable means for detecting any "drift" in a

[1] Hence, the term "studies" may be used interchangeably with the term "independent samples" throughout this paper. For example, when the researcher states that "261 studies were published studies", she means that 261 independent samples came from published sources.

single coder's process and decision-making that may occur over time (Card, 2012). Card suggests that intracoder agreement is best performed such that the two instances of coding a study are as independent as possible. For instance, the researcher should not have prior knowledge of which studies will be part of double-coding, should re-code clean copies of studies, and should let as much time as possible (within reason) elapse between original and double coding. All of these precautions were taken during the current intracoder ratings.

After the first round of coding was conducted, this researcher randomly selected 20 studies to re-code. This number falls within the range of 20-50 studies recommended for double-coding by Lipsey and Wilson (2001). Most study characteristics included in the current analysis were considered to be "low inference" or fairly objective, so a low number of studies provided sufficient evidence of intracoder agreement (Card, 2012). Re-coding took place an average of 1.66 months after the original coding of the studies. An agreement rate of 97% was calculated for major variables. Most errors found were typographical errors or misreadings of study information, which this researcher easily resolved by returning to the source material.

Data Analytic Strategy[2]

Publication bias. In order to stem the effects of the "file-drawer problem" in the current study, accessible, unpublished studies (e.g., dissertations, technical reports) were actively collected and included. Furthermore, one of the benefits of meta-analysis is that it can be relatively blind to the focus and conclusions of the original studies (Card, 2012). As such, even if gender is not a primary variable of interest in a creativity study, demographic information is almost universally collected, and sometimes gender controls or results are reported in passing. Inclusion of this type of secondary gender result—upon which publications decisions were

[2] All analyses were conducted in Excel or SPSS.

unlikely to have been based—possibly reduced publication bias in the current study. The "primacy of key variables" variable was included to provide a basis for objectively analyzing whether the study focus made a differences in effects. A similar rationale was used for including such a variable in a study of gender differences by Becker (1989).

Despite all efforts to minimize publication bias, it still behooved the researcher to analyze for publication bias after studies were collected to inform the interpretation of results (Card, 2012). Bias analysis strategies included constructing a funnel plot and statistically comparing studies based on publication status and primacy of study variables. Although computing a failsafe *N* is a common practice in assessing publication bias, Becker (2005) recommends against it for a variety of reasons, such as its easy misinterpretation, lack of a statistically-derived criterion, failure to incorporate sample sizes or the magnitude of effects, and challenges in incorporating moderators. Therefore, no failsafe *N* was included.

Research question 1. Research question 1 concerns the existence of general gender differences in creativity. In order to address this question, an overall mean effect size ($\bar{g}$) was calculated via a random-effects model. Although heterogeneity tests were conducted to assist in determining model type, scholars also emphasize the crucial need to consider other more conceptual factors (Borenstein et al., 2009; Card, 2012). Random-effects models (versus fixed-effects models) are appropriate when sampled studies are not assumed to be functionally similar and when the researcher wants to generalize to broader literature than strictly those studies included in the meta-analysis. Some researchers suggest that random-effects models are the appropriate choice in the majority of real-world meta-analyses and generally consider them the better "default" model (Borenstein, Hedges, Higgins, & Rothstein, 2010). Given the variety of measures and population types used in in the present analyses, a random effects model seemed

most appropriate conceptually, and formulas discussed from this point forward will reflect this model. The result of the overall meta-analytic mean will be discussed in terms of the significance and power of the analysis.

Research question 2-4. The remaining research questions each deal with exploring a different moderator. Research questions 2-4—concerning creativity construct, domain specificity, and format of the creativity measure—were evaluated either via a Z-test of mean differences (RQ2-3; Borenstein et al., 2009) or partitioning the heterogeneity of subgroups, which is similar to ANOVA (RQ4; Card, 2012). Again, moderator results will be discussed in terms of the significance and power of the analyses.

Research questions 5-6. Research questions 5 and 6 concern the role of participant age and study era in gender differences. Given that these are both continuous moderator variables, they were examined via separate weighted meta-regressions according to the procedures described in Card (2012). Each regression will be interpreted according to the significance of the overall model.

Overall analysis of moderators. Finally, all moderators found to be significant in the previous analyses were entered into a single weighted linear multiple regression (similar to that described for research questions 5-6) predicting effect sizes in gender differences. Results will be interpreted in terms of 1) which variables remain significant after controlling for other moderators, 2) the relative contributions of the different moderators in predicting effect sizes, and 3) the overall variance explained (Card, 2012).

CHAPTER 4

RESULTS

Descriptive Information

Systematic search efforts returned a total of 1,877 studies. Of this number, 271 met inclusion criteria, meaning 1,606 were excluded. Included studies yielded 480 independent samples, enabling the researcher to calculate 480 independent effect sizes. Effect sizes ranged from -1.59 to 1.69. Seven effect sizes were identified as outliers at greater than three standard deviations away from the mean effect size in either the positive or negative direction. These effect sizes were "Winsorized," or replaced by more moderate values (as described in Lipsey & Wilson, 2001). In this instance, the new values were set at the three-standard deviation mark—1.23 for positive outliers and -.109 for negative outliers. This procedure was implemented in order to retain valuable data without extreme scores potentially skewing results. Following the adjustment of outliers, a stem-and-leaf plot of effect sizes was constructed, which appears in Figure 1. This plot shows effect sizes to be approximately normally distributed.

Included studies were conducted between the years of 1958 and 2015, with an average publication date of 1983.79 (*SD* = 16.27). Of the overall pool of independent samples, most were drawn from journal articles (*k* = 246) and dissertations (*k* = 190). The majority of these studies utilized creative ability tests (*k* = 424), employing primarily domain-general tests (*k* = 400) and often DT tests (*k* = 376). The overall *N* (total number of participants) for included studies was 137,247, with an average of 285.93 (*SD* = 1143.60) participants per study. The average age of participants ranged from 3.74-70.60 years, with an average of 15.24 years (*SD* = 9.11). Thirty-seven nationalities were represented in the pool of studies[3]; however, a significant majority of

[3] Nationalities represented in the study pool included American, Australian, Belgian, British, Canadian, Chinese, Egyptian, French, German, Greek, Hungarian, Indian, Iranian, Israeli, Italian, Jamaican, Japanese, Jordanian,

Gender Differences (*g*)	
-1.0	8999
-0.9	
-0.8	1223667
-0.7	04
-0.6	144
-0.5	11122344456
-0.4	0001233344555556779
-0.3	000113344444556778
-0.2	00000000112223333344455566667777889
-0.1	000000011111222222233334445555666777777888999
-0.0	001111112222222333334444445555555555556666777777778888999
0.0	000111122222223333344444445555556666666777777788888888999
0.1	000000000001111122222222223333444445555556666677778889999
0.2	000111111122222333333344555555666666677777788888899999
0.3	00000000001112222223334445567778899999
0.4	01111223334445566677778 8
0.5	00122335666689
0.6	012222456
0.7	013458
0.8	13559
0.9	113456
1.0	02
1.1	2
1.2	023333

Figure 1. Stem-and-leaf plot of gender differences in creativity (*g*). Positive effect sizes represent higher female creativity; negative effect sizes represent higher male creativity. *g* is rounded to two decimal places.

samples were derived from the U.S. ($k = 299$). Special populations included students with hearing impairments, students with visual impairments, gifted//high-achieving students, at-risk youth, bilingual students, famous actors, student-athletes, inventors/scientists, and high-level business managers. Few studies included information on participants' race or socio-economic

Kenyan, Korean, Latvian, Malaysian, Nigerian, Polish, Russian, Saudi, Slovakian, Spanish, Sudanese, Swedish, Swiss, Taiwanese, Thai, Turkish, Vietnamese, and samples of mixed nationalities.

status (SES), but of those that did, White race and mixed-SES samples were most common. More details on these and other descriptive data about the study pool and participants are provided in Tables 3 and 4.

Publication Bias

Publication bias was assessed via a funnel plot and analyses of publication status and primacy of study variables. First, a funnel plot of effect sizes was constructed, as shown in

Table 3

Study Pool Descriptive Information

Continuous Variable	*M*	*SD*
Study era (pub. date)	1983.79	16.27

Categorical Variables	No. Studies	% Studies
Study source		
Journal article	246	51.3
Dissertation/thesis	190	39.6
Technical report	27	5.6
Conference paper	10	2.1
Book chapter	7	1.5
Creativity construct		
Ability	424	88.3
Achievement	55	11.5
Domain specificity		
General	400	83.3
Specific	80	16.7
Test format		
DT Test	376	78.3
Product	33	6.9
Self-report	52	10.8
Other-report	19	4.0

Note. Total number of studies (*k*) = 480.

