Personal factors and group creative outcomes: A correlational meta-analysis

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Role	AF	FG	NB	LS	JK
Conceptualization	•	•	•	•	
Pre-registration	•				
Data curation	•				
Formal analysis	•				
Funding acquisition					
Investigation	•				
Pre-registration peer review / verification		•	•	•	•
Data analysis peer review / verification					•
Methodology	•				•
Project administration	•				
Resources	•				
Software	•				
Supervision		•	•	•	
Validation	•				•
Visualization	•				
Writing-original draft	•				
Writing-review and editing	•	•	•	•	•

Note. See <https://www.casrai.org/credit.html> for the details and definitions of each role.

Abstract

Previous research has investigated the relationship between personal factors and group creativity outcomes. On one side, they indicated that individual differences play a role in group creativity. On the other side, they showed that group creativity activities have different outcomes, leading to numerous ways to assess effectiveness of creative activity. Nonetheless, no meta-analysis was performed on the relationship between the outcomes of the creative activity and personal factors of the group members. In this Registered Report, we conducted a meta-analysis ($n = 11$, $k = 72$) on the relationship between personal factors and group creativity outcomes. We found weak support for a positive correlation between self-efficacy and group creativity outcomes, between $r = .04$ and $r = .67$. We found weak support for a moderation effect of time constraint, with a stronger effect between 10 and 20 minutes than less. Finally we found that only a few studies concerning personal factors and creative outcome could be included in the meta-analysis, because they do not directly measure creativity, or they measure other, less common personal factors. We call for a more systematic and direct approach of measuring creativity, and an improvement of open science practices in the field. Data and analysis can be found in: <https://osf.io/xwph9>

Keywords: brainstorm, creativity, meta-analysis, personality, correlation

The preregistered manuscript stage one can be found here: <https://osf.io/nybg6>

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The influential Yale study (Taylor et al., 1958) was the first one to test the performance of the brainstorming technique on idea generation. Since then, group creativity activities have been extensively studied. A group creativity activity can be defined as a group activity designed to develop numerous ideas that are original and useful (Paulus & Nijstad, 2003; Taggar, 2019). In most cases, group creativity activities are based on explicit and elaborate instructions. For example, the brainstorming activity (Meadow et al., 1959) has four explicit rules (i.e., go for quantity, withhold criticism, welcome wild ideas, combine and improve ideas). Brainwriting (VanGundy, 1984) adds a fifth rule, as you must write down your ideas before sharing them with other group members. Other variants of brainstorming have also been proposed, for example, based on instructions to incite participants to evoke constraints related to the problem at hand, in addition to ideas (Bonnardel & Didier, 2020). Creative Problem Solving (CPS, Osborn, 1963) also has four rules (i.e., clarify, generate ideas, solve, and implement). Other names than ‘brainstorming’ can be used for group creativity activities such as collaborative idea generation or idea generation groups (Kenworthy et al., 2020). In this case, the instruction is generally brief, sometimes associated with just a demand to “try to be as creative as possible” but they give rise to generally poorer creative performance than more elaborated instructions (Niu & Liu, 2009). Generally, a group creative activity involves the generation of original and useful ideas, with a standard instruction to not criticize ideas, to say whatever ideas came to mind, to focus on generating as many ideas as possible, to build on ideas and to stay focus on the task (Coursey et al., 2018; Osborn, 1963; Putman & Paulus, 2009). The most typical outcomes examined in group

creativity research are the number, the originality (sometimes called novelty), and the usefulness (sometimes called relevance) of the ideas generated. While the number of ideas corresponds to a direct measure of quantity, the originality and usefulness of the ideas consist in measures of quality, and in most cases, external raters assign numerical values to the ideas. These idea ratings are then averaged within the groups to produce a group quality score (DeRosa et al., 2007).

Personal factors of group members are important to our understanding of how and why creative groups succeed in generating novel ideas and favoring innovation. At the individual level, several studies and meta-analyses have been conducted to study how personal factors, such as personality, affect creativity (Lebuda et al., 2021; Litchfield et al., 2017). At the group level, some studies have indicated that the composition of the group can affect the creative outcomes (e.g., Moreland et al., 1996). Since then, personality traits and cognitive trait differences have been studied in group creativity activities (for a review, see Coursey et al., 2018), but to our knowledge, no meta-analysis has been conducted regarding the link between personal factors and outcomes of group creative activities.

In this paper, we seek to answer two critical questions: (1) Which creative outcomes in group activities are associated with which personal factors; and (2) What are some potential moderators of the relationship between group creativity outcomes and personal factors?

