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Cognitive ability and creativity: Typology contributions and a meta-analytic review

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A R T I C L E I N F O

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A B S T R A C T

Our meta-analysis provides a comprehensive examination of the correlation between cognitive ability and creativity. Introducing an integrative typology of creativity, we assess how, at the individual level, cognitive ability at Stratum III, as well as different cognitive ability dimensions at Stratum II from Carroll's (1993) Three-Stratum Theory, correlate with three creativity perspectives (person, process, and product), and different dimensions within them. Using 135 independent samples containing 65,829 subjects, we found an observed meta-analytic correlation between cognitive ability at Stratum III and overall creativity of 0.27 (the corrected mean correlation was 0.33). The mean correlation was strongest for variables in the process perspective of creativity. We also observed that the Stratum II dimensions of cognitive ability most strongly related to creativity are broad retrieval ability and broad visual perception. In addition, we found that several conceptual and methodological moderators (e.g., cognitive ability measure, creativity measure, creativity domain, type of ratings) had a noticeable impact on the strength of the meta-analytic correlation. Dominance and sensitivity analyses tended to support our meta-analytic results. We discuss our study's contributions and practical implications and suggest future research avenues.

Creativity is widely recognized as an essential driver of economic growth and social progress (Hughes, Lee, Tian, Newman, & Legood, 2018; Motro, Spoelma, & Ellis, 2020). It has been argued that it is as important in contributing to the scientific, artistic, and developmental arenas (Unsworth, 2001) as it is in enabling organizational effectiveness (Motro et al., 2020). Creativity is currently a key requirement for hundreds of occupations (e.g., fine artists, creative writers, architects, robotics engineers; O*NET; www.onetonline.org/) and the McKinsey Global Institute suggests that it will remain relevant for decades to come. In fact, their forecasts indicate that the importance of and demand for creativity will substantially grow through 2030 (Bughin et al., 2018). As creativity will play a key role in future workforce demands, it is important to identify strong antecedents for it.

Prior research indicates problems and inconsistencies in creativity's definition and measurement (Furnham & Bachtiar, 2008). Although recent research recognizes creativity as a multifaceted construct (McKay, Karwowski, & Kaufman, 2017), the degree to which it is a general ability, rendering someone creative across different domains (e.g., science, the arts), or domain-specific, is a matter of debate (e.g., Kaufman, Glăveanu, & Baer, 2017). On the measurement side, many instruments designed to assess particular facets of creativity (e.g., creative traits, behavior, or products) have been criticized for capturing trivial aspects of creativity or lacking adequate psychometric properties (Baer, 1994; Said-Metwaly, Van den Noortgate, & Kyndt, 2017; Weiss et al., 2021). With issues on both the conceptualization and measurement of creativity, it is difficult to identify reliable predictors and make recommendations for to how foster and enhance creativity in different settings.

A fundamental question in creativity research has been to what extent this construct can be delineated from cognitive ability (Batey & Furnham, 2006), conceptualized as general mental ability, and also referred to as general intelligence or g (McDaniel & Banks, 2010). Cognitive ability has consistently emerged as the most important and generalizable predictor of job performance (e.g., Kell & Lang, 2017; Schmidt, Shaffer, & Oh, 2008), training success (Brown, Le, & Schmidt, 2006; Ree & Earles, 1991), attained occupational level, rate of promotion, and pay/income (Lang & Kell, 2020; Schmidt & Hunter, 2004). Cognitive ability is also a good predictor of academic achievement (Song

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et al., 2010) and scientific outcomes, such as publications, citations, awards, and honors (Feist & Barron, 2003). Over the past decades, these findings have informed both organizations and policy makers, the former increasingly including cognitive ability measures in their employment selection procedures (Le, Oh, Shaffer, & Schmidt, 2007; Schmidt, 2012).

As with creativity, cognitive ability is recognized as a complex, multi-dimensional construct (e.g., Baer & Kaufman, 2017). Whereas many studies show the general factor (i.e., GMA or g) to have significant predictive validity for important workplace and societal outcomes, and distinct abilities (i.e., its dimensions) to add a small amount to predictive efficiency (e.g., Brown et al., 2006; Ree, Earles, & Teachout, 1994), some recent research suggests that specific dimensions can be better predictors of workplace outcomes such as career success or performance (e.g., Kell & Lang, 2017; Lang & Kell, 2020). Recently, however, Ree and Carretta (2022) have highlighted some potential flaws associated with this research, which render the latter finding as questionable. Given that assessments of cognitive ability are widely used in employee selection processes, and considering the importance of creativity for today's organizations and broader society, a detailed examination of the relation between these two constructs seems vital in providing recommendations for the selection and training of employees or the design of developmental programs for different occupations and creativity domains.

Empirical work has found varying relations between the two constructs, sometimes seemingly due to distinct definitions and measures, study settings, and other sample and design characteristics. For instance, stronger relations have been reported when using psychometric rather than expert opinion tests and verbal rather than figural (i.e., graphic) assessments of creativity (Gajda, Karwowski, & Beghetto, 2017). A meta-analytic review can help bring clarity to a field of research where the relation of interest varies noticeably, possibly due to the presence of various moderators (Kepes, McDaniel, Brannick, & Banks, 2013). Thus far, few meta-analytic studies have examined the cognitive ability–creativity correlation, and those that have (Gajda et al., 2017; Kim, 2005) did not use comprehensive classification schemas of either cognitive ability or creativity. Working with limited classifications can result in an incomplete or perhaps an erroneous understanding of the correlation between two constructs. Prior meta-analyses in this area also assessed a limited number of moderators, likely leaving significant variability (i.e., heterogeneity) in the meta-analytic correlation unexplained.

We address these issues by using Carroll's (1993) Three-Stratum Theory of Cognitive Ability, which captures, at Stratum III, the general intelligence factor (g), and, at Stratum II, eight different broad categories/dimensions for it, each of which with different facets, described below. Furthermore, building on Rhodes' (1961) creativity typology, we develop a comprehensive list of creativity dimensions (i.e., categories) and facets (i.e., subcategories). Rhodes presented four perspectives on creativity (i.e., person, process, press, and product), but did not include specific variables for them. We integrate more recent classification attempts (e.g., Barron & Harrington, 1981; Ma, 2009) into Rhodes' well-established one and link this comprehensive typology of creativity with Carroll's (1993) Three-Stratum Theory of Cognitive Ability. This allows us to explore how dimensions and facets of creativity correlate with different dimensions of g. Differences in the strength of these correlations provide an enhanced understanding of the intricacies of the cognitive ability-creativity linkage and indicate avenues for future research in this area, as intelligence researchers can attempt to explain why such differences exist.

When examining the correlation between cognitive ability and creativity, we explore a range of conceptual (i.e., theoretical) and methodological moderators, such as the particular measure of cognitive ability and creativity, the domain of the creativity measure (general vs. specific), including the specific domain using Carson, Peterson, and Higgins (2005) established typology, the modality of the creativity measure (verbal vs. figural), the type of creativity measure rating (psychometric vs. expert opinion), and study setting (experimental vs. field). Although some of the moderators have been used in prior studies (e.g., Gajda et al., 2017; Kim, 2005), our study refines and extends their categories. For example, Gajda et al. (2017) used two cognitive ability measures (i.e., GPA vs. achievement test), and Kim (2005) studied four creativity tests (i.e., Guilford divergent thinking tasks, TTCT, Wallach & Kogan Divergent Thinking Task, "Other"); we examine a much more comprehensive list of measures for both constructs. Moreover, we assess the moderating effects of several additional variables (e.g., creativity measure domain specificity and specific domain, sample industry and occupation, whether the sample had a job traditionally regarded as creative, whether the creativity measure was a full scale or a subscale/shorter version of the full scale). Furthermore, our study has the largest sample size to date and is comprised of adult samples exclusively, as their creative traits, processes and outcomes are likely to more strongly impact organizational and societal outcomes.

From a methodological standpoint, in addition to a psychometric meta-analysis, we use a comprehensive sensitivity analysis approach (Greenhouse & Iyengar, 2009; Kepes et al., 2013), to assess the potential influence of reliability imputations, outliers, and publication bias on the obtained meta-analytic results. In addition, we conduct a dominance analysis to tease out the importance of certain variables in a nuanced fashion (Azen & Budescu, 2003; Thomas, Zumbo, Kwan, & Schweitzer, 2014). Thus, we carefully assess the robustness of the originally obtained meta-analytic results. Only if these factors do not substantially alter the meta-analytic results should the latter be considered robust to the influence of reliability imputations, publication bias, and outliers. Given the importance of creativity for numerous occupations and the need to identify creativity drivers in specific contexts, our research is timely, as well as scientifically and practically significant.

1. Theoretical background and hypotheses

1.1. Cognitive ability

Cognitive ability has been defined as a general mental capacity that includes abilities such as planning, abstract thinking, problem solving, and learning (Hunter & Schmidt, 1996; Ones, Dilchert, & Viswesvaran, 2012). The most widely accepted models in cognitive ability research include Spearman's (1904) General Intelligence Factor Model, Cattell's Crystalized and Fluid Intelligence Model, and Carroll's Three Stratum Theory of Cognitive Ability, with the latter building on the first two, being the most comprehensive (McDaniel & Banks, 2010), and considered to best represent cognitive ability (McGrew, 2005; Reeve & Blacksmith, 2009).

Carroll's (1993) Three Stratum Theory identified three strata (i.e., levels) of cognitive ability. Stratum III corresponds to the general factor of cognitive ability, which describes Spearman's *g*. Stratum II comprises eight dimensions of the general factor: Cattell's fluid and crystalized intelligence, as well as six other factors: general memory and learning, broad visual perception, broad auditory perception, broad retrieval ability, broad cognitive speediness, and processing speed, the last one being conceptualized as reaction time decision speed. Finally, Stratum I contains 69 factors for the Stratum II dimensions (see Figure SM1 in our Supplementary Material file). Our work adopts Carroll's (1993) conceptualization of cognitive ability with its terminology and typology.

1.2. Creativity

The "standard" definition presents creativity as the production of novel and useful ideas by individuals or groups (Runco & Jaeger, 2012; Simonton, 2017; Stein, 1953). This definition presents limitations, including its failure to (a) clearly differentiate between what is creative and what is not, (b) describe what constitutes creative problem-solving, and (c) explicitly account for the role of social appraisal in judgements about creative processes and products (e.g., Parkhurst, 1999).

Acknowledging some of these limitations, Plucker, Beghetto, and Dow (2004) defined creativity as "the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context" (p. 90). We adopt this definition because it is comprehensive, nuanced, and consistent with Rhodes' (1961) framework, the first widely cited creativity typology (El-Murad & West, 2004).