Table 4

Overall Sample Demographic Information

Continuous Variables	*M*	*SD*
Sample size (per study)	285.93	1143.60
% female	49.78	9.46
Sample age (years)	15.24	9.11

Categorical Variables	No. Studies	% Studies
Age group		
Children (≤11)	228	47.5
Adolescents (12-18)	123	25.6
College/Young adult (18-25)	82	17.1
Adult (25-65)	45	9.4
Older adult (≤66)	2	0.4
Race		
White	90	18.8
Asian	64	13.3
Hispanic/Latino	17	3.5
Black	15	3.1
Native Am.	1	0.2
Mixed groups	10	2.1
Not reported	282	58.8
Nationality[a]		
American (U.S.)	299	62.2
Indian	35	7.3
Canadian	17	3.5
Chinese	15	3.1
British	13	2.7
Mexican	12	2.5
German	10	2.1
SES		
Low	37	7.7
Middle	45	9.4
Upper	20	4.2
Mixed	87	18.1
Not reported	290	60.4

Note. Total participants across studies (*N*) = 137,247.

[a] Only nationalities constituting >2% of study pool included in table. Others nationalities discussed under Descriptive Information in Results section.

Figure 2. According to Card (2012), a funnel plot evidences bias if it shows asymmetry, such that non-significant results are under-represented (i.e., a lack of small effect sizes originating from small samples). The plot shows no evidence of asymmetry or absence of small effect sizes at smaller sample sizes; thus, the funnel plot does not indicate publication bias in the pool of studies.

Next, studies were statistically compared based on publication status and primacy of study variables. In the final sample of studies, 261 studies were published and 219 unpublished, and 327 employed creativity and gender variables in a primary capacity and 153 in a secondary capacity. Publication status and primacy were treated as additional, secondary moderator variables, analyzed according to the *Z*-test procedures discussed fully under Research Questions 2-3. The analyses showed no evidence that the effects for published studies differed from unpublished studies ($Z = -.84$, $p = .40$), nor that effects in variable-primary studies differed from variable-secondary studies ($Z = -.69$, $p = .49$). Thus, there is no evidence overall that publication bias was present in the collected study pool.

Research Question 1: Gender Differences in Creativity

In order to address this question, an overall grand mean effect size ($\bar{g}$) was calculated. First, the pool of individual effect sizes was assessed for heterogeneity to confirm the appropriate model. To assess for the presence and magnitude of heterogeneity, a *Q*-statistic and an I^2 index were computed using Formulas 5.1-5.2. The *Q*-statistic was 2314.06, which was found to be significant according to the χ^2 distribution ($df = 479$; $p < .001$). The I^2 index was 79.3%, which represents high heterogeneity according to the criteria of Higgins and colleagues (2003). Thus, according to the *Q*-statistic and I^2 index, the sample is considered heterogeneous. The studies are assumed to fall along a distribution of effect sizes in the population, and they should be

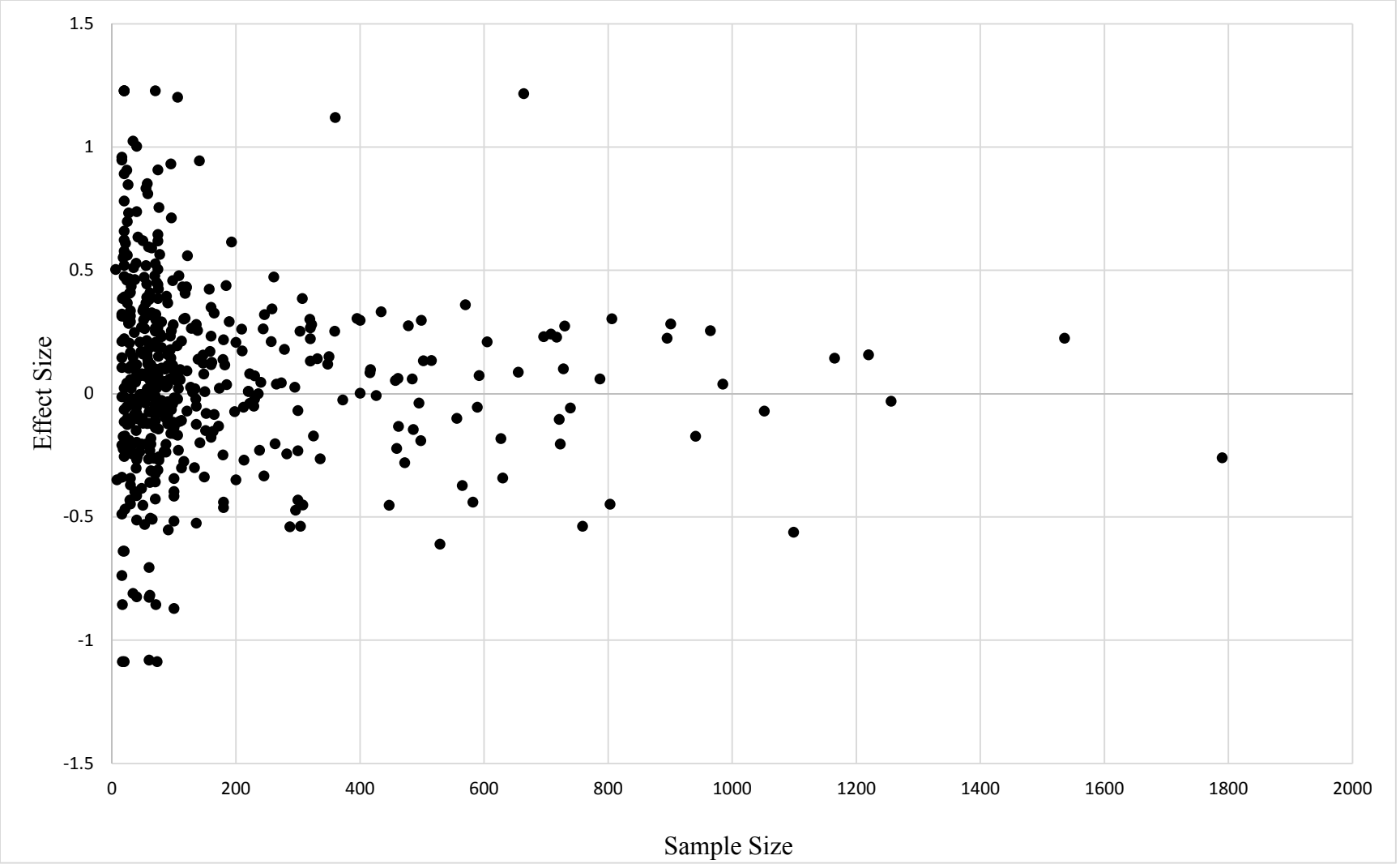

Figure 2. Funnel plot of gender differences in creativity (*g*). Eight data points that were extreme outliers due to sample size were excluded from this plot to improve visual quality.

Table 5

Meta-Analysis Formulas for Mean Effect Size

Formula Number	Formula Name	Formula	Source
5.1	*Q*-statistic (heterogeneity)	$\sum(w_i g_i^2) - \frac{(\sum(w_i g_i))^2}{\sum w_i}$	Card (2012)
5.2	I^2 index	$\frac{Q-(k-1)}{Q} * 100\%$	Card (2012)
5.3	Estimated Population Variance of Effect Sizes (τ^2)	$\frac{Q-(k-1)}{(\sum w_i) - \frac{(\sum w_i^2)}{(\sum w_i)}}$	Card (2012)
5.4	Random-Effects Weight for study *i* (w_i^*)	$\frac{1}{\tau^2 + SE_i^2}$	Card (2012)
5.5	Random-Effects Mean Effect Size ($\overline{g^*}$)	$\frac{\sum(w_i^* g_i)}{\sum(w_i^*)}$	Card (2012)
5.6	Standard Error of $\bar{g}^*$ ($SE_{\bar{g}}^*$)	$\sqrt{\frac{1}{\sum(w_i^*)}}$	Card (2012)
5.7	Variance of $\bar{g}^*$ ($v_{\bar{g}}^*$)	$\left(SE_{\bar{g}}^*\right)^2$	Bornstein et al. (2009)
5.8	95% Confidence Interval for $\bar{g}^*$	$\bar{g}^* \pm Z_{1-\alpha} SE_{\bar{g}}^*$	Card (2012)

Note. Some notation may have been changed from the original source notation to maintain uniformity across formulas. *SE* represents the standard error for a given study. *g* represents Hedges' *g* or the standardized mean difference effect size for a given study. *k* represents the number of studies overall. $Z_{1-\alpha}$ represents the two-tailed standard normal deviate for α significance level.

evaluated with a random-effects model (Card, 2012).