Toward this end, we performed a correlational meta-analysis to contribute to the literature on the association between creativity outcomes at the group-level and personal factors of members within the group. A theoretical account on these two constructs is first presented, and is followed by our hypotheses on why and how the two constructs may be connected. Then, we will describe the procedure for conducting this meta-analysis and the results it allowed us to obtain.

Personal Factors

Extensive research has been conducted on personal factors influencing individual creativity, but less research has been done on people in social contexts (Reiter-Palmon & Kaufman, 2018). Creativity was first investigated as an individual process, and teamwork was considered as a facilitator or inhibitor of individual creativity (Amabile, 1996; Reiter-Palmon et al., 2012). Today, team creativity is central in product design and development, and to solve challenging problems. Understanding how each member of the creative group can have a different impact on the outcome of creative thinking is crucial, since it can contribute to improve the process and customize the creativity activity for the participants. For a long time, the empirical literature examining creativity activities mostly associated personal factors with personality traits (Barron & Harrington, 1981; McCrae & Costa, 1995; Puryear et al., 2017; Yao & Li, 2021). Recently, researchers have started examining the effects of emotional disposition and cognitive differences to get a broader comprehension of individual differences and their contribution to group creative outcomes.

Relationships between Personal Factors and Group Creativity Outcomes.

There is a growing interest in the link between personal factors and group creativity outcomes. Many existing studies have been conducted regarding the personal factors involved in fluency and flexibility (Butler et al., 2003), originality and usefulness (Baer et al., 2008), and number of ideas (Brown et al., 1998). However, there have been debates regarding the relationship between personal constructs and group creativity outcomes due to mixed findings. Coursey et al. (2018) provided a review of individual factors in group creativity activities. In their overview, they said (p.26-27):

“It is presumed that there will be some degree of similarity between the effects observed for individuals and groups. However, we have highlighted a number of ways in which the effects of individual differences may not be simply additive. [...] Thus,

in agreement with the configural perspective of Moynihan and Peterson (2004), certain team compositions may be ideal for groups that go through the full phases of the creative process. One strategy would be to compose a team that had the “right mixture” for the multiple phases, or one could compose separate teams specifically for different phases.”

Indeed, in a group setting, some social traits can improve creativity potential, for example, traits that lead group members to be more attentive to the ideas of others, to process the shared ideas including the more radical ones, to be more motivated and persistent in the search for new ideas, to build on the ideas of others, and to share new ideas. We have summarized the list of personal factors we used in this meta-analysis in Table 1.

Table 1*Commonly used measures of personal factors in creative groups*

Main term	Definition	Literature	Description of Results
Personality trait	(Based on Costa & McCrae, 1992, p.5-6)		
Openness to experience	“The term to refer to a broader constellation of traits. High-O individuals are imaginative and sensitive to art and beauty and have a rich and complex emotional life; they are intellectually curious, behaviorally flexible, and nondogmatic in their attitudes and values.”	Schilpzand et al. (2011, p. 67)	“As expected, we found that openness to experience was important for creative team outcomes.”
Extraversion	“a broad group of traits, including sociability, activity, and the tendency to experience positive emotions such as joy and pleasure.”	Jung et al. (2012, p.30)	“In the first experiment, extraverts outperformed introverts in computer-mediated groups. In the second experiment, we exposed participants in computer-mediated groups to four levels of idea stimulation ranging from none to extremely high. Extraverts generated more unique and diverse ideas than did introverts in moderate- and high-stimuli conditions only.”
Conscientiousness	“Conscientiousness is a dimension that contrasts scrupulous, well-organized, and diligent people with lax, disorganized, and	Baer et al. (2008, p. 274)	“In addition to demonstrating that teams composed primarily of individuals high on extraversion, high on openness, or low on conscientiousness were highly creative when team creative confidence was high, our results also indicated that composing teams mainly of high neuroticism or of low agreeableness members had little effect on team creativity.”