Rhodes (1961) suggested that there are four perspectives on creativity (labelled "the four Ps of creativity"), which are assumed to operate in unity: (a) the person (who creates), (b) the process (i.e., the cognitive processes involved in generating creative ideas), (c) the press (i.e., the environment in which creativity occurs), and (d) the product (i.e., the outcome of the creative process). The *person perspective* includes individual traits, such as one's creative personality, temperament or intellect, attitudes, value systems, and creative behavior. The *process perspective* focuses on aspects of one's motivation, perception, thinking, learning, and communicating, with an emphasis on the stages of the thinking process. The *press perspective* is concerned with the environment the creative process takes place in, as well as the degree of congruence/fit between the person and the environment. Last, the *product perspective* centers on information pertaining to various characteristics of the outcome of a creative process. By product, Rhodes referred to "a thought which has been communicated to other people in the form of words, paint, clay, metal, stone, fabric, or other material" (p. 309).

Typologies that grouped creativity variables in a manner similar to Rhodes (1961) were subsequently developed. For instance, Barron and Harrington (1981) discuss creativity as a multidimensional construct including dispositions or attitudes, ability, and achievement. These dimensions correspond to a great extent to Rhodes' person, process and product perspectives, respectively. Whereas Rhodes did not provide specific dimensions of the four Ps, under ability, Barron and Harrington discuss divergent thinking, associational abilities, analogical and metaphorical abilities, access to more primitive modes of thought, imagery abilities and problem finding abilities. These can be regarded as dimensions of the "creative process." More recently, Ma (2009) provided a thorough review of the variables used under the creative person, process, press, and product perspectives. Under process, in addition to the main dimensions, Ma included subdimensions or facets. For instance, for the problem-solving process dimension, such facets are defining the problem, retrieving problem-related knowledge, generating potential solutions, and producing evaluation criteria for selecting solutions. We integrate the creativity dimensions of Barron and Harrington with Ma's dimensions and facets and offer a refined and expanded creativity typology (see Fig. 1), which includes categories of variables studied under each perspective. Since our view on cognitive ability focuses on the general intelligence factor and its dimensions, and excludes less established constructs, such as emotional and practical intelligence (e.g., Locke, 2005), we also excluded Ma's (2009) emotional creativity category. In addition, because an individual's cognitive ability is unlikely to be related to the particular environment in which a creative process takes place, we do not focus on the press perspective, but only on the person, process, and product perspectives (referred to as "the 3 Ps" from here onward).

1.3. The correlation between cognitive ability and creativity

Decades of research on the relation between creativity and cognitive ability yielded correlation coefficients that range from negative to positive, in both professional and non-professional samples (Barron & Harrington, 1981; Batey & Furnham, 2006; Plucker, Esping, Kaufman, & Avitia, 2015). Overall, however, the correlation between cognitive ability and creativity appears to be modest, but generally positive when both constructs are conceptualized as broad/global (Batey & Furnham,

PERSON

- Traits
- Behavior
- Attitudes and dispositions
- Values

PRESS

- Climate for creativity
- Person-environment fit

PROCESS

- Associational abilities
- Analogical and metaphorical abilities
- Access to more primitive modes of thought
- Imagery abilities
- Problem-solving abilities
  - Problem definition abilities
  - Knowledge retrieval abilities
  - Divergent thinking abilities
    - Solution generating abilities
    - Evaluation abilities
  - Convergent thinking abilities
    - Selection abilities (for identified solutions)
    - Implementation abilities (for identified solutions)

PRODUCT

- Verbal ideation with less evaluation
  - Verbal fluency
  - Verbal flexibility
  - Verbal elaboration
  - Verbal originality
  - Verbal abstractness of titles
  - Verbal resistance to premature closure; overcoming fixation
- Non-verbal ideation with less evaluation
  - Nonverbal fluency
  - Nonverbal flexibility
  - Nonverbal elaboration
  - Nonverbal originality
  - Nonverbal abstractness of titles
  - Nonverbal resistance to premature closure; overcoming fixation
- Ideation with more evaluation
  - Fluency of solution
  - Flexibility of solution
  - Elaboration of solution
  - Originality of solution
  - Quality of solution

Fig. 1. The four perspectives of creativity and their (categories of) variables.
Note: The four perspectives of creativity (person, press, process, product) are defined consistent with Rhodes (1961). The creativity dimensions and facets listed under these are based on Barron and Harrington (1981) and Ma (2009) and follow their definitions and examples.

2006; McKay et al., 2017). Thus, we put forth:

Hypothesis 1. *The correlation between overall cognitive ability and overall creativity will be positive and modest in strength.*

Considering the categorization of creativity variables according to the perspectives in Fig. 1, and given the mixed findings on the cognitive ability and creativity correlation, we ask:

Research Question 1. *How does overall cognitive ability correlate with the 3 Ps and the dimensions and facets within each creativity perspective?*

Cho, Nijenhuis, Vianen, Kim, and Lee (2010) examined the correlation between the two most popular Stratum II cognitive ability dimensions from Carroll (1993) Three Stratum Theory of Cognitive Ability, crystalized and fluid intelligence. Aligned with prior research (e.g., Horn & Cattell, 1966; Yamamoto, 1965), the authors found that crystalized intelligence was significantly related to creativity in instances when fluid intelligence was not and argued that "the mental operation of creativity may be different from that of intelligence, and crystalized intelligence may be used as a resource for the mental operation of creativity" (p. 134). Other research also suggests that the strength of the relation between cognitive ability and creativity is influenced by the particular dimension of cognitive ability assessed (e.g., Horn & Cattell, 1966). We thus formally ask:

Research Question 2. *How do Carroll's (1993) Stratum II cognitive ability dimensions correlate with overall creativity?*

The bandwidth-fidelity hypothesis (Cronbach & Gleser, 1957; Steel, Schmidt, Bosco, & Uggerslev, 2019) suggests that broad measures of individual differences constructs are better at predicting broad criteria, whereas specific dimensions or facets of the criterion are better predicted with specific dimensions of the predictor that capture certain characteristics depicted in the criterion. What this suggests for our focal correlation is that linkages between factors at the same level (i.e., overall cognitive ability and overall creativity, Stratum II cognitive ability dimensions and creativity dimensions within each perspective, respectively) are stronger than those between factors at different levels (e.g., overall cognitive ability and creativity dimensions and facets within each perspective). To determine if this hypothesis applies to the cognitive ability-creativity correlation, in addition to answering research questions 1 and 2, it is also necessary to examine how the Stratum II cognitive ability dimensions relate to each dimension and facet of creativity under the 3 Ps. Thus, we ask:

Research Question 3. *How do the Stratum II cognitive ability dimensions correlate with the 3 Ps and the dimensions and facets within each perspective?*

1.4. Conceptual moderators of the correlation between cognitive ability and creativity

1.4.1. Creativity measure domain specificity

Kaufman et al. (2017) highlight a long-standing debate as to whether creativity is domain-general (i.e., individuals creative in one domain are likely to be creative in other domains) or domain-specific. Baer and Kaufman's (2005) Amusement Park Theoretical (APT) model proposes that both domain-general and domain-specific factors enable creative performance within a hierarchical structure with four components, representing increasing levels of domain specificity: Initial Requirements (i.e., intelligence/cognitive ability, motivation and an environment conducive to creativity), General Thematic Areas (i.e., everyday, scholarly, math/scientific, artistic, and performance creativity), Domains (e.g., within math/science, domains could be chemistry, physics, or economics), and Microdomains (e.g., within psychology, micro-domains would be clinical, cognitive, or organizational). This model suggests that cognitive ability at Stratum III is more strongly correlated to creativity in general thematic areas than in domains and microdomains, as, in the latter categories, creative performance also largely depends on other, domain/micro-domain-specific motivational, social, and environmental factors (Szen-Ziemianska, Lebuda, & Karwowski, 2017). Using the domain-general vs. domain-specific categorization of creativity measures from Kaufman et al. (2017) and the logic underlying the APT model, we expect overall cognitive ability to be more strongly related to broader (i.e., domain-general) creativity measures than narrower (i.e., domain-specific) ones. Thus, we forward:

Hypothesis 2. *The domain-specificity (domain-general* vs. *domain-specific) of the creativity measure moderates the correlation between overall cognitive ability and overall creativity, such that the correlation is stronger for domain-general measures.*

Research on individual differences predictors of domain-specific creativity reveals different effects in different domains. For instance, conscientiousness, a Big Five personality trait, was found to have a significant positive effect on creativity in science, but a significant negative effect on creative writing (Kaufman et al., 2017). Given that conscientiousness is tightly related to one of the initial requirements in the APT model (i.e., motivation), it seems likely that cognitive ability, as another initial requirement, could have different effects in different domains, too. Although the APT model presents several theoretical strengths (e.g., it is comprehensive, does not focus on high creative achievement), the many domains proposed make it difficult to use in empirical work. A more parsimonious and widely used model is that of Carson et al. (2005). The latter has two factors (arts and science) and ten domains: drama, humor, music, writing, visual arts, dance, science, invention, culinary, and architecture. We adopt this model because of its parsimony and practicality. As no prior research has theorized on the moderating effect of the creativity measure domain in the correlation between cognitive ability and creativity, we simply ask:

Research Question 4. *Does the domain of the creativity measure moderate the correlation between overall cognitive ability and overall creativity?*

1.5. Methodological moderators of the correlation between cognitive ability and creativity

1.5.1. Construct measures

Kim (2005) suggested that the correlation between cognitive ability and creativity depends on the measure of cognitive ability (e.g., Wechsler Intelligence Scale, Terman Concept Mastery Test). This is likely due to the tests' different formats and being meant to assess different dimensions of cognitive ability (Cho et al., 2010). For instance, the Wonderlic tends to better assess working memory capacity than fluid intelligence (Hicks, Harrison, & Engle, 2015), the Wechsler Adult Intelligence Scale focuses on fluid and crystallized intelligence (Carlsson, Dahl, Öckert, & Rooth, 2015), and Raven's Advanced Progressive Matrices captures the speed of information processing under time constraints (Bors & Stokes, 1998). Kim (2005) found that the strength of the cognitive ability-creativity relation also depends on the creativity measure used, perhaps because different creativity tests assess distinct aspects of the creative person, process, and product. For instance, the "Unusual Uses Test" (Guilford, Merrifield, & Wilson, 1958) assesses divergent thinking abilities, the Biographical Inventory of Creative Behaviors (BICB; Batey, 2007) evaluates everyday creative achievement, and Schaefer (1971) assesses abilities involved in the production of analogical and metaphorical images. For both the cognitive ability and the creativity measure, no sound theoretical arguments provide a direction for moderation. As such, using a much-expanded set of distinct cognitive ability and creativity measures than Kim (2005), we ask:

Research Question 5. *Does the measure of a) cognitive ability and b) creativity moderate the correlation between overall cognitive ability and overall creativity?*

1.5.2. Modality of creativity measure: verbal vs. figural

Creativity tests are often categorized by modality, into verbal (i.e., requiring participants to provide verbal answers to specified problems) and figural (i.e., requiring participants to draw the solution; Gajda et al., 2017). In a systematic review of factor analytic studies on intellectual abilities, Carroll (1993) reported that verbal abilities loaded more strongly on a broad factor of idea generation than figural abilities. Other empirical studies, using samples that included children and adolescents, also suggest that cognitive ability and creativity are more strongly related when verbal tests of creativity are used (e.g., Nakano, Wechsler, Campos, & Milian, 2015; Preckel, Holling, & Wiese, 2006). In a meta-analysis on the correlation between creativity and academic achievement, a surrogate for cognitive ability, Gajda et al. (2017) found that verbal tests generated significantly higher effects than figural tests of creativity as well. Building on this, we hypothesize:

Hypothesis 3. *The modality of the creativity measure moderates the correlation between overall cognitive ability and overall creativity, such that the correlation is stronger for verbal rather than figural tests of creativity.*

1.5.3. Type of creativity measure rating: psychometric vs. expert opinion

Creativity measures can be categorized into two broad categories: the more scientific psychometric measures (i.e., tests that measure a psychological construct using standardized assessment tools) and the more subjective, but frequently used, 'expert opinion' ratings (El-Murad & West, 2004; Sessa, 2008). Early research suggested that cognitive ability is negatively (but weakly) related to professionally rated creativity and positively (and highly) related to self-ratings of creativity (Mackinnon, 1962). Gajda et al. (2017) reported the opposite: the correlation between academic achievement and creativity was stronger when using creativity tests as compared to self-reports, and standardized tests of achievement rather that student GPA. Given the somewhat conflicting findings in this area, we ask:

Research Question 6. *Does the type of creativity measure rating moderate the correlation between overall cognitive ability and overall creativity?*

1.5.4. Study setting: experimental vs. field

A substantial body of research suggests that relations between variables tend to be stronger in laboratory than in field settings (e.g., Berkowitz & Donnerstein, 1982; Vanhove & Harms, 2015), partly because subjects tend to be isolated from their social surroundings, such that the impact of proximal cues on the focal phenomenon is amplified and the effects of distal cues are minimized. Research from the creativity literature, however, suggests that cognitive ability tends to have weaker relations with creativity when the latter is assessed in a game-like/non-evaluative context (Kim, 2005; Kogan & Pankove, 1972; Wallach & Kogan, 1965). Given that a game-like context, with possible warm-up activities for creativity tests, can be more easily created in a laboratory setting, it seems likely that a weaker correlation between cognitive ability and creativity will be observed in laboratory rather than field settings. Because of the contradictory evidence from prior research, we ask:

Research Question 7. *Does study setting (experimental* vs. *field) moderate the correlation between overall cognitive ability and overall creativity?*

2. Method

When conducting the meta-analysis, we followed APA's Meta-Analytic Reporting Standards (MARS) and best practice recommendations (Appelbaum et al., 2018; Hunter & Schmidt, 1996; Kepes et al., 2013).

2.1. Literature search

To identify relevant primary sources, in March 2019, we conducted a search using three academic search engines (EBSCO Host, Proquest, and PsycNet), each of which include a large number of very comprehensive research databases (e.g., ABI/INFORM Collection, Academic Search Complete, Business Source Complete). We used the following search strings: "'cognitive abilit*' AND (creativ* OR innovati*)", "'mental abilit*' AND (creativ* OR innovati*)", "intelligen* AND (creativ* OR innovati*)"[1] in the title and abstract fields. The search was limited to journal articles, dissertations, theses, book chapters, reports, and conference proceedings and yielded 11,538 records. After removing duplicates, we retained 8,872[2] unique records, which we reviewed for relevance. To be included in our sample, records needed to: 1) be available in English, 2) be empirical in nature and contain at least one primary study, 3) use a sample comprised of individuals over the age of 18, 4) provide the sample size, 5) report or provide information to determine a correlation coefficient between measures of cognitive ability and creativity (or a similar innovation-related measure) at the individual-level using standard methods (Borenstein, Hedges, Higgins, & Rothstein, 2009). After removing a few records with identical samples (we retained the most recent record), we were left with a final sample of 125 records, all published journal articles, containing 135 independent samples. A PRISMA diagram displaying our search process is included in our Supplementary Material (see Figure SM2).

2.2. Data extraction, coding, and preparation

For each identified article, we extracted author names, year of publication, research outlet (e.g., journal title), study title, type of study (experimental vs. field), study number, sample size, industry, and occupation, actual work setting (yes/no), actual/traditional creative job (yes/no), cognitive ability and creativity variable (i.e., authors' labels for variables), cognitive ability and creativity measures (i.e., the instruments used to assess the variables), publication year for the original as well as the actually used (cited) cognitive ability and creativity measures, creativity measure format (full scale vs. subscale/shortened scale), creativity measure domain (general vs. specific), specific domain for creativity measure (drama, humor, music, writing, visual arts, dance, science, invention, culinary, and architecture), modality of creativity measure (verbal or figural), type of creativity measure rating (psychometric or expert opinion), type and value of effect size, and reliability of the cognitive ability and creativity variables. Three trained coders worked in dyads to complete the coding, using a consensus rating approach. The entire list of records to code was divided into three and each of the three dyads was assigned approximately a third of the records. Each record was independently reviewed and coded by both dyad members. Then, once both coders of a dyad had completed the coding of about ten articles, the members met and reviewed their individual coding and discussed any differences. Next, the members independently coded ten more articles, compared their ratings and discussed differences to reach consensus. The process continued until all records assigned to each dyad were coded. The overall initial consensus rate (prior to discussion) for the three dyads was 96% and, after discussing differences, 100% agreement was reached. Prior research suggests that, when raters discuss and reach consensus, the resulting ratings are more reliable than individual ones, as discussion and consensus eliminate unique errors or idiosyncrasies in individual ratings (Fine & Cronshaw, 1999). For this reason, Fine and Getkate (1995) recommend the use of consensus rather than independent ratings in coding and much research in the management and psychology literature has adopted this approach (e.g., Liu, Wang, & Wayne, 2015; Yammarino, Dionne, Chun, & Dansereau, 2005).

[1] We have searched for both creativity and innovation because variables captured under the "product" perspective in our typology are often referred to as "innovation" (Woodman, Sawyer, & Griffin, 1993).

[2] The large number of initial unique records was due to the very common use of terms such as "creative*" or "innovati*" in abstracts. The vast majority of these initial records did not measure cognitive ability and creativity.

Creativity and cognitive ability variables were assigned to categories (i.e., the rows in Tables 1–3) using Figure SM1 for cognitive ability (see our Supplementary Material file) and Fig. 1 for creativity, based on the primary studies' measure descriptions. The cognitive ability dimensions at Stratum II were easy to differentiate, given their distinct definitions, as well as the Stratum I factors (subdimensions) Carroll (1993) provided, some of which are represented in Figure SM1. When coding for creativity, we followed our typology (see Fig. 1). As an illustrative example for our coding, the study of Avitia and Kaufman (2014) used cognitive ability variables such as Glr, a measure capturing long term storage and retrieval assessed via Kaufman's Assessment Battery for Children–-Second Edition, and Gc, a measure capturing word recognition and reading comprehension assessed via a reading subtest of the Kaufman Test of Educational Achievement. Based on their measures, for cognitive ability, we placed Glr under “general memory and learning” and Gc under “crystalized intelligence”, respectively. This same study used several measures of creativity. For instance, participants were asked to write a poem on the topic of “An embarrassing moment” and draw a picture of something that made them happy. These were assessed using the Consensual Assessment Technique (CAT; Amabile, 1982). We coded both the participants' poem and drawing as product, ideation with more evaluation, combined (i.e., rater creativity scores captured a combination of fluency, originality, and quality of the solution). In instances where a variable could be coded in more than one way, we discussed and reached a consensus on the most appropriate category, such that no study was double counted.

2.3. Meta-analytic procedures

To analyze our data, we followed the psychometric meta-analytic analytic approach as it allows for the correction of statistical artifacts, such as measurement error (Schmidt & Hunter, 2015). Specifically, we used the *R* package *psychmeta* (Dahlke & Wiernik, 2020) and selected the recommended random-effects (RE) estimation model and corrected the data for unreliability in both the predictor and the criterion. To address data independence issues, if a sample included more than one relevant effect size for the same variable from the same sample, we used the composite method when pooling effect sizes before estimating the meta-analytic mean. This was done at the level of the meta-analytic distribution. The majority of studies either did not provide reliability estimates or did not report established statistics (e.g., Cronbach's alpha, inter-rater reliability). For cognitive ability, this information was missing in 81% of the correlations; for creativity, it was missing 72% of the time. In these cases, we imputed the respective average (the averages for all 135 independent samples were 0.84 for cognitive ability and 0.83 for creativity). To determine if a particular variable functions as a moderator, we used *psychmeta*'s ANOVA function, which conducts Wald-type pairwise comparisons.

2.3.1. Sensitivity analysis

We conducted a variety of sensitivity analyses to assess the extent to which the obtained results remain stable when assumptions or aspects of data or analyses change (Greenhouse & Iyengar, 2009; Kepes et al., 2013). First, due to the large amounts of missing reliability information, we imputed alternative reliability values and assessed whether the originally obtained results changed. Second, following past recommendations (Kepes, Banks, McDaniel, & Whetzel, 2012; Kepes & McDaniel, 2015), we used established outlier diagnostics and a battery of publication bias methods to examine the potential influence of extreme data points (i.e., outliers) and publication bias on the observed meta-analytic results. These analyses were conducted in *R* using the *metafor* package (Viechtbauer, 2020).

2.3.2. Dominance analysis

When trying to determine the strength or importance of different variables, traditional approaches using standardized coefficients, such as meta-analytic means, can be misleading, partly due to multicollinearity. We thus used dominance analyses (Azen & Budescu, 2003; Braun, Converse, & Oswald, 2019) when comparing the importance of particular variables. We selected dominance analysis instead of the popular relative weights analysis (Banks, Woznyj, Kepes, Batchelor, & McDaniel, 2018; Tonidandel & LeBreton, 2015) as the latter has been criticized as mathematically flawed (Thomas et al., 2014). Dominance analyses were conducted in *R* using the *dominanceanalysis* package (Navarrete & Soares, 2020).