Next, the individual effect size for each study was weighted according to Formula 5.4, and the overall mean effect size ($\bar{g}$) and standard error were computed via a random-effects

model (Formulas 5.5-5.6). Additionally, a 95% confidence interval was calculated around the grand mean using Formula 5.8. The grand mean of all independent effect sizes was $\bar{g} = .056$; the overall standard error was .015; and the 95% confidence interval was .026-.087. Because the 95% confidence interval does not contain zero, $\bar{g}$ is significant at $p < .05$ (Hedges & Becker, 1986). Since $\bar{g}$ is significant in the positive direction, it indicates that females evidence higher mean creativity across studies. However, it should be noted that, while significant, a mean Hedges' *g* of .05 only falls in the "small" range of magnitude for standardized mean difference effect sizes (Cohen, 1977).

A power analysis for research question 1 (RQ1) was performed via the methods described by Valentine and colleagues (2010), using their formulas which are reproduced in Table 6 (Formulas 6.1-6.2). Power for the analysis of the main mean effect size was .96. This power level indicates that, with the observed number of studies and mean effect size, there was a 96% chance of correctly rejecting the null hypothesis, and the researcher can be confident that low power was not an issue when interpreting the results above.

Research Question 2: Creativity Construct

Research question 2 concerned the contrasting of effects based on measures of creative ability versus creative achievement. Similar to RQ1, a 95% confidence interval was used to evaluate whether the subgroup means differed from zero. To evaluate the categorical moderator, a Z-test comparing the mean effect size for ability studies versus the mean effect for achievement studies was used (Card, 2012). First, means and standard errors were calculated for each subgroup—creative ability and creative achievement—according to the same procedures discussed for RQ1. The mean effect size for studies using creative ability measures was .045 (*SE* = .016). The mean effect size for studies using creative achievement measures was .151 (*SE* =

Table 6

Power Calculation Formulas

Formula Number	Formula Name	Formula	Source
6.1	Noncentrality Parameter for $\bar{g}^*$ (λ^*)	$\frac{\overline{\bar{g}^*} - 0}{\sqrt{v_{\bar{g}}^*}}$	Valentine et al. (2010)
6.2	Random Effects Power for $\bar{g}^*$	$1 - \Phi(c_\alpha - \lambda^*)$	Valentine et al. (2010)
6.3	Random Effects Noncentrality Parameter Between 2 Groups (λ_B^*)	$\frac{(\overline{g_A^* - g_B^*})^2}{v_A^* + v_B^*}$	Valentine et al. (2010)
6.4	R.E. Noncentrality Parameter Between 3+ Groups (λ_B^*)	$\sum \frac{1}{v_j^*}(\bar{g}_j^* - \bar{g}^*)$	Valentine et al. (2010)
6.5	Random Effects Power for Categorical Moderators	$1 - F(c_\alpha \mid p-1;\ \lambda_B^*)$	Valentine et al. (2010)

Note. Some notation may have been changed from the original source notation to maintain uniformity. $\bar{g}$ represents the mean effect size. * denotes a random effects value. Φ(x) represents the standard normal cumulative distribution function. In Formula 6.2, c_α is the critical value for the standard normal distribution. At $\alpha = .05$, $c_\alpha = 1.64$ for a one-tailed test; $c_\alpha = 1.96$ for two-tailed. In 6.5, c_α is is the one-tailed critical value for of a central χ^2 distribution with *df* at $p - 1$. p is the number of levels in a categorical variable. F(x) is the cumulative distribution function of a noncentral χ^2 with noncentrality parameter λ_B^* (Valentine et al., 2010).

.067). Neither the 95% confidence interval for ability measures (.014-.076) nor achievement measures (.020-.282) included zero, so both means were significantly different from zero. A *Z*-test was conducted between the means according to Formulas 7.1-7.2. The effect failed to reach significance, $Z = -1.55$, $p = .94$. The trend of the effect was in the direction opposite of that predicted: the prediction was that gender differences in achievement would surpass ability, favoring males, but the data showed that gender differences in achievement nearly surpassed ability, favoring *females*. If female superiority in achievement had been the predicted direction,

Table 7

Meta-Analysis Formulas for Moderators

Formula Number	Formula Name	Formula	Source
7.1	Z-test for Subgroup Mean Differences (Z^*)	$\frac{\bar{g}_A^* - \bar{g}_B^*}{\sqrt{v_A^* + v_B^*}}$	Borenstein et al. (2009)
7.2	P-value for Z-Test (one-tailed)	$p^* = 1 - [\Phi(\lvert Z^* \rvert]$	Borenstein et al. (2009)
7.3	P-value for Z-Test (two-tailed)	$p^* = 2[1 - (\Phi(\lvert Z^* \rvert))]$	Borenstein et al. (2009)
7.4	Heterogeneity Within Subgroup *j* (Q_j^*)	$\sum(w_i^* g_i^2) - \frac{(\sum(w_i^* g_i))^2}{\sum w_i^*}$	Borenstein et al. (2009)
7.5	Heterogeneity Within All Subgroups (Q^*_{within})	$\sum Q_j^*$	Borenstein et al. (2009)
7.6	Heterogeneity of All Effect Sizes (Q^*_{total})	$\sum(w_i^* g_i^2) - \frac{(\sum(w_i^* g_i))^2}{\sum w_i^*}$	Borenstein et al. (2009)
7.7	Heterogeneity Between Subgroups (Q^*_{bet})	$Q^*_{bet} = Q^*_{total} - Q^*_{within}$	Borenstein et al. (2009)
7.8	*SE* Correction for Meta-Regression (adjusted *SE*)	$\frac{SE_{output}}{\sqrt{MS_{residual}}}$	Card (2012)

Note. Some notation may have been changed from the original source notation to maintain uniformity across formulas. *j* represents a given subgroup. SE_{output} represents the standard error provided by the software output. $MS_{residual}$ represents the residual mean square.

the *p*-value for this analysis would have indicated marginal significance at $p = .06$.

Power analyses for this research question were performed via the methods described by Valentine and colleagues (2010; Formulas 6.3, 6.5). Power for the ability mean effect size was

.82; power for the achievement mean was .62; and power for the *Z*-test was .34. Traditionally, adequate study power is defined as .80 (Cohen, 1977). Power for the ability mean fell above this benchmark, but power for the achievement mean and *Z*-test did not. Therefore, there is the possibility that the current results, in part, reflect a Type II error (i.e., not detecting a significant effect in the sample when it truly exists in the population). For instance, the Z-test offered only a 34% chance of correctly rejecting the null hypothesis with the given data. Uneven cell sizes between ability and achievement studies—there were substantially fewer achievement studies, $k = 55$, than ability studies, $k = 424$—likely increased the within-group heterogeneity and reduced power in the analyses involving achievement.

Research Question 3: Domain Specificity

Research question 3 concerned the contrasting of effects based on the domain specificity of the measure. Analytic procedures for RQ3 were identical to those used for RQ2. The mean effect size for studies using domain-general measures was .049 ($SE = .016$). The mean effect size for studies using domain-specific measures was .099 ($SE = .048$). The *Z*-test failed to reach significance, $Z = -.98$, $p = .16$. However, neither the 95% confidence interval for general measures (.017-.081) nor specific measures (.005-.193) included zero, so both means were significantly different from zero.

A power analysis was again conducted according to the same procedures as those discussed in RQ2. Power for the general measure mean was .86; power for the specific measure mean was .54; and power for the Z-test was .16. As in RQ2, these latter two values falls below the benchmark of .80, indicating that the non-significant results may represent Type II error. Also again, uneven cell sizes between domain-general ($k = 400$) and domain-specific ($k = 80$) studies likely increased the within-group heterogeneity and reduced power.