	lackadaisical individuals.”		
Agreeableness	“Agreeableness is primarily a dimension of interpersonal behavior. High-A individuals are trusting, sympathetic, and cooperative; low-A individuals are cynical, callous, and antagonistic”	Taggar (2002, p. 323)	“An individual's extraversion, conscientiousness, and agreeableness are positively associated with intragroup process behavior (team creativity-relevant processes at the individual level). In the regression equation, about 31 percent ($p < .001$) of the variation in intragroup process behavior was explained. Beta weights showed that conscientiousness contributed mostly to explaining team creativity- relevant processes at the individual level, followed by extraversion and agreeableness”.
Neuroticism	“The individual's tendency to experience psychological distress.”	Baer et al. (2008; p. 260)	“The above arguments suggest that teams composed of members who are likely to criticize others' ideas and to provide candid feedback, that is, individuals high on neuroticism, should possess the potential to experience creative synergies.”
Emotion			
Social Anxiety	“Been nervous or feeling uncomfortable in a social context (Leary & Kowalki, 1993)”.	Camacho & Paulus (1995, p.1078)	“The results reported suggest that when social anxiousness is minimized, group brainstorming can be nearly as productive as nominal group brainstorming. Our results thus suggest that interactive brainstorming may be best suited for people who are low in social anxiety.”
Emotional intelligence	“The ability to monitor one's own and others' feelings and emotions, to discriminate among them, and to use this information to guide one's thinking and actions”. Wang (2015, p. 325)	Wang (2015, p. 340)	“The present study [...] showed that average member EI increased elaboration, which in turn led to better performance in the informationally diverse condition.”
Cognition			

Cognitive style	“Individuals who tend to stick to a topic are known as convergent thinker. Individuals who are more likely to free-associate and jump between topics are known as divergent thinkers.” (Brown et al., 1998, p. 498)	Brown et al. (1998, p. 519)	“When a divergent thinker changes from a divergent partner to a convergent partner, their output (spoken ideas) increases. When a convergent thinker changes from a convergent partner to a divergent partner, their output decreases.”
Need for Closure	“a desire for a definite answer to a question, any firm answer, rather than uncertainty, confusion, or ambiguity” (Chirumbolo, 2005, p. 61)	Chirumbolo et al. (2005, p.74)	“The need for cognitive closure exerts an adverse effect on creativity in groups. Specifically, groups composed of individuals high (vs. low) in need for closure revealed a lower degree of productivity across multiple measures of group creativity. High (vs. low) need for-closure groups exhibited significantly lesser fluency of ideas.”
Creative Self-efficacy	“The capacity judgement about creative endeavors” (Richter et al. (2012, p.1283)	Richter et al. (2012, p.1287)	“The positive relation between [creative self-efficacy] and creativity was stronger in teams with greater shared [knowledge of who knows what].”
Epistemic Motivation	“Group members’ epistemic motivation—their willingness to expend effort to achieve a thorough and rich understanding of the world, including the group task or decision problem at hand” (Bechtold et al., 2010, p.623)	Bechtoldt et al. (2010, p.633)	“We proposed that group creativity improves when members have high rather than low epistemic motivation. With regard to creative fluency—the number of nonredundant ideas and insights generated by the group—our hypothesis was supported in all three tests.”

Need for Cognition	“The tendency for an individual to engage in and enjoy effortful thinking,” (Huang and Liu (2021, p. 2)	Huang and Liu (2021, p. 1)	“Psychological safety climate and the need for cognition were positively associated with team creativity through information elaboration.”
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To point out important findings in the literature, firsts, Feist (1998) asserted that creative individuals need to balance between social stimulation and quiet reflection. Therefore, extroverted people may show better creative performance in some groups, depending on the need to interact with others (see also Anderson et al., 2008). Conscientiousness, which leads people to adhere to norms and rules (Roberts et al., 2009), may help generate a high number of ideas, but not necessarily ideas that are original or useful. This idea is supported by Feist (1998), who found that artists, who need to develop original ideas individually, were generally low in conscientiousness. Agreeableness is a strong predictor of team performance because it is related to trust and morale (Hogan et al., 1994). However, creative people are generally low in agreeableness (Bechtoldt et al., 2012; Karwowski & Lebuda, 2016). Low neuroticism could be a more beneficial trait to have in a group creativity setting (Bell, 2007; Da Costa et al., 2015; Peeters et al., 2008). Other personal factors can have differential links with various creativity outcomes. Emotional factors can play a role, (Kuška et al., 2020) such as anxiety (Camacho & Paulus, 1995), and emotional intelligence (Wang, 2015). That is also the case of cognitive dispositions such as cognitive orientation or cognitive styles (Brown et al., 1998), and other cognitive traits such as creative self-efficacy (Taggar, 2019; Tierney & Farmer, 2002), epistemic motivation (Bechtoldt et al., 2010), Need for Closure (Chirumbolo et al., 2004, 2005), and Need for Cognition (Wu et al., 2014). For example, Need for Closure, a cognitive tendency to avoid ambiguity, is related to the quality of ideas generated but not originality (Watts et al., 2017). Most studies mentioned above examined the relationships of interest at the individual level. At the time of writing, there is no literature review or meta-analysis on the relationship between personal factors and creativity outcomes in a group setting.