3. Results

The results of the psychometric meta-analysis are presented in Tables 1–3. Table 1 presents the meta-analytic results on the correlation between overall cognitive ability and the person, process, and product perspectives of creativity (Rhodes, 1961), including their dimensions and facets. Table 2 shows meta-analytic results for the correlation between the Stratum II cognitive ability dimensions (Carroll, 1993) and overall creativity. Table 3 displays the results for the moderating variables. Additional meta-analytic results are reported in our Supplementary Material (see Tables SM1 and SM2). These tables contain descriptive information and meta-analytic statistics, including the observed naïve ($\bar{r}$)[3] and the psychometrically corrected ($\hat{\rho}$) meta-analytic mean estimates, as well as their respective standard deviations, the 95% confidence interval (95% CI), and the 80% credibility interval (80% CR) around $\hat{\rho}$. The former interval can be used to determine whether an obtained meta-analytic mean estimate is statistically different from zero; the latter to examine the likelihood that moderating effects are present (Kepes et al., 2013).

Table 1 shows that overall cognitive ability and overall creativity are positively corelated.[4] Thus, *Hypothesis 1* was supported. Although the 95% CI is narrow, the credibility interval is very wide, suggesting the presence of substantial moderating effects. Thus, in *Research Question 1,* we asked whether the relation between overall cognitive ability and creativity is stronger for creativity variables included in the person, process, or product perspective. Our ANOVA results indicate that the meta-analytic mean correlations for the 3 Ps are statistically significantly different from each other. The mean correlation between overall cognitive ability and creativity is substantially stronger for the process than for the other two creativity perspectives. However, the credibility intervals still suggest the presence of substantial moderating effects. Thus, we examined the different facets of the 3 Ps.

Under the *person* perspective, overall cognitive ability is most strongly correlated with creative behavior, the effect being positive and moderate in strength (for effect size magnitude interpretations, see Bosco, Aguinis, Singh, Field, & Pierce, 2015), less strongly with creative attitudes and dispositions, and comparatively weakly with creative traits (e.g., creative personality). The ANOVA results also indicate that the differences in meta-analytic means are statistically significant (although this result may be partly driven by the very small *k*s of two distributions, as most of the 95% CIs overlap). Under the *process* perspective, the different outcomes also have significant moderating effects, as indicated by the ANOVA. Still, the process perspective contains several distributions with very small *k*s and many of the 95% CIs overlap noticeably. Regardless, overall cognitive ability is strongly correlated with problem-solving abilities, less strongly with imagery abilities and analogical and metaphorical abilities,

[3] The naïve meta-analytic mean effect refers to the mean without any adjustments for measurement error or any other potential biases (e.g., publication bias; Copas & Shi, 2000). It is thus conceptually similar to the bare-bones meta-analytic mean (Hunter & Schmidt, 2004).

[4] We note that several of the distributions in our tables are quite small (e.g., *k*s with three or less independent samples). The results from such distributions are unlikely to be robust. Still, unless $k = 1$, we include them in our tables for transparency- and completeness-related reasons.

Table 1
The correlation between overall cognitive ability and creativity: psychometric meta-analytic results.

Creativity perspectives and their variable categories and facets	k	N	$\overline{r}$	SD_r	$\overline{\rho}$	SD_ρ	95% CI	80% CR	Moderator test [F(df), p-value]
Overall creativity (all data)	135	65,829	.27	.17	.33	.19	.30, .36	.09, .57	
Person	59	29,609	.20	.14	.25	.16	.21, .29	.05, .45	53.00 (2, 86.30), <.001
- Attitudes and dispositions	3	433	.13	.14	.15	.17	−.08, .37	−.07, .36	9.90 (2, 5.35), .016
- Behavior	47	23,544	.24	.14	.29	.15	.24, .33	.10, .47	
- Traits	23	7,631	.09	.12	.11	.13	.05, .17	−.05, .27	
- Combined[a]	1	270							
Process	37	20,839	.43	.13	.51	.14	.47, .56	.33, .70	
- Associational abilities	8	1,272	.19	.11	.23	.09	.14, .32	.11, .35	13.60 (3, 11.60), <.001
- Analogical and metaphorical abilities	5	529	.22	.14	.27	.12	.12, .41	.11, .42	
- Imagery abilities	2	224	.29	.00	.38	.00	.36, .39	.38, .38	
- Problem solving abilities	26	19,417	.45	.12	.53	.13	.48, .58	.36, .70	
- Knowledge retrieval abilities	2	132	.33	.25	.39	.26	−.02, .80	.05, .73	4.12 (3, 2.41), .170
- Divergent thinking abilities	5	1,425	.29	.12	.35	.11	.23, .46	.20, .49	
- Solution generating abilities	4	903	.31	.14	.36	.14	.20, .52	.18, .55	
- Evaluation abilities	2	566	.27	.03	.32	.00	.27, .37	.32, .32	
- Convergent thinking abilities	18	17,583	.47	.10	.55	.11	.50, .60	.42, .69	
- Selection abilities	18	17,583	.47	.10	.55	.11	.50, .60	.42, .69	
- Indeterminable[b]	2	322	.13	.13	.17	.12	−.05, .38	.01, .32	
Product	81	24,183	.19	.10	.23	.10	.20, .26	.10, .36	
- Verbal ideation with less evaluation	59	19,519	.18	.09	.22	.09	.19, .24	.10, .33	1.70 (2, 33.10), .198
- Verbal fluency	37	10,970	.15	.08	.18	.06	.15, .21	.11, .26	1.49 (5, 20), .237
- Verbal flexibility	14	2,265	.21	.12	.25	.11	.18, .33	.11, .40	
- Verbal elaboration	7	3,395	.17	.12	.20	.13	.10, .30	.04, .36	
- Verbal originality	34	16,275	.17	.10	.20	.11	.16, .24	.06, .35	
- Combined[a]	19	5,333	.22	.09	.26	.09	.21, .32	.15, .38	
- Indeterminable[b]	4	2,058	.19	.07	.23	.07	.14, .31	.14, .31	
- Non-verbal ideation with less eval.	14	3,071	.22	.08	.26	.06	.21, .31	.18, .33	
- Non-verbal fluency	4	511	.22	.10	.26	.07	.14, .38	.17, .35	2.10 (4, 6.78), .187
- Non-verbal flexibility	1	150							
- Non-verbal elaboration	3	867	.30	.06	.35	.04	.27, .43	.31, .40	
- Non-verbal originality	4	1,068	.21	.07	.25	.04	.17, .33	.19, .30	
- Combined[a]	7	1,539	.19	.05	.23	.00	.18, .28	.23, .23	
- Indeterminable[b]	3	590	.16	.03	.19	.00	.15, .23	.19, .19	
- Ideation with more evaluation	27	4,623	.23	.14	.27	.15	.21, .34	.08, .46	
- Fluency of solution	2	131	.11	.21	.12	.20	−.22, .46	−.14, .38	.99 (4, 4.81), .491
- Originality of solution	6	695	.23	.11	.28	.06	.18, .37	.21, .35	
- Quality of solution	5	788	.28	.08	.32	.04	.24, .41	.27, .38	
- Combined[a]	14	3,024	.24	.15	.28	.16	.19, .37	.07, .49	
- Indeterminable[b]	3	135	.02	.19	.02	.14	−.24, .28	−.16, .21	

Note: k = number of independent samples contributing to the distribution; N = total sample size; $\overline{r}$ = mean observed correlation; SD_r = observed standard deviation of r; $\overline{\rho}$ = mean true-score correlation; $SD_{\overline{\rho}}$ = standard deviation of $\overline{\rho}$; CI = confidence interval around $\overline{\rho}$; CR = credibility interval around $\overline{\rho}$. [a] Combined: Combination of some of the above measures. [b]Indeterminable: Unknown measures.

and only weakly with associational abilities. For outcomes associated with problem-solving abilities, overall cognitive ability is most strongly correlated with convergent thinking abilities, followed by knowledge retrieval abilities and divergent thinking abilities. Despite the noticeable and seemingly practically meaningful differences between some of these problem-solving abilities, our ANOVA results suggest that the means are not significantly different from each other.

Under the *product* perspective, the meta-analytic mean correlations between overall cognitive ability and verbal ideation with less evaluation, non-verbal ideation with less evaluation, and ideation with more evaluation, respectively, are not statistically different from each other – all three are positive and modest in strength, with very similar confidence intervals. Our ANOVA results indicate that the same is true for the various specific outcomes under these three outcome categories. Finally, with a few exceptions, the credibility intervals for the analyzed substitutions were not noticeably narrower, indicating the presence of additional moderating effects (the few exceptions are likely due to the small sample size associated with the respective distributions).

Research Question 2 asked how Carroll's (1993) Stratum II cognitive ability dimensions correlate with creativity. Table 2 shows that the meta-analytic means for these dimensions are statistically significantly different from each other. Ignoring the "other" group (i.e., measures that did not fall into any of Carroll's Stratum II dimensions), "combined GMA dimensions" (i.e., measures combining two or more specific Stratum II dimensions) has the strongest meta-analytic mean correlation with overall creativity, followed by broad retrieval ability and broad visual perception. The two most well-known Stratum II dimensions of cognitive ability, fluid and crystalized intelligence, have weaker correlations with overall creativity. Broad cognitive speediness, general memory and learning, and processing speed have even weaker correlations with overall creativity. As such, there is considerable variability in the strength of the correlations between Carroll's Stratum II cognitive ability dimensions and overall creativity. Furthermore, the credibility intervals associated with these effect sizes suggest that much between-sample

Table 2
The correlation between Stratum II cognitive ability dimensions and overall creativity: psychometric meta-analytic results.

Dimensions of cognitive ability	k	N	$\bar{r}$	SD_r	$\bar{\rho}$	SD_ρ	95% CI	80% CR	Moderator test [F(df), p-value]
Cognitive ability (all data)	135	65,829	.27	.17	.33	.19	.30, .36	.09, .57	5.35 (8, 27.50), <.001
- Fluid intelligence	66	23,034	.18	.09	.21	.09	.18, .24	.09, .33	
- Crystallized intelligence	48	9,804	.20	.15	.24	.16	.19, .29	.03, .45	
- General memory and learning	13	2,086	.12	.13	.15	.13	.06, .24	−.02, .32	
- Broad visual perception	18	12,766	.24	.10	.28	.11	.23, .34	.14, .43	
- Broad retrieval ability	3	442	.25	.10	.30	.09	.16, .45	.19, .41	
- Broad cognitive speediness	11	2,434	.12	.15	.13	.15	.04, .23	−.05, .32	
- Processing speed	6	1,196	.08	.16	.10	.17	−.05, .25	−.11, .31	
- Combined GMA dimensions	57	31,341	.32	.20	.38	.22	.33, .44	.10, .67	
- Other	22	5,393	.35	.26	.41	.28	.29, .53	.06, .77	

Note: k = number of independent samples contributing to the distribution; N = total sample size; $\bar{r}$ = mean observed correlation; SD_r = observed standard deviation of r; $\bar{\rho}$ = mean true-score correlation; $SD_{\bar{\rho}}$ = standard deviation of $\bar{\rho}$; CI = confidence interval around $\bar{\rho}$; CR = credibility interval around $\bar{\rho}$.

variability remains after accounting for the Stratum II cognitive ability dimensions.