Research Question 4: Creativity Measure Format

Research question 4 regarded the format of the creativity measure. Mean effect sizes and standard deviations for the subgroups were as follows: DT test ($\bar{g}$ = .075; *SE* = .016), product measures ($\bar{g}$ = .036; *SE* = .076), self-report ($\bar{g}$ = .007; *SE* = .052), and other-report ($\bar{g}$ = -.052; *SE* = .069). The only one of these subgroup means that differed significantly from zero (based on a 95% confidence interval) was DT tests, wherein females showed higher performance. The analytic procedure for RQ4 used partitioning of the heterogeneity of subgroups (similar to an ANOVA; Borenstein et al., 2009; Card, 2012), conducted according to Formulas 7.4-7.7. The Q_{bet} value was evaluated by computing a *p*-value for Q^* using the CHIDIST function in Excel (Borenstein et al., 2009). Q_{bet} (Q^* = 4.57) failed to reach significance (*p* = .21), meaning that no gender differences were observed between creativity test formats. The ANOVA-type procedure was an omnibus test; however, since it was not significant, the planned follow-up comparisons were not appropriate.

Again, a power analysis similar to that in RQ2 and RQ3 was conducted, and it indicated that power for the DT test mean effect size approached 1.00, but power for each of the other three measure groups fell below .10. Power for the omnibus test was .42 Again, these latter values fall below .80, indicating a likelihood of Type II error. As has been the case for other categorical moderators, uneven cell sizes between the studies using the four types of measurement formats likely contributed to the lower-than-desired power.

Unlike the previous analyses thus far, this analysis could be modified in an attempt to increase power. In order to maintain the spirit of RQ4, the researcher retained the DT test subgroup (*k* = 376) and combined all other subgroups (product, self-report, and other-report) into another group (*k* = 104). This grouping makes sense statistically because it helps to make the

number of studies (and therefore the number of participants) across the levels of the variable more even. This grouping makes sense conceptually because DT tests measure basic, piecemeal creativity skills directed in a controlled setting whereas the other tests (product, self-report, and other-report) represent more holistic, real-world applications and observations of creativity. The researcher hypothesized that female advantage would be less for holistic measures than for DT tests, given the evidence discussed previously that females' creative accomplishment trail males' (e.g., Reis, 2001). Analytic procedures for this alternative conceptualization of RQ4 were identical to those used for RQ2 and 3. The mean effect size for DT test studies was again .075 (*SE* = .016). The mean effect size for studies using the holistic measures was .000 (*SE* = .037). The *Z*-test reached significance, $Z^* = 1.84$, $p = .03$, indicating that females show a greater advantage on DT tests than other types of measures, and in fact, show no advantage on more holistic measures. As mentioned previously, DT tests' mean was significantly different from zero, but holistic tests' mean was not (see 95% confidence intervals in Table 8). Again, the power for the DT test mean effect size approached 1.00; power for the holistic test group mean was still less than .10; and the power for *Z*-test was .45. The results of RQ1-RQ4 are summarized in Table 8.

Research Question 5: Participant Age

Question 5 considered the association between participant age and effect size. Continuous moderators were examined via weighted meta-regression according to the procedures described in Card (2012) and Borenstein and colleagues (2009). Prior to the regression, outlier analyses of the age variable were conducted. Twelve samples with a mean age greater than 42.46 (3 standard deviations above the mean age) were removed, leaving $k = 468$ for this analysis only. Next, the age variable was entered into a regression predicting the effect size of gender differences, using

Table 8

Summary of Results: RQ1-4

RQ	$\bar{g}$	*SE*	95% Confidence Interval	*Z*-Test
RQ1: Global	.056	.015	.026-.087*	—
RQ2				
Ability	.045	.016	.014-.076*	
Achievement	.151	.067	.020-.282*	Z = -1.55†
RQ3				
General	.049	.016	.017-.081*	
Specific	.099	.048	.005-.193*	Z = -.98
RQ4				
DT tests	.075	.016	.044-.106*	
Holistic tests	.000	.037	-.073-.073	Z = 1.84*

Note. The 95% confidence interval indicated whether the grand mean effect size and subgroup mean effect sizes differed significantly from zero. *Z*-tests indicated whether subgroup means differed significantly from each other. It should be noted that RQ2 was marginally significant in the direction opposite of that originally predicted.
$^{\dagger}p < .10$, $*p < .05$.

the random effects weight, w_i^*, specified as its weighted least squares (WLS) value in SPSS. Because the regression only had one predictor, the significance of the overall model ($Q_{\text{regression}}$) was used to determine the significance of the predictor. $Q_{\text{regression}}$ was 3.43 and was evaluated for significance by comparing it against a χ^2 distribution using Excel's "chiiniv" function. The analysis indicated that age marginally predicted creativity effect sizes (β = -.09, p = .06)[4], such that the older the sample was, the greater advantage males showed in creativity.

[4] It should be noted that power was not computed for regression analyses. In order to compute power for meta-regression, a full-covariance matrix for predictors and effect sizes is necessary (Valentine et al., 2010). Given that these values are typically not available in primary sources, power analysis was not attempted.

Research Question 6: Study Era

Question 6 addressed the effect of study era on gender differences. The procedures for analyzing the question were identical to those for RQ5 except that all studies were retained (k = 480), including age outliers. The results rendered a $Q_{regression}$ value of 2.06, which failed to reach significance (β = -.07, p = .15), meaning that there was no evidence suggesting that gender differences in creativity varied reliably according to the era of the study.

Overall Moderator Analysis

Finally, all moderators found to be at least marginally significant in the previous analyses (i.e., construct, format, and age) were entered into a single weighted linear multiple regression predicting effect sizes in gender differences. Categorical variables—creativity construct and measure format—were dummy-coded using the procedures recommended by Card (2012). Creativity construct was dummy-coded such that ability = 0, and achievement = 1. Measure format was dummy-coded such that DT tests = 0, and all other measures = 1. The overall predictive power of the regression equation was again evaluated by comparing $Q_{regression}$ against a χ^2 distribution.

The results showed that $Q_{regression}$ was 2.75 and R^2 was 0.041, which means that construct, format, and age combined explained 4.1% of the heterogeneity in gender differences in creativity. The overall model was not significant (p = .43). The βs for specific predictors ranged from -.24 to .27. Significance of specific moderators was evaluated using a one-tailed Z-test (Z = B/adjusted SE, where B was the predictor's unstandardized regression coefficient). Creativity construct was found to be a marginally significant predictor of creativity effect sizes in the positive direction (β = .27, p = .06). Practically speaking, this means that, regardless of measure format and age of the sample, females' higher creative performance relative to males is greater in

achievement than in ability. Measure format was also found to be a marginally significant predictor of creativity effect sizes, but in the negative direction (β = -.24, p = .08). Controlling for creativity construct and sample age, females tended to excel more so on DT tests than on other types of measures (i.e., product, self-report, other-report). Both of these findings are consistent with those previously reported for these two moderators in their individual analyses. Alternatively, when entered into this model, sample age was no longer a significant moderator of the creativity-gender relationship (β = -.01, *ns*). In other words, the effects of sample age noted in the individual analysis may, in fact, be attributable to the other variables included in the regression. The results of all regression analyses are summarized in Table 9.

Table 9

Summary of Results: RQ5-6 & Overall Regression

RQ	$Q_{regression}$	*B*	*SE B*	β
RQ5: Age	3.43	-.004	.002	-.085†
RQ6: Era	2.06	-.001	.001	-.065
Overall Analysis	2.75			
Construct	—	.312	.196	.268†
Format	—	-.220	.158	-.242†
Age	—	.000	.005	-.010

Note. SE B is adjusted according to Formula 7.8. R^2 = .007 for RQ5; R^2 = .004 for RQ6; and R^2 = .041 for the overall analysis. For overall analysis, Construct is coded Ability = 0, Achievement = 1. Format is coded DT tests = 0, Holistic tests = 1.
$^{\dagger}p < .10$, $^{*}p < .05$,

CHAPTER 5

DISCUSSION

The purpose of the current study was 1) to systematically investigate the accumulated evidence on gender differences in creativity and 2) to explore the conceptual factors and potential moderators that may account for past discrepancies in the literature. In order to address these questions, a comprehensive meta-analysis was conducted, addressing six research questions. To estimate overall gender differences across the literature, a grand mean effect size was calculated. To ascertain the effects of moderators, *Z*-tests, an ANOVA-type model, and meta-regressions were performed with five moderating variables: creativity construct, domain specificity, measure format, participant age, and study era. To round out statistical procedures, an overall multiple meta-regression was conducted, gauging the respective effects of significant moderators. This chapter discusses the results of each of these analyses, interpreting them within the context of the original hypotheses, the broader literature, and extant theory. Study limitations and avenues for future research are also detailed. Finally, the strengths of the study and its practical significance and implications are discussed.