Research Aims and Hypotheses

In this study, we sought to examine: (1) the overall relationship between personal factors and creativity outcomes in group settings; and (2) moderators of these relationships.

Moderators

We examined different moderators in the relationships between personal factors and group creativity outcomes, including environmental influence on how the activity was conducted, tasks factors related to the rules of the creative activity, and personal factors such as demographic. Our moderator hypotheses were exploratory and mostly based on the last review available on the subject (Coursey et al., 2018). In this review, researchers had indicated that there were very few studies on the subject, and we expect some moderators to be untestable meta-analytically in the absence of primary-level empirical data. We explored and reported all available relationships. In italics below are the hypotheses for which the literature on the subject tends to provide evidence for a relationship.

Familiarity

Familiarity of the group is the extent to which group members know each other (Sosa & Marle, 2013). For example, familiarity can range from participants who do not know each other in a laboratory setting to teammates who have already worked with each other for a long time. In the study conducted by Sosa and Marle (2013), it was found that the more familiar group members are to one another, the better the creative outcomes. We hypothesized that individuals who struggle with novelty will produce better group creativity outcomes if they are familiar with the other group members. These groups include participants high in introversion (Orengo Castellá et al., 2000), Need for Closure (Chirumbolo et al., 2004), and social anxiety (Camacho & Paulus, 1995).

Familiarity: In non-familiar context, introversion, need for closure and social anxiety is negatively associated with creative outcomes. In familiar context, the negative correlation is weaker than in non-familiar context.

Skill and Knowledge Diversity

The idea behind skill diversity is similar to familiarity: people who are closer to each other tend to bond easier with others, leading to less perceived stress and a more positive social climate, resulting in better creative outcomes. On the contrary, synergy can be difficult to appear in an overly homogeneous group, because not every member adds creative value beyond the others (Nijstad & De Dreu, 2002). A group with members who have substantial overlap in skills and knowledge may have limited creativity due to a lack of diversity. We exploratively tested the moderation hypothesis that skill and knowledge diversity in a group modifies the relationships between personality traits and creative outcomes.

Group Demography

Diversity may be a key to group creativity. Having diversity in groups, such as having diversity with respects to hierarchical status, gender, age, field of study, leads groups to be more creative (Choi, 2007; Paulus & van der Zee, 2015). In small groups, and using electronic brainstorming, research indicated that group composed of women showed greater fluency (i.e., produced more ideas) than mixed groups, groups composed of men or “solo” groups (Peter et al., 2021). For Group creativity, competition had a positive effect on creative outcomes for groups composed of men, but negative effect for groups composed of women (Baer et al., 2013). We explored the hypothesis that group demography modifies the relationships between personality traits and creative outcomes.

Constraint

Constraint refers to the degree of freedom in creative activity. Two major types of constraints regarding the conditions of the brainstorming activity can be pointed out:

production blocking where a rule was imposed on the members to not share their ideas as they come to mind, and asynchrony where the participants are generating ideas individually, before sharing them with each other. In the production blocking condition, individual factors are less important for creativity (Nijstad & Stroebe, 2006) than in the non-production blocking condition, whereas in the asynchronous condition, individual factors are more important than in synchronous condition (Paulus & Kenworthy, 2018). Thus, we hypothesize that constraint weakens the relationship between personal factors and group creativity outcomes, operationalized as production blocking and synchrony conditions.

Constraint: In production blocking setting, the relationships between individual factors and creative outcomes is lower than in non-production blocking setting. In asynchrony setting, the relationships between individual factors and creative outcomes are higher than in synchrony setting.

Type of Task

The type of task can influence the relationship between personal factors and creative outcomes. In conjunctive tasks, creative tasks in which participants pass ideas from one to another, the performance of the group is most strongly influenced by persons with traits that are highly positively or negatively related to creative outcomes. In disjunctive tasks, where participants share idea before the selection, the influence of each individual is weaker because they do not influence the sharing process (Coursey et al., 2018). We explored the evidence for an effect of this type of task in creative processes.

Type of task: In disjunctive tasks, the relationships between personal factors and creative outcomes are negatively or positively lower than for conjunctive tasks.