To answer *Research Question 3*, we examined how Stratum II cognitive ability dimensions correlate with each dimension and facet of creativity under the 3 Ps (see Table 3). We found that "combined GMA dimensions" and fluid intelligence are strongly correlated with variables under the process perspective, especially problem-solving abilities. The results are similar for fluid intelligence. The correlation between fluid intelligence and problem-solving abilities is particularly strong (albeit not significantly different from the other categories under the process perspective). Crystalized intelligence is also significantly more strongly correlated with variables under the process than person and product perspectives. Both fluid and crystalized intelligence had modest to moderate correlations with variables under the product perspective, with the highest correlations here being with non-verbal ideation with less evaluation. Weak to modest correlations were found for variables under the person perspective.

The meta-analytic correlations between the remaining Stratum II cognitive ability dimensions and creativity categories tend to be modest or moderate in size. However, many distributions are rather small and their results unlikely to be robust. Thus, we urge caution when interpreting these means. On average, the credibility intervals tend to remain quite large, indicating considerable amounts of heterogeneity. The results for the correlations between "combined GMA dimensions" and broad visual perception and the creativity perspectives are very similar as well. However, the sample sizes are quite small, which is why we view these results as – at best – preliminary.

Our results up to this point allow us to address the validity of the bandwidth-fidelity hypothesis in this area and determine whether the correlations between factors at the same level (i.e., overall cognitive ability and overall creativity, cognitive ability at Stratum II and creativity dimensions within each perspective, respectively) are stronger than those between factors at different levels. Thus, our findings do not unequivocally support the bandwidth-fidelity hypothesis, as we observed inconsistent results.

We next examined domain-specificity of the creativity measure as moderator (*Hypothesis 2*). Together, the different mean estimates with sometimes quite different 95% CIs, as well as the ANOVA results, indicate that this moderating effect exists. We found a significantly stronger meta-analytic mean correlation between overall cognitive ability and creativity for domain-general rather than domain-specific measures of creativity. However, the meta-analytic means and 95% CIs of the two largest distributions, which provide the most robust results, are quite similar; the differing results tend to come from mostly small distributions. Thus, there is mixed support for *Hypothesis 2*.

To answer *Research Question 4*, we examined whether the domain of the creativity measure is a moderator and found that it is not. The mean correlations for different domain specific measures did not vary significantly although some of the differences between the means seem to be practically significant. Examining distributions with more than five studies, we found a strong correlation between overall cognitive ability and creativity in the scientific discovery domain, a moderate correlation for the visual arts, and a weak to moderate one for creative writing.

Research Question 5 asked whether the measures of cognitive ability and creativity moderate our relation of interest. For the cognitive ability measure, the meta-analytic means varied substantially across the different distributions. Furthermore, several of the 95% CIs were quite different and did not overlap. Also, our ANOVA results suggest that the measure of cognitive ability does act as a moderator. We observed the largest effect size for the Ang and Van Dyne (2008) measure of cultural intelligence. Because this measure is a self-report cultural knowledge one, and the studies using it also use a self-report measure of creativity, this result is likely affected by common method variance. However, we found other strong mean correlations, including for the Intelligence Structure Battery (ISB) and the Multidimensional Aptitude Battery (MAB) (this omits the 'other – general' category).[5] The lowest meta-analytic means were observed for course grades, the Mill Hill Vocabulary Test, as well as GPA. Surprisingly, the Wonderlic, maybe the most prominent measure of cognitive ability, immediately followed GPA.

As with the cognitive ability measure, many of the meta-analytic means for the different measures of creativity are quite different. Furthermore, several of the 95% CIs do not overlap. The ANOVA results also support this moderating effect. We found a strong correlation between overall cognitive ability and overall creativity when the latter was assessed with Zhou and George (2001) creativity measure, followed by the RAT, drawing production (a sub-category of the drawing task measure), and the Inventory of Creative Activities and Achievements (ICAA) (this omits the 'other – general' category and the 'write a story' measure [$k = 2$]). The Runco Ideational Behavior Scale had no correlation with creativity and both the BICB and the Barron-Welsh Art Scale had negative ones. As before, the credibility intervals tend to remain wide, indicating the presence of important additional moderating effects.

To test *Hypothesis 3*, we examined whether the modality of the creativity measure (verbal or figural) acted as a moderator. Our results suggest that the focal mean correlation tends to be stronger with verbal rather than figural assessments of creativity and that this difference is

[5] We note that the number of independent effect sizes is rather small ($k = 3$ and 4, respectively).

statistically significant. Hypothesis 3 is thus supported. Relatedly, *Research Question 6* asked whether the type of creativity measure rating (psychometric or expert option) acts as a moderator. Our results suggest that it does: The mean correlation between overall cognitive ability and overall creativity tends to be significantly stronger when using expert opinion measures of creativity.

Finally, to answer *Research Question 7*, we examined study setting (laboratory vs. field) as a potential moderator and found that both meta-analytic means were the same. Thus, study setting does not moderate our focal relation.

3.1. Supplementary analyses

3.1.1. Additional theory-driven analyses

As an extension of *Research Question 4*, we examined how the Stratum II cognitive ability dimensions correlate with domain-specific creativity. Unfortunately, the number of independent samples contributing to the individual distributions tended to be small and several results are unlikely to be robust (see Table SM1 in our Supplementary Material file for the results).

We also investigated additional moderators potentially relevant for our focal correlation. Specifically, we examined the publication years of the original and actually used (cited) cognitive ability and creativity measures (the former refers to the originally published measure, the latter to a published modification of the original), whether the creativity measure was a full scale or a subscale/shortened scale, additional sample characteristics (e.g., industry, occupation, whether the occupation was traditionally considered creative or not), whether the tasks were performed in a work setting, the level of creativity required, and whether the tasks were rated using CAT. These results are presented in Table SM2 and explained in Description SM1 of our Supplementary Material file. In short, we found stronger correlations between overall cognitive ability and overall creativity for newer (post 2010) cognitive ability measures. We found the opposite for creativity measures, as older instruments (from the 1971–1990 period) yielded the strongest mean correlation. We also found a stronger focal correlation for tasks

Table 3
The correlation between Stratum II cognitive ability dimensions and perspectives of creativity: psychometric meta-analytic results.

Dimensions of cognitive ability and creativity	k	N	$\bar{r}$	SD_r	$\bar{\rho}$	SD_ρ	95% CI	80% CR	Moderator test [F(df), p-value]
Fluid Intelligence and Dimensions of Creativity Perspectives									7.17 (2, 37.40), .002
Person	24	5,835	.12	.11	.14	.11	.09, .20	.01, .28	
- Attitudes and dispositions	1	59							.26 (1, 19.20), .615
- Behavior	17	3,908	.13	.10	.16	.10	.10, .22	.03, .29	
- Traits	11	2,561	.11	.12	.13	.12	.04, .22	−.03, .29	
Process	21	3,776	.27	.16	.33	.17	.25, .42	.11, .55	
- Analogical and metaphorical abilities	4	484	.16	.09	.19	.02	.09, .30	.17, .21	3.57 (2, 5.04), .108
- Associational abilities	3	380	.14	.15	.18	.13	−.01, .38	.01, .36	
- Imagery abilities	1	180							
- Problem solving abilities	15	2,918	.31	.15	.38	.17	.28, .47	.16, .59	
Product	44	18,265	.18	.08	.21	.08	.18, .24	.11, .31	
- Verbal ideation with less evaluation	37	15,727	.17	.08	.21	.08	.18, .24	.10, .32	1.60 (2, 16.80), .231
- Non-verbal ideation with less eval.	10	2,126	.23	.08	.27	.07	.21, .33	.18, .36	
- Ideation with more evaluation	10	2,378	.17	.10	.20	.09	.13, .27	.08, .31	
Crystallized Intelligence and Dimensions of Creativity Perspectives									5.35 (2, 34.90), .010
Person	20	4,450	.13	.13	.15	.14	.08, .22	−.03, .33	
- Attitudes and dispositions	2	329	.22	.11	.26	.10	.07, .45	.13, .39	1.19 (2, 2.93), .419
- Behavior	16	2,999	.16	.11	.19	.11	.12, .25	.05, .33	
- Traits	9	2,239	.07	.16	.08	.18	−.04, .21	−.14, .31	
- Combined[a]	1	270							
Process	18	3,561	.31	.20	.36	.22	.25, .47	.08, .65	
- Analogical and metaphorical abilities	2	267	.23	.04	.27	.00	.20, .34	.27, .27	1.65 (2, 2.77), .337
- Associational abilities	3	601	.21	.01	.25	.00	.23, .27	.25, .25	
- Problem solving abilities	13	2,693	.33	.22	.40	.25	.26, .54	.07, .72	
Product	31	7,289	.20	.12	.23	.13	.18, .29	.07, .40	
- Verbal ideation with less evaluation	23	4,817	.20	.12	.25	.13	.19, .31	.09, .41	.30 (2, 17.60), .745
- Non-verbal ideation with less eval.	8	2,420	.22	.09	.27	.09	.19, .34	.16, .38	
- Ideation with more evaluation	10	2,043	.19	.15	.21	.17	.09, .32	−.00, .42	
Combined GMA Dimensions and Dimensions of Creativity Perspectives									51.80 (2, 38.90), .001
Person	29	11,743	.12	.12	.15	.13	.10, .20	−.01, .32	
- Attitudes and dispositions	1	104							4.72 (1, 31.80), .037
- Behavior	20	6,503	.16	.12	.19	.12	.13, .25	.04, .35	
- Traits	15	6,247	.08	.10	.10	.11	.03, .16	−.04, .24	
Process	13	17,213	.47	.09	.55	.10	.49, .61	.42, .68	
- Associational abilities	4	657	.26	.06	.31	.00	.24, .38	.31, .31	24.50 (1, 7.97), .001
- Imagery abilities	1	44							
- Problem solving abilities	9	16,660	.48	.09	.56	.09	.49, .62	.44, .68	
Product	31	6,660	.19	.15	.23	.16	.17, .29	.02, .43	
- Verbal ideation with less evaluation	21	4,999	.20	.15	.24	.16	.16, .32	.03, .45	.01 (2, 17.40), .993
- Non-verbal ideation with less eval.	5	1,152	.20	.06	.24	.00	.18, .30	.24, .24	
- Ideation with more evaluation	11	1,374	.20	.17	.24	.18	.12, .36	.01, .47	