Global Gender Differences in Creativity

Research question 1 (RQ1) addressed global gender differences in creativity across all studies. Practically speaking, do gender differences in creativity exist in a broad way across all people, measures, and time periods? Given the mixed nature of the previous literature in this area, no a priori directional hypothesis was provided for this question. Results indicated that females showed a slight, but significant advantage in creativity over males across all studies. This finding is in line with the determinations of past narrative reviews, which have suggested that females may show a trend toward higher creativity than males, in general (Baer & Kaufman,

2008; Baer, 2012; Kogan, 1976). The current result is also consistent with Ma's 2009 meta-analysis, which similarly showed a small female creative advantage ($\bar{g}$ = 0.14). Although the current study's result was significant, the mean effect size was slightly smaller in size ($\bar{g}$ = .056) than Ma's finding. As was discussed in the Literature Review, the current study attempted to improve upon narrative reviews and Ma's (2009) methodology by conducting a more exhaustive, focused literature search, so it is hoped that the current mean effect size represents an improved estimate of the true effect size between creativity and gender.

Past narrative reviewers (Baer & Kaufman, 2008; Baer, 2012; Kogan, 1976) have cautioned that gender differences, on average, tend to be very slight and that there is still much inconsistency from study to study. Likewise, it should be reiterated that the current study's mean effect size ($\bar{g}$ = .056), while statistically significant, is a "small" effect size according to common standards (Cohen, 1977), and the sample showed significant heterogeneity (Q = 2314.06, p < .001). As such, it is possible that this small female advantage may be of limited practical significance in predicting the behavior and success of the genders in reality. If females are truly more predisposed—even slightly—to creativity, it makes the real-world evidence of female underperformance in creativity all the more puzzling. Luckily, when there is significant heterogeneity among primary study findings, as there undoubtedly is in the creativity-gender field, it is often more informative to investigate moderators than the mean effect size alone (Card, 2012; J. C. Kaufman, personal communication, July 6, 2015). As will be discussed below, investigation of moderators may have helped to untangle some of the contradictions in the creativity-gender issue.

Creative Ability vs. Creative Achievement

Research question 2 (RQ2) concerned the difference in effects observed between studies using measures of creative ability versus those using measures of creative achievement. It was hypothesized that gender differences in creative achievement would be significantly higher than differences in ability, favoring males. Analyses did detect a marginally significant effect of creativity construct, but in the direction opposite of that predicted: gender differences in creative achievement were higher than those in ability, favoring *females.* In other words, females were found to surpass males in both creative ability and achievement, but achievement even more so than ability. The finding regarding superior creative ability is in line with a small body of work showing that girls perform slightly better on standardized measures and self-reports (e.g., Hill et al., 2008; Runco, Cramond, et al., 2010). However, the findings regarding creative achievement are contrary to the original hypothesis and rebut generally accepted knowledge about female creative productivity. Thus, results should be interpreted cautiously, and several possible perspectives should be considered.

First, it is possible that the current results were partially spurious. Findings involving creative achievement were marginally significant and based on a relatively low-powered analysis. Unfortunately, lower power is one of the drawbacks of using a random effects model relative to fixed effects (Card, 2012). Furthermore, despite the efforts of the current study to be comprehensive in its literature search, relatively few achievement studies ($k = 55$) were gathered relative to ability studies ($k = 424$). The achievement study group may not have approximated true gender differences in the population as well as the ability study group. An unrepresentative sample of studies can lead to low power and/or unexpected findings (Heiman, 2002), perhaps not reflecting true relationships between constructs. Indeed, the majority of past reviews of the

subject suggest that there are gender differences in creative productivity, with males being the higher achievers (Abra & Valentine-French, 1991; Baer & Kaufman, 2008; Baer, 2012; Eysenck; Runco, Cramond, et al., 2010). The female advantage in achievement over ability in the current study may not exist in reality.

On the other hand, it is possible that the current results, while unexpected, do reflect reality. As was noted in the literature review, summaries of past work have tended to reference statistics, case studies, and historical figures versus quantitative, empirical studies. It is possible that the current study *did* amass more comprehensive evidence on the matter and uncovered patterns that have gone undetected in the past. The current meta-analysis used a more exhaustive search strategy and incorporated many studies not previously incorporated in narrative reviews. Perhaps, females do surpass males in creative achievement to a greater degree than ability—at least, in research settings.

A third perspective is that the current results reflect certain measurement issues in self-report measures and product creation tasks. For instance, females may have reported higher achievement on self-report measures due to a greater range of interests. Eccles (2011) suggests that women show a different "density of goals," tending to pursue multiple fields, interests, or hobbies when men tend to stick to a narrow, small set. Reis' (2002b) Diversification Theory of Female Creativity describes the many domains of life into which females simultaneously pour their innovative energies: family relationships, friendships, personal relationships, service to others, spirituality, work, hobbies, personal appearance, and home tasks (decorating, cooking, stretching the budget, scheduling, organizing). Such a theory suggests that females hold their own in terms of creative accomplishment; they simply aim for breadth over depth. Hence, while females may not be shining at the heights of Big-C creative accomplishment, they may be

secretly flourishing as "creative polymaths" (i.e., multi-taskers) at the Little-c or Pro-C levels (Kaufman et al., 2010a). Males may still surpass females in eminence or quality of more narrow of achievement, but as discussed in the literature review, typical self-report scales do not take differences between quantity and quality of achievement into account.

In the case of in-vivo product achievement measures, it could be that females only surpass males in achievement in artificial settings. The majority of the achievement studies in the current study pool were based on Amabile's consensual assessment technique (Amabile, 1982a; 1982b), which is a procedure resulting in an experimentally dictated creative product. These studies have shown that females generally produce more creative products when intrinsically motivated, and males in situations wherein they are extrinsically motivated (Baer, 1998). Although some studies did offer external reward during product creation tasks, this was not always the case, and in some studies this point was not clear. It is possible then that the current results reflect a group of product studies showcasing male underperformance relative to females due to a lack of external incentive during the experimental procedures. Unfortunately, neither issues of creative motivation nor quantity vs. quality of achievement were included as part of the current investigation due to a lacking number of studies addressing these sub-questions. However, issues of creative achievement motivation and breadth would be fruitful areas for future inquiry.

Domain Specificity

RQ3 addressed the issue of whether the domain-specificity of creativity measures made a difference in the effect sizes observed. It was anticipated that domain-general creativity measures would show significantly greater gender differences than domain-specific measures. Results did not support the hypothesis: specificity of measures did not moderate associations between

creativity and gender. In other words, females showed a slight and similar advantage on both domain-general and domain-specific measures. Such findings align with previous work showing females exceling across a variety of domains, including verbal, nonverbal, interpersonal, and artistic (Amabile, 1996; DeMoss et al., 1993; Hong & Milgram, 2010; Kaufman, 2006). The lack of domain specificity as a moderator also lends support to the theory of domain generality as a whole, given that creative performance patterns seemed unified by a core underlying ability, regardless of measurement domains (Plucker, 1998).

However, as with creativity construct, this finding possibly represents other interpretations. It must again be considered whether low power in the analysis masked true effects. Power was assessed at .16, meaning that there was only a 16% chance of correctly rejecting the null hypothesis with the current data. Again, with this variable, one sub-group—domain-specific measures—was under-represented relative to the other subgroup—domain-general measures. It is possible that this smaller group of domain-specific studies did not fully represent the complex gendered patterns that emerge in real-world creative fields. Particularly, given the numerous and disparate ways domains can and have been parsed across the literature (e.g., Kaufman, 2012; Milgram & Milgram, 1976), a greater number of studies would have been desirable to fully illustrate the diversity of domain-specific measures and increase the sensitivity of gender analyses. Further work using the more recently-developed domain-specific measures will hopefully ameliorate the current imbalance and add more clarity to the issue of gender, creativity, and domain-specificity.

Creativity Measure Format

RQ4 was another question involving measurement issues, and it asked whether the format of creativity measures used across studies influenced results. Initially, four measurement

formats were considered—DT tests, products, self-report scales, and other-report scales. It was anticipated that self-report measures would show stronger gender differences (favoring males) than other measurement formats, and DT tests were expected to show weaker gender differences. Findings ultimately did show moderation of the creativity-gender relationship by test format, but results were different from those expected. In fact, DT tests showed *stronger* differences than other types of measures, in favor of females. Product measures, self-report, and other-report tests (which were ultimately grouped together under the concept "holistic measures") did not show any significant, discernable gender differences, neither as a group nor individually. The results for DT tests generally fall in line with previous conclusions in the literature: "Overall, girls [tend] to outperform boys on divergent thinking tests, but the differences were small..." (Baer, 2012, p. 220). In terms of the creative person theories discussed in the Literature Review, females and males appear to be similar in personal characteristics and potential, with females possessing perhaps slightly more innate proclivity toward creativity.