Creative phase

Harvey (2013) had found that the diversity of ideas was related to divergent creativity, and to a diminishing of convergent thinking. Also, convergent thinkers could perform better

in the convergent phase than in the divergent phase, mirroring the divergent thinkers (performing better in the divergent phase than in the convergent phase). As hypothesized in Coursey et al. (2018), introverts could be better at building and integrating creative ideas in the convergent phase, while extroverts could be less inhibited and make more contribution during the divergent phase.

Creative phase: Divergent thinking and extraversion are more strongly and positively associated with creative outcomes in the divergent phase than in the convergent phase.

Convergent thinking and introversion are less negatively associated with creative outcomes in the convergent phase than in the divergent phase.

Number of Participants

The number of group members is critical in creating, sharing, and transforming ideas and information into projects. The number “5” is generally admitted as optimal in terms of maximizing interacting group performance (Steiner, 1972). As the number increases, the creative performance of the group decreases (Fellers, 1989). The problem is that, as the number of participants increases, the likelihood of dysfunctional behaviors also increases (i.e., dominance by individual members, fear of personal evaluation, fear of speaking in public, pressure for conformity, and task restrictions, see Fellers, 1989). For personal factors, the number of participants might “dilute” the creative contribution of each member, leading to a weaker (positive or negative) relationship. Dugosh and colleagues (2000) also found that high levels of off-task communication were detrimental in face-to-face brainstorming groups, and that off-task communication increases with the number of participants (particularly extrovert participants).

Number of participants: the more the participants, the less strong is the (negative or positive) relationships between personal factors and creative outcomes.

Time pressure

The possibility to create and share information depends on the time available. Most creative tasks are structured and time-limited, mostly because creativity is mentally effortful. Time limitation is detrimental to group creativity (Karau & Kelly, 1993). Chirumbolo and colleagues (2004) found that time pressure reduced the percentage of creative acts during a group discussion and was positively related to personal need for closure (both reduced creative outcomes).

Time pressure: the negative relationship between need for closure and creative outcomes in group creativity is stronger under time pressure than with no pressure.

Leadership

It is challenging to assess how the leadership type will influence the relationship between personal factors and creativity. We decided to split leadership into two traditional types: transformational and transactional. In transformational leadership, the leader clearly states the goal and pushes the group toward attaining this goal. In transactional leadership, the leader relies on an exchange process in which group members are rewarded for accomplishing specific goals (Jung, 2001; Mumford et al., 2019). Research has found that transformational leadership leads to higher creative outcomes than transactional leadership (Jung, 2001; Sosik & Cameron, 2010; Zhang et al., 2011). Sosik and Cameron (2010) indicated that transformational leadership was related to an increase in motivation to create more ideas and ideas that are more original. On the contrary, Taggar (2019) explained that a cohesive team might follow the dominant actors in the team instead of trying to find more ideas. Thus, he hypothesized that a too strong cohesion in a team following a (transformational) leader could impair creative collective efficacy. Anderson and Fiedler (1964) also showed that groups with participatory leaders (i.e., transactional leader) had the highest number of ideas generated, and groups with supervisory leaders had the most original

and useful ideas. We hypothesized that the leadership type has an effect in the relationship between personality and creative outcomes. Leaders close to the team and who create a non-judgmental climate could help improve the performance of anxious, introverted, and less motivated members. On the other side, leaders with a more distant relation with the group, in the exchange process to attain the goal and who do not contribute to the task, could reduce the performance of these members, reducing the global creative performance. We explored the hypothesis that the type of leadership influences the relationships between personality traits and creative outcomes, leading to give more weight to the indication from Sosik and Cameron (2010) that transformational leadership leads to a stronger positive link or to the explanation of Taggar (2019) that transactional leadership leads to a stronger positive link.

Publication Status

We examined publication status for possible moderating effects on the relationship between personal factors and creativity outcomes. Several recent meta-analyses (Mathur & VanderWeele, 2020; Moreau & Gamble, 2020; Schmucker et al., 2017; Vosgerau et al., 2019) have suggested that including unpublished work can help improve the capture of the ‘true’ effect size. Accordingly, we expected that studies that were published are likely to report stronger associations than those that remained unpublished.

Publication status: published studies report stronger negative and positive relationships than unpublished studies.

Methods

Open Science Disclosures

We shared all procedures, materials, datasets, and analysis code on the Open Science Framework (https://osf.io/xwph9/?view_only=335369af22dc425096b1149cea66426a). The pre-registration and additional information about decisions are available in the supplementary materials.