Dimensions of cognitive ability and creativity	k	N	$\overline{r}$	SD_r	$\overline{\rho}$	SD_ρ	95% CI	80% CR	Moderator test [F(df), p-value]
General Memory and Learning and Dimensions of Creativity Perspectives									.47 (2, 10.50), .637
Person	6	1,033	.08	.15	.10	.15	−.04, .24	−.10, .29	25.80 (2, 3.09), .012
- Attitudes and dispositions	2	329	−.04	.02	−.04	.00	−.07, −.02	−.04, −.04	
- Behavior	3	574	.09	.02	.11	.00	.08, .14	.11, .11	
- Traits	3	516	.11	.19	.14	.22	−.13, .41	−.14, .42	
- Combined[a]	1	270							
Process	6	1,275	.13	.10	.15	.09	.05, .25	.03, .27	5.64 (1, 4.37), .071
- Analogical and metaphorical abilities	1	93							
- Associational abilities	3	546	.02	.08	.03	.04	−.08, .14	−.02, .07	
- Problem solving abilities	5	1,092	.16	.08	.19	.06	.11, .28	.12, .26	
Product	9	1,576	.15	.11	.18	.10	.10, .27	.06, .31	.13 (2, 4.38), .880
- Verbal ideation with less evaluation	8	1,460	.14	.09	.16	.07	.09, .24	.08, .25	
- Non-verbal ideation with less eval.	4	817	.13	.09	.16	.06	.06, .26	.08, .24	
- Ideation with more evaluation	3	309	.19	.17	.23	.17	−.00, .46	.01, .44	
Broad Visual Perception and Dimensions of Creativity Perspectives									4.26 (2, 7.87), .056
Person	6	10,695	.24	.10	.29	.11	.20, .38	.14, .43	3.38 (1, 2.19), .196
- Behavior	3	9,763	.26	.04	.31	.05	.25, .37	.25, .38	
- Traits	3	932	.03	.20	.04	.24	−.24, .32	−.26, .35	
Process	5	723	.35	.12	.42	.12	.28, .55	.26, .57	.13 (1, 1.05), .780
- Analogical and metaphorical abilities	2	138	.39	.27	.46	.30	.02, .91	.09, .84	
- Associational abilities	1	93							
- Problem solving abilities	4	678	.32	.05	.38	.00	.30, .46	.38, .38	
Product	10	1,922	.18	.07	.21	.00	.16, .26	.21, .21	.26 (2, 2.30), .790
- Verbal ideation with less evaluation	7	810	.17	.08	.22	.00	.14, .29	.22, .22	
- Non-verbal ideation with less eval.	2	133	.27	.22	.33	.22	−.03, .69	.04, .62	
- Ideation with more evaluation	3	1,112	.18	.00	.20	.00	.19, .21	.20, .20	
Broad Cognitive Speediness and Dimensions of Creativity Perspectives									.17 (2, 2.77), .851
Person	2	372	.13	.09	.15	.06	.01, .29	.08, .22	
- Behavior	2	372	.13	.09	.15	.06	.01, .29	.08, .22	
Process	3	461	.00	.31	.01	.35	−.40, .42	−.43, .45	n/a
- Analogical and metaphorical abilities	1	131							
- Associational abilities	1	148							
- Problem solving abilities	1	182							
Product	9	2,080	.10	.13	.12	.13	.02, .22	−.05, .29	2.67 (1, 6.50), .150
- Verbal ideation with less evaluation	7	1,001	.04	.17	.04	.17	−.10, .19	−.18, .27	
- Non-verbal ideation with less eval.	1	149							
- Non-verbal ideation with more eval.	2	1,079	.16	.02	.17	.00	.14, .20	.17, .17	
Processing Speed and Dimensions of Creativity Perspectives									1.10 (2, 3.24), .432
Person	2	567	.04	.05	.05	.00	−.02, .13	.05, .05	n/a
- Behavior	1	183							
- Traits	1	384							
Process	2	596	.13	.06	.15	.01	.06, .25	.15, .16	n/a
- Associational abilities	1	183							
- Problem solving abilities	1	413							
Product	5	812	.08	.19	.10	.20	−.10, .29	−.16, .36	.00 (1, 4.97), .983
- Verbal ideation with less evaluation	5	812	.07	.19	.09	.20	−.11, .29	−.17, .35	
- Non-verbal ideation with less eval.	2	291	.08	.06	.09	.00	.00, .18	.09, .09	
- Ideation with more evaluation	1	180							
Broad Retrieval Ability and Dimensions of Creativity Perspectives									n/a
Person	—	—	—	—	—	—	—	—	
Process	1	222							
- Analogical and metaphorical abilities	1	222							
Product	2	220	.33	.10	.39	.07	.22, .57	.30, .49	
- Verbal ideation with less evaluation	2	220	.33	.10	.39	.07	.22, .57	.30, .49	
Other and Dimensions of Creativity Perspectives									6.70 (2, 10), .014
Person	12	3,919	.39	.26	.45	.28	.29, .61	.10, .81	.91 (1, 2.38), .428
- Behavior	11	3,619	.43	.21	.49	.22	.36, .62	.22, .77	
- Traits	3	783	.22	.32	.27	.37	−.16, .70	−.21, .75	
Process	3	439	.05	.09	.06	.06	−.07, .20	−.01, .14	
- Problem solving abilities	3	439	.05	.09	.06	.06	−.07, .20	−.01, .14	
Product	10	1,557	.24	.21	.30	.23	.14, .45	−.00, .59	12.60 (1, 7.95), .008
- Verbal ideation with less evaluation	3	668	.06	.06	.08	.01	−.02, .17	.06, .09	
- Non-verbal ideation with less eval.	1	239							
- Ideation with more evaluation	7	889	.36	.19	.43	.20	.26, .60	.17, .69	

Note: k = number of independent samples contributing to the distribution; N = total sample size; $\bar{r}$ = mean observed correlation; SD_r = observed standard deviation of r; $\bar{\rho}$ = mean true-score correlation; $SD_{\bar{\rho}}$ = standard deviation of $\bar{\rho}$; CI = confidence interval around $\bar{\rho}$; CR = credibility interval around $\bar{\rho}$.

requiring a lower as compared to higher level of creativity, and for studies where creativity was assessed via subscales/shortened scales as compared to full scales/instruments. Table SM3 in our Supplementary Material file summarizes the results of all examined moderators.

3.1.2. Sensitivity analyses

To assess the robustness of our main meta-analytic results, we conducted a comprehensive sensitivity analysis (e.g., Borenstein et al., 2009; Kepes et al., 2012), as well as some dominance analyses (Azen & Budescu, 2003; Braun et al., 2019). Sensitivity analyses assess the degree to which the results of a meta-analysis remain stable when conditions of the data or the analysis change (Greenhouse & Iyengar, 2009; Kepes et al., 2013). They are thus a vital tool to determine whether one's obtained results are robust and likely to generalize. First, we assessed the effects of our reliability imputations as well as publication bias and outliers on the obtained results. Using three additional imputation approaches, we found that the originally obtained results are robust to our imputation approach (see Description SM3 in our Supplementary Material file). Next, we used a battery of previously recommended outlier diagnostics and publication bias detection methods, including trim and fill, cumulative meta-analysis, section models, and PET-PEESE (Kepes, Keener, & McDaniel, 2018; Kepes & McDaniel, 2015) to determine the degree to which our results were affected by outliers and/or publication bias. Overall, we found that the reported results tend to be robust to the influence of these phenomena. Our Supplementary Material file includes these results and a more detailed description of them (see Descriptions SM3, Tables SM4 through SM6).

3.1.3. Dominance analyses

Finally, to account for the potential effects of multicollinearity on some of our main results, we followed recommendations by Thomas et al. (2014) and used dominance analysis (Azen & Budescu, 2003; Braun et al., 2019) to examine the relative importance of particular variables. We used this analytical approach as multicollinearity can adversely affect meta-analytic results when trying to determine the relative importance, including incremental validity, of predictors (Tonidandel & LeBreton, 2015). Dominance analysis determines the importance or dominance of one predictor variable over another by comparing their additional R^2 contributions across all subset models. The individual equations for these analyses, including predictors and criteria, are in our Supplementary Material (Tables SM10 – SM12). We found that, in terms of the relative importance of Stratum II cognitive ability dimensions for overall creativity, broad visual perception is around twice as important as crystallized intelligence, which is followed by fluid intelligence (see Table SM10). General memory and learning and processing speed are comparatively unimportant (due to data constraints, broad auditory perception, broad retrieval ability, and broad cognitive speediness were excluded from this analysis).[6]

We also explored the relative importance of the effects between cognitive ability and the 3 Ps of creativity. Our results indicate that the effect between overall cognitive ability and creativity variables under the process perspective is substantially stronger than the correlation between overall cognitive ability and creativity under the other two perspectives (see Table SM11). Finally, our coded data allowed us to examine the relations between overall cognitive ability and the creative product facets (i.e., originality, flexibility, fluency, elaboration; see Table SM12). Our results suggest that overall cognitive ability is more highly related to the flexibility facet than any other one, followed by the elaboration, originality, and fluency facets (due to data constraints, the quality facet was not part of the analysis).

4. Discussion

Our meta-analysis provides a comprehensive typology of creativity, which integrates those of Rhodes (1961), Barron and Harrington (1981), and Ma (2009). Using this new typology, we examined the correlation between creativity and its oldest and possibly most controversial predictor, cognitive ability, conceptualized as general mental ability or g (Silvia, 2008). For cognitive ability, we adopted a comprehensive and well-established typology (i.e., Carroll's (1993) Three Stratum Theory). The breath and detail of the typologies employed enhanced our understanding of the intricacies of the focal correlation and allowed us to determine, for the first time in this research area, whether the bandwidth-fidelity hypothesis applies to the cognitive ability-creativity relation. We found it did not.

In addition to the comprehensive typologies used, we examined a large number of conceptual and methodological moderators, many of which have not been examined previously (see Table SM3 for a list of all moderators). We also assessed the relative importance of five Stratum II cognitive ability dimensions for overall creativity, for the 3 Ps of creativity, and for four creative product facets (i.e., originality, flexibility, fluency, elaboration). Through such a nuanced approach, we were able to identify and provide more specific recommendations for practitioners regarding, for example, which type and measure of cognitive ability may provide the most value for a particular context. As our results are based on adult samples, they are likely highly relevant for workplace creative outcomes, but also broader societal ones.