Alternatively, product, self-report, and other-report measures were found not to differ by gender. Indeed, the majority of previous research conclusions suggest no significant difference in products made in research settings (Baer & Kaufman, 2008), and a batch of previous empirical work has shown gender equality in self- and other-report (e.g., e.g., Charyton, Basham, et al., 2008; Chong & Ma, 2010; Gralewski & Karwowski, 2013; Jaussi et al., 2007; King et al., 1996; Kousoulas & Mega, 2009; Tan et al., 2007). Such null findings substantiate viewpoints like the Gender Similarities Hypothesis (Hyde, 2005) that suggest males and females are not so different after all.

Despite the current findings, the gender differences observed for the holistic measures were generally expected to be stronger than observed, and the lack of effects found warrants

some consideration. First, it should be reiterated that the majority of product studies used some version of the CAT. As mentioned previously, CAT procedures have evolved to include a variety of permutations, using different product domains, manipulating competition, or changing the salience of evaluation from study to study. Given that past research has suggested that manipulation of such factors may influence gender findings (e.g., Baer, 1998b; Conti, Collins, & Picariello, 2001; Hyde, 2005), it is possible that definitive gender patterns get washed out when mixing research paradigms that lend advantage to one gender or the other.

Second, lab-based products are not tantamount to real-world achievement. Asking a person to write a short poem or make a collage is a very different matter from someone making the choice to dedicate themselves to higher level creative achievements in the poetry or art world—taking the necessary risks and making the sacrifices to be successful. A greater number of the product studies in the meta-analysis focused on short-term, lab-based productivity rather than real-world productivity. In terms of Kaufman and Beghetto's (2009) Four-C model, more Little-c studies have been conducted that Pro-C or Big-C. If more studies focusing on these higher level products were included, results may look different—especially as males are thought to excel at these higher levels (Abra & Valentine-French, 1991; Baer & Kaufman, 2008; Baer, 2012; Eysenck; Runco, Cramond, et al., 2010).

Finally, it should again be noted that analyses involving creativity measure format were relatively low in power, and the different measurement types were not evenly represented in the study pool. There were a greater number of DT test studies than studies using all other types of measures combined. Card (2012) suggests that a meta-analyst only needs approximately five studies to adequately represent different levels of a categorical moderator, a standard which was attained for all test types. However, it is unlikely that data gathered for the 19 other-report

studies matches the complexity of the data gathered for the 376 DT test studies. Thus, as has been mentioned for other categorical analyses in the current meta-analysis, a more balanced collection of studies more evenly representing all types of measurement may have produced different moderator results. It is still possible that some of the hypotheses suggested—lesser magnitude of gender differences in DT tests, male advantage on self-report measures, etc.—may exist in reality. Luckily, as discussed in the Literature Review, recent research design in the creativity field has begun trending toward multi-method paradigms, incorporating a broader variety of measurement types (e.g., Ai, 1999; Bender et al., 2013; Charyton & Snelbecker, 2007; Dollinger et al., 2004; Gralewski & Karwowski, 2013; Jauk et al., 2014; Silvia et al., 2012). In the coming decades, more data should be available to speak to issues of gender, creativity, and creativity measurement.

Age Differences

The fifth research question asked whether gender differences varied over the course of human development. The a priori hypothesis suggested that gender differences would grow with age, with females falling behind as they encountered myriad, unique challenges to their creativity in adolescence, young adulthood, and adulthood. Analyses initially supported this supposition, with a marginally significant result showing that effect sizes became progressively more negative with older samples. In other words, males began to surpass females in creativity with age. This finding would be in line with past scholarship suggesting that female creativity becomes suppressed as they mature (Baer & Kaufman, 2008; Piirto, 1991), or alternatively that males' creativity blossoms as they come of age. Such a result would give credence to theories suggesting that women face challenges unique to their gender (or men experience supports

unique to their gender) that surface during peak creative productivity times in the lifespan (Abra & Valentine-French, 1991; Reis, 2002a; Simonton, 1994).

However, a follow-up analysis indicated that age no longer remained a significant moderator after controlling for measurement issues. In other words, some of the moderating effect of age observed in the current study may have had less to do with age per se and more to do with the different types of measures used with different age groups. A trend in the creativity field noted in the current data collection was that different measurements tend to be used with children (e.g., DT tests, products) versus adults (e.g., self-report, real-world accomplishment). Thus, it seems that the significant age finding may have reflected more of this shift in the type of measurement across the lifespan than actual changes in capacity.

In addition, it should be mentioned that the current study was somewhat limited by an age ceiling in studies. Creativity has tended to be a more popular subject of inquiry among youth than adults (Claxton et al., 2005). The average age of participants across all studies was 15.24 years, and only 47 samples focused on adults relative to 228 focusing on children alone. Future research more adequately assessing creativity across the lifespan and with a variety of measures would be beneficial for filling gaps in the literature. Such work is especially important given that developmental issues have sometimes been taken as fact in the creativity field: "For years we have been puzzled by the superiority of girls over boys during the early school years and by the superiority of men over women in scientific discovery, invention, musical composition, art, and other high achievement." (Torrance, 1963, p. 13-14).

Study Era

The final research question in the current study (RQ6) regarded whether the era of a study had an effect on gender differences in results. In other words, have gender differences

changed over time, historically? It was expected that study era would significantly moderate gender-creativity associations, such that any gender differences would have decreased over time. With the prominence of gender equality movements over the past half century, it was presumed that more recent, equal opportunity for all would help remediate any gender gaps seen in early studies included in the meta-analysis. Ultimately, results did not support this hypothesis. Study era was not found to moderate the relationship between creativity and gender. Although conceptually it makes sense that modern gender rights movements and opportunities would influence gender patterns (Runco, Cramond, et al., 2010), this researcher's narrative overview of studies (see Literature Review) did not suggest a definitive gender pattern either. Several suggestions accounting for the current results are offered below.

First, it is possible that there is a nonlinear relationship between study era and gender effect sizes. The studies collected went back quite far into the history of formalized creativity research. The earliest study included was from 1958. During these early studies, there could have been a plateau of sorts, with no notable gender change taking place until the women's rights movements of the 70s and 80s took hold and permeated into the wider culture. The analyses used in the current study would not have been sensitive to such nuances.

Another notable point was that different types of creativity measures have been more prominent at different points in history. DT tests are one of the oldest and most well-established method for empirically measuring creativity (Hocevar, 1981). As of the year 1984, 75% of all published creativity studies had used some variant of a Torrance test (Torrance & Presbury, 1984), and they certainly dominated the current study pool, as well. CAT measures did not emerge until the 1980s, and self- and other-reports have only become popular over the last few decades. Although the current study pool represented all eras well, different eras tended to be

represented by different measures. If females have always excelled at DT tests to a small extent, any struggles they may have had in earlier eras in terms of creative productivity may have been masked by the lack of measurement of these other areas. As such, more definitive conclusions regarding study era as it relates to creativity and gender may not be possible without more historical analysis of female creative achievements as they have related to males'.

Study Limitations & Future Research

Although some limitations of the current study have already been discussed above as they related to specific research questions, it is important to acknowledge the study's broader limitations in order to best discuss its utility and place the findings in context. One of the main limitations was that of measurement across different levels of moderators. The current study collected a preponderance of studies measuring creative ability, using domain-general DT tests with youth. Creative achievement, domain-specific, non-DT test, and adult studies were all under-represented. Analyses involving these constructs were underpowered, leading to multiple possible interpretations of results. In a primary study, when a group is under-represented, the researcher can always re-initiate data collection to shore up the deficiencies. However, in meta-analyses, search efforts attempt to be exhaustive, so shortcomings are difficult to rectify without further primary studies. Scholars have already begun to point out the literature gaps—for instance, that studies are more likely to focus on trying to understand causes of creative achievement differences than documenting them (Baer, 2012)—so future generations of researchers can do much to shed light on the blind spots in our current analyses and knowledge.

While creativity measurement issues were relatively unique to this study, several other problematic issues were weaknesses common to all meta-analyses. For instance, studies that did not fully report the information for performing calculations, that were not accessible to the

researcher ("file-drawer problem"), or that did not report results in English were excluded (Card, 2012). On the other hand, at least a few studies with methodological concerns were *included* in order to preserve a full, robust sample of studies. For instance, despite criticism over their narrowness in scope (Plucker & Makel, 2010), a large number of DT test studies were included. Additionally, several studies have used convenience samples uneven in gender composition (e.g., Alpaugh & Birren, 1975; Batey et al., 2010; Kaufman, 2006). To some extent, these flaws of primary studies became the flaws in the current meta-analysis (Card, 2012), and it should be noted that using different inclusion/exclusion criteria might produce different results.

As discussed previously, another risk in meta-analyses is encountering the "apples and oranges" problem (Card, 2012) of combining conceptually disparate studies. In order to avoid this issue, the current study was narrowed in strategic ways. Exclusion criteria specified that non-binary definitions of gender or gender identity and secondary creativity variables (e.g., personality, environment) would be omitted from the current study. Despite evidence that these are important factors in discussing gender differences (Kaufman, 2009; Norlander et al., 2000), these other conceptions surfaced rarely in the literature and represented deviations from how the main constructs were defined in the current study. Although omitting such concepts helped preserve the integrity of the study, excluding such variables limited the generalizability of the meta-analysis to only those constructs included. Following-up with further primary studies (and eventually meta-analyses) in areas such as androgyny or creative environments would certainly add more nuance to the picture of gender differences in the future.

Another way in which the current study was limited was in giving full consideration to issues of ethnicity, nationality, and culture. The literature search made all efforts to be comprehensive in obtaining diverse samples and a global representation of studies. However, the

creativity-gender literature does not currently comprise enough accessible primary studies fully representing different nationalities to use cultural variables as moderators, and it is surprising how often primary studies, particularly those from earlier decades, neglected to report any information on ethnicity. The lack of differentiation by nationality/ethnicity may affect the current study's generalizability because there is some evidence that gender gaps may vary by culture (Torrance, 1972) and ethnicity (Kaufman, 2006). Further primary work exploring issues of culture, ethnicity, and gender, as well as meta-analyses of the literature available outside of the English language, would do much to supplement the findings of the current study and represent promising areas for future study.

Finally, the meta-analysis was somewhat limited in that its aim was mainly descriptive and not explanatory. The research questions revolved around issues of what gender differences in creative ability and achievement look like. The study offers little evidence as to *why* the differences occur. Past theoretical and review work suggests that certain internal and external conditions—biology, gender role socialization, opportunities for education and training, levels of family support and obligations, discrimination, cultural zeitgeists, etc.—may lead to differing levels of creative expression for women and men (Cowen, 1996; Runco, Cramond, et al., 2010; Simonton, 1999). Another line of work suggests that females may be more susceptible to the aspects of pressure, evaluation, and competition inherent in creative work, whereas males often seem less vulnerable (Baer, 1997; Baer, 1998b; Kogan, 1974; Walton & Kemmelmeier, 2012). Generally, studies testing such causal factors, particularly in combination with each other, are sparse. Therefore, empirically evaluating the *why* behind any clear gender differences will be a crucial next step for ongoing creativity research.

Study Strengths & Implications

In spite of the above limitations, the current study succeeded in conducting an initial meta-analysis of gender differences in creativity, demonstrating methodological strengths and rendering practical implications. One of the main strengths of the study was its thorough, systematic literature search. One of the largest meta-analyses reviewed by the current researcher had an overall participant count of 40,000. The current study included a total of more than 137,000 participants across studies. Studies from all time periods from the 1960s onward were well-represented, and the study pool showed little evidence of publication bias. Having such a comprehensive set of studies allowed the researcher to be confident that the results were relatively generalizable (to the extent made possible by existing literature). Also, having amassed such a large set of studies has provided a useful description of the current state of creativity scholarship. Hopefully the descriptive statistics will be a helpful resource for future researchers wanting to gauge where the majority of work so far has concentrated and where it would be most informative for future studies to focus.

Another strength of the meta-analysis is that it enables researchers to see bigger trends across "messy" literatures. Indeed, the current study helped to substantiate what many reviews have suggested—that gender differences (on DT tests especially) are slight, but tend to favor females. Practically speaking, such a finding helps to undermine insidious stereotypes and biases that females are less creative, funny, visionary, etc. (Abra & Valentine-French, 1991; Lebuda & Karwowski, 2013; Lee, 2002; Torrance, 1963). According to Csikszentmihalyi's Systems Model (as described by Kaufman, 2009), success requires interaction between a domain's gatekeeper and a creative person/product. The eradication of potentially inaccurate viewpoints held by gatekeepers (often men) about women, girls, and creativity is crucial to stem the existing

discrimination thought to diminish the opportunities for females to be leaders in innovation (Abra & Valentine-French, 1991).

In addition to broader synthesis, another benefit provided by meta-analytical methods is the ability to analyze moderators in relationships. Because the creativity-gender literature has shown such diverse findings, it was important to attempt to explain and organize some of that past heterogeneity. For instance, females were found to be using their creative energies at a level on par with males, and in fact, they were found to out-perform men even more so in achievement. Although some caveats were provided regarding this finding, it also begs the question of whether female accomplishments not being as readily acknowledged as males' partially explains supposed gaps between female ability and achievement. Helson (1978) has suggested that men and women are "equal but different" (p. 558) in their interests, except that male interests tend to result in products more easily recognized as creative. If females are achieving and being undervalued, more objective research is certainly needed to uncover the ways in which females' contributions may be overlooked in the classroom and the workplace in order to suggest points of intervention at the systems level.

Still, the resounding consensus suggests that females do lag behind in real-world creative eminence, at least at the highest levels (Abra & Valentine-French, 1991; Baer & Kaufman, 2008; Baer, 2012; Eysenck; Runco, Cramond, et al., 2010). As such, it seems important also to consider the alternative interpretation provided above—that the current data do not fully capture the real world state of affairs—and discuss the implications of that scenario. Overall, there are a host of steps parents, teachers, counselors, peers, coworkers, bosses, and politicians can take to support female creativity. For instance, Reis (2001) recommends that young females should be encouraged to explicitly talk with one another about external barriers and that they should also

be directly coached in planning for challenges females face in attempting to be creative (e.g., teaching them healthy responses to feedback and competition). Reis (2001) and Eccles (1985) both stress the importance of career counseling for the young creative female in order to ensure she understands the full range of options available. In adulthood, female-friendly options such as flexible scheduling, working from home, or even flexible tenure tracks may help women make compromises between their family and creator roles (Charyton et al., 2011; Reis, 2002a). Further implications could range from suggestions for creating more female-friendly creative classrooms and workplaces (e.g., focusing less on competition and more on cooperation) to restructuring entire schools (e.g., same-sex education so that each gender's creative needs may be attended to; Baer & Kaufman, 2008; McVey, 2004).

A final finding from the study that has practical implications was that regarding measurement. Based on the current study, DT tests were actually found to be biased in favor of females. This may help explain some of the previous heterogeneity seen across studies, and researchers certainly will want to take note of the gender implications of using different types of measures in their work. However, creativity measures are also increasingly being incorporated in high-stakes situations, such as gifted program admissions (Kaufman, 2009). Thus, given that DT tests seem to favor females (and potentially disadvantage males), such gender-biased scores may not be recommended for such purposes unless an "affirmative action" effect were desired to improve female identification.

Overall, it has been the purpose of the present study to illuminate patterns in the mysterious creativity literature and also to generate specific recommendations for closing creative gender gaps in the playroom, the classroom, the workplace, and the global stage.

Interestingly, the study has, in fact, shown that females may not be in "creative crisis" to the degree initially thought. As Kogan (1974) stated,

> The time may come when the study of "sex differences in creativity" will cease or undergo a radical change in focus…as investigators stop asking about the handicaps facing women in the quest for creativity, and begin inquiring whether men and women are genuinely different in the form or manner in which creativity is expressed. (p. 12)

For decades, creativity researchers have been scratching their heads about gender differences and females' lacking accomplishments. Yet, perhaps the time has come to stop scratching our heads and look for the ways females' abilities and unique achievements are already making their way into the world and incorporate these contributions into the existing structures for recognition and success.

APPENDIX A

VARIABLE CODING GUIDELINES

Table 10

Variable Coding Guidelines

Variable	Level (if applicable)	Description
Study ID Number		Unique study identifier. Start at 1, and assign a number to each study. If multiple studies/samples are included in one paper, assign decimal points to main number stem (e.g., 20.1, 20.2, etc.).
Study Authors		Record all authors by full name, last name first.
Study Date		Year study made available in print publication (not online publication date), year dissertation defended, or year other unpublished work was written. For studies of historical data, code this as missing data.
Publication Status	Y= Yes/N = No	Yes: journal articles, book chapters No: dissertations, technical reports, conference papers
Publication Type	Journal article/Book chapter/Dissertation/Technical Report/Conference Paper	
Publication Name		Enter the name of journal or book.
Study Discipline	Psychoeducation/Neuroscience/ Business/Sports Psychology	Psychoeducation: Studies using traditional psychoed. measures of creativity in school, university, or community settings. Neuroscience: Studies primarily concerned with brain imaging and/or standard neurological assessments. Includes studies from medical field. Business: Studies of adult employees conducted within corporate settings. Sports Psychology: Studies of athlete samples using measures of creativity in the context of sports.