Our meta-analytic results indicated that overall cognitive ability is significantly and positively corelated with overall creativity, and that the relation is substantially stronger for variables pertaining to the process perspective of creativity as compared to the person and product perspectives. Our dominance analysis results support this meta-analytic finding. The fact that overall cognitive ability corelated more strongly with variables under the creative process rather than product perspective is likely partly due to the fact that products depend on additional motivational, social, and environmental factors (Szen-Ziemianska et al., 2017). Thus, for occupations requiring creativity, cognitive ability measures may be used for organizational practices, but close attention also needs to be paid to creating and maintaining environments where resources (e.g., financial, technical, emotional) necessary to implement the ideas developed during the creative process are present.

Using dominance analysis, we assessed for which creative product facet (i.e., originality, fluency, flexibility, elaboration) cognitive ability was most important. We found overall cognitive ability to be considerably more strongly related with flexibility than the other creative product facets. Thus, cognitive ability seems to contribute more to the generation of a variety of different ideas, than the generation of rare ideas, many ideas (irrespective of their variety or distinctiveness), or the provision of as much detail on ideas as possible. As such, cognitive ability tests are likely more useful for organizational practices for occupations requiring high flexibility (e.g., biochemists and biophysicists), than occupations requiring originality, elaboration, or fluency of ideas

[6] An anonymous reviewer inquired whether we could run an incremental validity analysis to determine whether the unique non-g variance in the Stratum II cognitive abilities dimensions add incremental validity over Stratum III (g). Although we did not have data to conduct this analysis, we ran an incremental validity analysis for each possible pair of the Stratum II dimensions. The results are in Table SM13 of our Supplementary Material file and are similar to those obtained from the dominance analysis.

(e.g., fine artists, creative writers, architects).

Under the process perspective, we found overall cognitive ability to be strongly correlated with problem-solving abilities and somewhat less strongly with imagery abilities, as well as analogical and metaphorical abilities. This suggests that using cognitive ability tests for organizational practices is most useful for creative jobs where problem-solving abilities are essential (e.g., special effects artists, video game designers). As for the person perspective, cognitive ability was less strongly related to variables under this perspective. However, within this category, it was most strongly correlated with creative behavior. Although not all creative behavior translates into valuable creative products, it is a predictor of creative performance (Hocevar & Bachelor, 1989; Said-Metwaly et al., 2017). This strengthens the idea that one should use cognitive ability-based assessments for selection and training in occupations requiring creativity.

Among the cognitive ability dimensions examined, "combined GMA dimensions" (i.e., instruments using a combination of two or more Stratum II cognitive ability dimensions) was the strongest predictor of creativity. Broad retrieval ability and broad visual perception had strong correlations as well, followed by fluid and crystalized intelligence. Although the rather small number of studies on broad retrieval ability did not allow us to include it in our dominance analysis, the obtained results support the meta-analytic ones and indicate that broad visual perception is considerably more strongly related with overall creativity than crystalized and fluid intelligence.

We also found stronger correlations for domain-general rather than domain-specific creativity measures. This was not surprising given that most cognitive ability measures assessing domain-general creativity involve a combination of cognitive ability dimensions (e.g., the SAT and ACT tests measure both fluid and crystalized intelligence) rather than a single dimension. When looking into specific domains and considering distributions with more than five independent samples, we found noticeably stronger correlations for scientific discovery and visual arts than for architectural design (see Table 4). This suggests that using cognitive ability measures for organizational practices in, for instance, scientific discovery and visual arts domains should be more useful and likely justified than for, for example, architectural design.

Our results related to domain-general creativity are more relevant to predicting creative potential than creative performance and are thus primarily useful in low-stakes situations, such as training during a creative educational program (Baer, 1994). If selection and training are needed in a specific rather than a more general program, the literature recommends tests that explicitly assess the cognitive ability dimension (s) most relevant for that particular domain (Baer, 1994; Said-Metwaly et al., 2017). For instance, for recruitment and training into a visual arts program (rather than a general arts program), a test assessing broad visual perception should be most useful. However, examining the mean correlations between cognitive ability dimensions and creativity domains, we found that both fluid and crystalized intelligence had stronger correlations with creative products in the visual arts domain than broad visual perception (see Table SM1). This may be because some visual arts products require the use of logic and prior knowledge (e.g., drawing completion tasks or drawing productions using a certain theme). We also found crystalized intelligence to be moderately to strongly correlated with creative writing. Given that crystalized intelligence refers to language comprehension and production, and communication ability, this finding is consistent with some domain-specific creativity research (e.g., Kaufman et al., 2017). As such, the use of cognitive ability tests assessing both fluid and crystalized intelligence for selecting and training in visual arts occupations or programs, or crystalized intelligence only for creative writing occupations, could be recommended.

When examining how the Stratum II dimensions of cognitive ability correlate with variables under the three creativity perspectives, we found that fluid and crystalized intelligence are most strongly correlated with variables under the process perspective. Under this latter perspective, both fluid and crystalized intelligence were most strongly correlated with problem-solving abilities (see Table 3). These results mirror the ones we obtained for the general cognitive ability factor. Thus, for creative jobs heavily depending on problem-solving, cognitive ability tests assessing both fluid and crystalized intelligence seem more important and useful.

We also found that the measure of cognitive ability moderates our focal relation. Disregarding the Ang & Van Dyne (2008) self-report cultural knowledge measure, we obtained the largest effect sizes for the ISB and the MAB. The ISB is a comprehensive cognitive ability test based on the Cattell-Horn-Carroll intelligence model (Carroll, 1993), which, in turn, is based on Carroll's Three-Stratum Theory and assesses all cognitive ability dimensions included in our meta-analysis. Therefore, it is not surprising that it had the strongest correlation with overall creativity. Given this measure's good psychometric properties (i.e., it is highly reliable and valid; Arendasy et al., 2004; Hart, 2021), and because it was designed to measure work-related abilities in a fair and economical manner (Hart, 2021), we recommend its use for selection into creative occupations and educational programs requiring general, rather than specific, creativity. Similarly, the MAB assesses a multitude of Stratum II cognitive ability dimensions, has sound psychometric properties, and has been successfully used in selection for various business, military, and law-enforcement settings (Sigma Assessment Systems, 2021).

The measure of creativity also moderated our focal correlation. In particular, we obtained the strongest correlations when creativity was assessed with Zhou and George (2001) measure, followed by the RAT, drawing production tasks rated via the CAT (a sub-category of the drawing task measure), and the ICAA. This implies that cognitive ability is most relevant for the creativity facets these measures assess; specifically, the work-related creative behaviors captured by Zhou and George (e.g., coming up with new and practical ideas to enhance performance and increase quality, searching out new technologies, product ideas, processes, or techniques), associational abilities, drawing products, and the creative achievements and accomplishments captured under ICAA (e.g., writing a newspaper article, producing a sculpture). Given that overall cognitive ability was significantly correlated with creative behavior, the result regarding Zhou and George's measure is not surprising. Importantly, this measure focuses on creative behavior in the workplace, typically rated by a supervisor. Considering that ratings of others are more accurate than self-ratings (Fleenor, Smither, Atwater, Braddy, & Sturm, 2010), the fact that cognitive ability tends to be strongly correlated with a more objective assessment of creative behavior is notable. Indeed, when examining the type of creativity measure rating as a moderator, we found the correlation between overall cognitive ability and overall creativity to be substantially stronger when using expert opinion rather than psychometric assessments.

Other moderator analyses revealed interesting findings as well. For instance, the mean correlation between overall cognitive ability and overall creativity tended to be stronger with verbal rather than figural assessments of creativity. Thus, in occupations where verbal creativity is important, it seems to make more sense to select using cognitive ability tests than it does for occupations or programs where figural creativity is needed. Somewhat surprisingly, the mean correlation between overall cognitive ability and overall creativity was equally strong in field and laboratory settings. Despite the view that results from laboratory studies are less generalizable (Berkowitz & Donnerstein, 1982), for this particular relation of interest, they do not seem to be. As such, our findings indicate that we can rely on laboratory findings regarding the correlation between cognitive ability and creativity and make fairly sound inferences regarding what may happen in the field.

Other interesting findings are in our Supplementary Material file (see Table SM2). For instance, we found stronger correlations between overall cognitive ability and overall creativity for newer cognitive ability measures, but weaker ones for newer creativity measures (post 2010). The former finding may be due to newer cognitive ability measures incorporating creativity aspects, whereas, in terms of the latter, it is possible that older creativity measures tend to capture domain-general creativity, thus yielding a stronger effect size, and that newer creativity measures assess more specific aspects of creativity, thus relating to a lower extent to cognitive ability. We also found that our focal relation does not change if assessed in jobs traditionally considered creative or not, but that the level of creativity required for a task makes a difference. We found the weakest mean correlation for tasks requiring higher levels of creativity, likely because such tasks tend to require domain-specific, rather than domain-general, creativity. Last, our focal correlation is much stronger when subscales/shortened scales rather than full scales and batteries of creativity are used. It could be that, because comprehensive measures of creativity assess creativity across several domains, and cognitive ability does not predict creativity in some, but rather inhibit it (e.g., we found a negative correlation between cognitive ability and humor production), some smaller or negative effect sizes cancel stronger positive ones out, decreasing the average observed effect size.

5. Limitations and future research directions

First, although we went into considerably more depth than prior research in this area, and examined the correlations between different Stratum II dimensions of cognitive ability and overall creativity, different Stratum II dimensions of cognitive ability and different dimensions of creativity, as well as different perspectives and dimensions of creativity and overall cognitive ability, several meta-analytic distributions were small in size. Furthermore, cognitive ability dimensions at Stratum I could not be examined due to a lack of primary studies. Thus, to understand the complexities and nuances inherent in the cognitive ability-creativity relation, we call for more primary research that focuses on the scarcely studied Stratum II dimensions and Stratum I facets of cognitive ability. For instance, at Stratum II, there are only three studies measuring cognitive ability as broad retrieval abilities, six as processing speed, and none as broad auditory perception. Some distributions for the dimensions of creativity are very small as well. Knowledge retrieval abilities, imagery abilities, and evaluation abilities under divergent thinking are examples of such dimensions under the process perspective. Under the product perspective, we found very similar situations. Essentially, the results from distributions in our tables with only few

Table 4
Moderating effects in the correlation between overall cognitive ability and overall creativity: psychometric meta-analytic results.