Table 10 (Continued)

Variable	Level (if applicable)	Description
Primacy of Key Variables	P = Primary/S = Secondary	How central the constructs of interest in the current research are to a given study. Primary: Gender differences in creativity included as a research question. Secondary: Results for gender differences reported in passing as demographic control.
Sample Size		Sample size (*n*) of each sample or subsample used to render an effect size. Multiple samples and effect sizes can come from one written report.
Sample Size Female		Number of females in a single independent sample.
Sample Size Male		Number of females in a single independent sample.
Sample Gender Proportion		Proportion of female participants in each sample (coded as a decimal value).
Sample Age		Mean age of each sample. If sample reports grade level only, use the following for each grade's approx. age level: K = 5.5, 1^{st} = 6.5, 2^{nd} = 7.5, 3^{rd} = 8.5, 4^{th} = 9.5, 5^{th} = 10.5, 6^{th} = 11.5, 7^{th} = 12.5, 8^{th} = 13.5, 9^{th} = 14.5, 10^{th} = 15.5, 11^{th} = 16.5, 12^{th} = 17.5, and undergraduate = 20.5. If adult sample with no mean age indicated = 35.
Sample Age SD		Standard deviation of sample age.
Sample Age Group	Children/Adolescent/College Student or Young Adult/Adult/Older Adult	Children: Ages birth to 11. Adolescents: Ages 12-18 (includes pre-adolescents) College/Young adults: Ages 18-25 Adults: 25-65 Older Adults: Over age 65.
Sample Grade		Mean grade level. If preschool or kindergarten sample, enter 0. If college sample, enter 13 (e.g., Becker, 1989). If graduate school sample, enter 17.

Table 10 (Continued)

Variable	Level (if applicable)	Description
Sample Grade Range		Full range of grades included in the sample. If college sample, enter 13 for undergraduates and 17 for graduate students.
Sample Nationality		If single nationality, identify specific nationality. If mixed, enter "mixed." If not stated, assume sample is same nationality as researcher institution. If researchers are from multiple nations and sample origin is not apparent, code as missing data.
Sample Primary Racial Group	White/Asian/Black/Hispanic/Arab/ Native American/Mixed White/Mixed Minority	A primary racial group is defined by 60% or more of participants belonging to one group. If no group meets this 60% mark but White is still the largest racial group, code as "mixed White." If the majority of participants come from a variety of non-White groups, code as "mixed non-White."
Sample SES	Low/Middle/Upper/Mixed	Select based on definitions and labels provided in original report. "Mixed" indicates a mixture of any of the other 2-3 categories.
Sample Full Demographic Composition		Write out verbatim, full sample demographic composition (race, nationality, SES, etc.) as described in the paper.
Special Sample		Make notes about any special characteristics of the sample that would cause them to differ from the general population (e.g., gifted/honors students).
Creativity Construct	AB = Creative Ability/ ACH = Creative Achievement	Creative Ability: i.e., divergent thinking, ideational fluency, remote associations, creative potential, creative thinking, creative competency. Creative Achievement: i.e., real-life creativity, creative accomplishment, creative productivity, creative activity, creative behavior, creative expression, creative performance.

Table 10 (Continued)

Variable	Level (if applicable)	Description
Measure Domain Specificity	G = Domain General/S = Domain Specific	Domain General: Measure focusing on general creative ability/skills. Typically includes DT tests, undifferentiated self-report, and undifferentiated other-report. Domain Specific: Measures targeting skills in specific domains (e.g., math). Typically includes CAT methods, self-report on specific domains, and other-report on specific domains.
Measure Format	DT Test/Product/Self-report/Other-report	Product: e.g., poem, cartoon caption Other-report: e.g., awards/recognitions, ratings based on observations
Creativity Variable		Enter the exact label authors originally used for particular creativity variable under study (e.g., "ideational fluency").
Creativity Measure Name		List exact names of formal creativity measures. If informal "homegrown" measure, list author names and brief description of measure (e.g., "3-item Likert-type scale").
Page Number of Statistics		Page number on which statistical data used to calculate effect size were found in original report.
Original Statistic Type	Means/Correlation/ANOVA/ T-value/Other (specify)	
Creativity Mean Females		Mean on creativity measure (in original units) for females only.
Creativity Mean Males		Mean on creativity measure (in original units) for males only.
Creativity SD Females		Standard deviation of creativity measure mean for females only.
Creativity SD Males		Standard deviation of creativity measure mean for males only.

Table 10 (Continued)

Variable	Level (if applicable)	Description
T-Statistic		T-statistic for the mean difference between females and males. Also can calculate according to formula 2.4, if necessary.
F-Statistic		F-statistic for the mean difference between females and males in a one-way ANOVA.
SS/*df*		Sums of squares and degrees of freedoms values necessary to calculate effect size from factorial ANOVA (see formula 2.6).
Correlation		The original point-biserial correlation (*r*) between gender and creativity.
P-value		Exact p-value or range (e.g., $p < .05$) reported for inferential test.
Stats Estimated	Y= Yes/N = No	Yes: In effect size, some portion of original statistics had to be estimated due to missing information in report (e.g., $p < .05$). No: All statistics original. Exact effect size derived.
Other Stats Details		Record all important, original stats information (e.g., means, *SD*, *t*, *r*, *F* and/or *df* values) not otherwise recorded.
Formula Used		Enter formula used to calculate effect size.
Effect Size (*g*): Uncorrected		Calculate one effect size per independent sample in original report.
Corrected Effect Size (*g'*)		Standard correction for Hedges' *g* is applied to every effect size. Multiple dependent effect sizes allowed per study.
Standard Error		Standard error of *g'*.

Table 10 (Continued)

Variable	Level (if applicable)	Description
Study Weight (w_i)		Weight of study *i*.
Direction of Effect	P = Positive/ NS = Not significant/ N = Negative	Direction of reported relationship between creativity and gender. Positive: females superior Not significant: gender difference not significant Negative: males superior
Subgroup Categories		If subsets of participants present (i.e., data reported separately based on different sets of participants), enter categories used to establish subgroups.
Main Effect Size		Calculated according to formulas in Table 2 for studies with single possible effect size. If multiple effect sizes possible, this value is the average effect size or the single effect size chosen to represent a study. Derive only one independent main effect size per study.
Main Standard Error		Standard error for main effect size.
Main Study Weight		Study weight based on main standard error.
Main ES Type	Original/Chosen/Average	Original: Possible to derive only one effect size from study. Re-enter original value computed. Chosen: Out of all dependent effect sizes computed, one effect size/measure was selected to represent the study. Average: All dependent effect sizes originally computed from study statistically combined to render an average effect size value for study.
Main Direction of Effect	P = Positive/ NS = Not significant/ N = Negative	Direction of main effect size. Positive: females superior Not significant: gender difference not significant Negative: males superior

Table 10 (Continued)

Variable	Level (if applicable)	Description
Exclusion Reason	Inaccessible/Language/Non-Quantitative/Experimental/Duplicate /No creativity variable/No gender variable/Minimal information/Insufficient stats/Methodological issues	Coded only for studies excluded from the final sample. Describes the reason for exclusion. Select only one primary reason. Inaccessible: Researcher was not able to gain access to study. Language: Study was reported in language other than English. Non-quantitative: Study does use quantitative measurement of variables (e.g., review, qualitative, case study). Experimental: Study involves experimental manipulation and reports post-test data only. Duplicate: Study reports the same data set as another study already included in the meta-analysis. No creativity variable: Study does not include individually measured, quantitative creativity variable, measured as operationalized in "Creativity Measurement" section. No gender variable: Study does not include gender variable as operationalized in "Definitions" section. Minimal information: Study does not provide enough information about the design, sample, instrumentation, etc. to evaluate it for inclusion. Insufficient stats: Study does not provide enough statistical information to calculate effect size. Methodological issues: Study design flawed for purposes of current study (e.g., dichotomized variables, confounds).

Note. Any variable not reported or not able to be derived from study information may be coded as missing or "MMMMM".

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