Dimensions of cognitive ability and creativity	k	N	$\overline{r}$	SD_r	$\overline{\rho}$	SD_ρ	95% CI	80% CR	Moderator test [F(df), p-value]
Measure of cognitive ability									9.62 (19, 26.60), <.001
- Ang and Van Dyne (2008)	3	1,678	.52	.11	.56	.10	.44, .68	.43, .69	
- Ang et al. (2007)	3	661	.24	.00	.28	.00	.28, .28	.28, .28	
- Baddely Reasoning Test	4	736	.15	.10	.19	.08	.07, .31	.08, .29	
- Catell Culture Fair Intelligence Test	9	1,878	.14	.11	.17	.10	.08, .25	.03, .30	
- Course grades	6	15,016	.25	.04	.29	.04	.26, .33	.24, .34	
- Ekstrom et al. (1976)	4	504	.12	.10	.15	.05	.03, .26	.09, .21	
- GPA	8	4,810	.07	.05	.09	.03	.04, .13	.04, .13	
- International Cognitive Ability Resource Project	5	2,460	.23	.09	.28	.09	.19, .37	.17, .39	
- Intelligence Structure Battery	3	729	.32	.06	.40	.00	.32, .48	.40, .40	
- Intelligence Structure Test	4	608	.06	.14	.08	.13	−.08, .24	−.09, .24	
- Multidimensional Aptitude Battery	4	860	.32	.13	.39	.16	.22, .56	.19, .59	
- Mill Hill Vocabulary Test	3	468	.04	.05	.06	.00	−.01, .13	.06, .06	
- Primary Mental Abilities (Thurstone)	5	559	.09	.07	.10	.00	.03, .18	.10, .10	
- Raven's Adv. Progressive Matrices	21	3,882	.19	.11	.23	.10	.18, .29	.11, .35	
- SAT	4	455	.15	.09	.17	.00	.08, .27	.17, .17	
- Symmetry Span task	3	688	.09	.07	.11	.02	.01, .20	.08, .13	
- Weschler Adult Intelligence Scale	9	1,362	.26	.12	.31	.11	.22, .40	.17, .45	
- Wonderlic	8	3,148	.09	.08	.10	.08	.03, .17	.00, .21	
- Other – Specific	31	7,340	.19	.10	.22	.10	.18, .26	.09, .35	
- Other – General	66	45,622	.34	.20	.40	.23	.35, .46	.11, .69	
Measure of creativity									98.40 (17, 24.30), <.001
- Biographical Inventory of Creative Behaviors	4	485	−.01	.09	−.02	.03	−.13, .09	− .06, .02	
- Barron-Welsh Art Scale	3	213	−.13	.01	−.15	.00	−.16, −.14	−.15, −.15	
- Creative Achievement Questionnaire	7	12,136	.24	.05	.29	.05	.25, .33	.22, .35	
- Creative Behavior Inventory	3	624	.17	.08	.20	.05	.10, .31	.14, .26	
- Creative Personality Scale	5	642	.08	.08	.09	.00	.01, .18	.09, .09	
- Creative writing task	6	816	.26	.07	.30	.00	.23, .37	.30, .30	
- Write a poem	2	166	.22	.08	.27	.00	.13, .40	.27, .27	
- Write a story	2	242	.35	.02	.42	.00	.40, .45	.42, .42	
- Drawing task	11	2,071	.24	.05	.28	.00	.24, .32	.28, .28	
- Drawing completion	6	1,589	.22	.03	.26	.00	.23, .29	.26, .26	
- Drawing production	5	482	.30	.06	.36	.00	.31, .41	.36, .36	
- Guilford & Wallack-Kogan	40	16,149	.18	.09	.22	.09	.19, .25	.11, .33	
- Alternate Uses Test	11	1,355	.13	.10	.16	.07	.08, .23	.07, .24	
- Consequence Test	6	9,826	.17	.07	.20	.07	.14, .26	.11, .29	
- Guilford & Wallack-Kogan Mixed	15	2,249	.24	.12	.29	.11	.22, .36	.15, .43	
- Usual Uses Test	9	2,813	.21	.09	.25	.07	.19, .32	.16, .35	
- Humor production	2	226	.10	.04	.13	.00	.05, .21	.13, .13	

Dimensions of cognitive ability and creativity	k	N	$\bar{r}$	SD_r	$\bar{\rho}$	SD_ρ	95% CI	80% CR	Moderator test [F(df), p-value]
- Inventory of Creative Activities and Achievements	7	2,091	.26	.09	.32	.07	.24, .39	.22, .41	
- Insight problem	4	1,231	.24	.15	.29	.18	.11, .47	.06, .51	
- Metaphor task	4	436	.21	.14	.24	.13	.08, .41	.08, .41	
- Metaphor production	3	391	.16	.06	.19	.00	.11, .27	.19, .19	
- Remote Associates Test	14	2,505	.34	.12	.41	.12	.34, .49	.25, .57	
- Runco Ideational Behavior Scale	3	381	.01	.08	.00	.00	−.11, .12	.00, .00	
- Torrance Test of Creative Thinking	12	2,580	.21	.09	.26	.08	.20, .32	.16, .36	
- Zhou and George (2001)	4	2,199	.52	.06	.56	.05	.50, .61	.50, .62	
- Other - specific	18	4,603	.13	.10	.16	.09	.10, .21	.04, .28	
- Other - general	57	29,974	.33	.20	.40	.22	.34, .46	.11, .69	
Creativity measure domain									
- Domain general	102	46,367	.30	.18	.36	.20	.32, .40	.10, .62	11.80 (1, 90.20), .001
- Domain specific	38	6,203	.21	.13	.25	.12	.20, .30	.09, .41	
- Architectural design	1	17							
- Creative writing	14	2,431	.17	.12	.20	.11	.13, .28	.06, .35	
- Humor	3	451	.23	.13	.28	.11	.12, .44	.15, .42	.57 (4, 8.95), .690
- Music	1	10							7.97 (2, 81.80), <.001
- Scientific discovery	6	580	.28	.19	.33	.20	.14, .51	.07, .58	
- Visual arts	15	2,526	.23	.09	.27	.07	.21, .33	.18, .36	
- Combined[a]	5	1,347	.25	.16	.27	.17	.11, .43	.05, .50	
- Inventory (several domains)	30	17,152	.22	.09	.26	.10	.22, .30	.13, .40	
- Indeterminable[b]	3	2,812	.10	.06	.13	.05	.05, .20	.06, .19	
Modality of creativity test									
- Verbal	59	19,519	.18	.09	.22	.09	.19, .24	.10, .33	16.60 (2, 96.30), <.001
- Figural	38	6,955	.23	.13	.27	.13	.22, .32	.10, .43	
- Indeterminable[b]	87	48,236	.30	.18	.37	.20	.32, .41	.11, .62	
Type of creativity measure									
- Psychometric	62	30,258	.20	.16	.25	.18	.20, .30	.02, .48	16.10 (1, 135), <.001
- Expert opinion	98	41,109	.31	.17	.37	.19	.33, .41	.13, .61	
Study setting									
- Experiment	116	47,962	.27	.18	.33	.20	.29, .37	.07, .59	.11 (1, 33.30), .740
- Field	19	17,866	.27	.12	.32	.13	.26, .38	.15, .49	

Note: k = number of independent samples contributing to the distribution; N = total sample size; $\bar{r}$ = mean observed correlation; SD_r = observed standard deviation of r; $\bar{\rho}$ = mean true-score correlation; $SD_{\bar{\rho}}$ = standard deviation of $\bar{\rho}$; CI = confidence interval around $\bar{\rho}$; CR = credibility interval around $\bar{\rho}$. [a] Combined: Combination of some of the above measures. [b]Indeterminable: Unknown measures. [c]Inventories of creative activities and achievements are presented as a separate category as they assess creativity in multiple specific domains. [d] "Other - Specific" categories under measure of cognitive ability and measure of creativity, respectively, include established measures of creativity, where k < 3; "Other - General" categories under these moderators include measures of little notoriety or for which we could not establish a source; k was also <3 for all these measures. References for the cognitive ability and creativity measures listed in the table are provided in our Supplementary Material file (p.68–69).

studies should be viewed with caution. More primary research is needed to determine whether these preliminary results hold.

Second, whereas we examined a comprehensive list of moderating effects, our wide credibility intervals indicate there are other boundary conditions that affect our relation of interest that we have not accounted for. As an example, Unsworth's (2001) problem type (open vs. closed) by driver for engagement (external vs. internal) creativity classification could function as a moderator. We encourage future work in this research area to expand our list and examine other conceptual and methodological variables for potential moderating effects.

Third, certain creativity variables have been categorized as process variables by some researchers and as product variables by others. For instance, Said-Metwaly et al. (2017) categorized variables assessed via the SOI, TTCT, and Wallach-Kogan creativity measures as process variables, whereas Ma (2009) classified them as product (ideation with less evaluation). We used the latter approach but acknowledge that these variables, as well as others (e.g., metaphor production), may be classified as either process or product. Moreover, some researchers view divergent thinking as cognitive ability, rather than creativity (e.g., Said-Metwaly, Taylor, Camarda, & Barbot, 2022). We thus encourage creativity researchers to revisit prior typologies and reach consensus regarding the classification.

Fourth, although we worked with comprehensive typologies for both creativity and cognitive ability, these typologies do not capture some traits or abilities that prior research suggests may be related to cognitive ability and creativity, respectively. For instance, executive function, a construct defined as the set of abilities necessary to guide behavior toward a goal, in novel, unstructured, and nonroutine situations requiring judgment (Banich, 2009), is likely related to cognitive ability, but Carroll's (1993) typology does not capture it. Similarly, openness to experience, a Big 5 personality trait, seems to be correlated with different measures of creativity (Dollinger, Urban, & James, 2004). Our "person" perspective on creativity, based on the typologies of Barron and Harrington (1981) and Ma (2009), does not include this personality trait, but only traits specifically labelled as "creative" (e.g., creative personality). We acknowledge the limitations associated with the typologies we used and encourage future research to explore these related constructs in relation to either creativity or cognitive ability.

Fifth, many studies in our sample did not report reliability information. As rigorous research is needed for robust, generalizable findings, primary studies should use well-established measures, and report reliability estimates for both cognitive ability and creativity. Finally, many of the results in our tables are associated with considerable degrees of heterogeneity, even after we accounted for moderating effects. Thus, more moderators are affecting the cognitive ability-creativity relation and we call for future research to explore possibilities. Despite these limitations, we have confidence in the accuracy and validity of our results. Indeed, our comprehensive sensitivity analysis suggested that, overall, our results tend to be robust to the influence of reliability imputations, outliers, and publication bias, which is, unfortunately, not the case for many psychological phenomena (e.g., Kepes, Banks, & Oh, 2014). As such, in general, we have confidence in the robustness of the reported results and associated conclusions.

Data availability

Our data and coding appear in our Supplementary Material file attached.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.intell.2023.101757.

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