Design

Our first construct, **personal factors**, is explained in Table 1. It is decomposed as *personality traits*: 1) openness, 2) conscientiousness, 3) extraversion, 4) agreeableness, 5) neuroticism; *emotion*: 1) social anxiety and 2) emotional intelligence; *cognition*: 1) Cognitive style, 2) epistemic motivation, 3) self-efficacy, 4) need for closure, 5) Need for Cognition. The three categories of our second variable, **creative outcomes**, are 1) number of ideas generated, 2) originality of these ideas and 3) usefulness of the ideas.

Eligibility Criteria

Studies including personal factors (see Table 1) and measuring creative outcomes in group settings are included in our analysis.

Search Strategy

Database searches. To identify articles that are potentially relevant to our topic of investigation, we conducted searches using Google Scholar, Psychinfo, Web of Science - social science citation index, Proquest- dissertations and theses (for suitability, see Gehanno et al., 2013; Martin-Martin et al., 2019; Moreau & Gamble, 2020).

For personal factors, the keywords were *personality trait**, *openness*, *extraversion*, *introversion*, *conscientiousness*, *agreeability*, *neuroticism*, *anxiety*, *social anxiety*, *thinking style*, *convergent thinking*, *divergent thinking*, *Need for Closure*, *creative self-efficacy*, *epistemic motivation*, *Need for Cognition*, *emotional intelligence*. For creative outcomes, the

keyword is creativity. On the overall, all search patterns included the following operators: “group*” OR “team” AND “correlation”.

During the search, keywords related to constructs were linked with the Boolean logic operators “OR” and keywords between construct 1 and construct 2 with “AND”. Variations of the keywords were included in the search with the original keywords if search results yield less than 100 results, linked with “OR”. (e.g., “personality trait*” AND “useful*”). More information on the search pattern process can be found in the coding sheet under the tab “search pattern”. Database searches for each search pattern was terminated after combining through 30 records consecutively without potentially relevant papers for the inclusion criteria.

The search included papers listed under the “related articles” and “cited by” features in Google Scholar to identify papers that are similar or have cited the identified articles that can be included in our analysis. We looked at other articles that were published by identified authors in the field to check if there were relevant papers that we may have missed. We systematically contacted the authors of the identified articles (see the pre-registered email template in supplementary) and issued a call for unpublished findings on ResearchGate and Twitter to find relevant unpublished data. For all the articles, titles, abstracts, tables, and methods sections were scanned to identify the relevance of a source.

Inclusion and Exclusion Criteria

Correlational meta-analyses typically exclude studies that had manipulations of the target variable before the said variable was measured (e.g., Chevance et al., 2019), or conduct a separate meta-analysis for studies with manipulations or interventions (e.g., Schmitt et al., 2014; van Kleeck et al., 2010). First, we restricted our meta-analysis to correlational studies that measure personal factors in creative contexts. Studies were excluded if they 1) experimentally manipulated IV-related of personal factors (e.g., manipulated motivation, social climate and anxiety, information and Need for Closure, etc.), 2) failed to report the

crucial statistics necessary for a meta-analysis (i.e., correlation coefficient or other effect sizes that can be transformed into correlation coefficient, sample size), or 3) not written in English or French unless all necessary information was provided in English or could be obtained from the authors.

Screening

Studies that met our criteria were coded into the “Searched articles” tab within the coding sheet. Articles were scanned to determine whether they should be included into the main coding sheet or not. If excluded, a reason will be documented along the article recorded. Authors of studies with missing statistics were contacted for relevant datasets/information through the “contacting author” tab and the corresponding mail template (see supplementary). If the dataset was provided, we included the article in the main coding tab. Finally, the process of inclusion can be found through the PRISMA diagram in Figure 1 and the included studies in Table 2.

Figure 1

Meta-analysis flow diagram in accordance with PRISMA 2020 (Page et al., 2020).

Table 2*All studies/datasets included in the meta-analysis*

No.	Article	N	Personal factors measured	Creative outcome(s)	Publication status	Country
1	Morgan (1996)	90	Need for cognition	Number of Ideas	Published	USA
2	London (2006)	160	Self-efficacy, anxiety	Number of Ideas, originality	Published	USA
3	Brophy (1995)	375	Need for cognition	Number of Ideas	Published	USA
4	Multu (2017)	135	Big Five	Number of Ideas, Originality	Published	UK
5	He (2019)	109	Self-efficacy	Originality, Usefulness	Published	China
6	Lee (2020)	267	Big five	Number of Ideas, Originality and Usefulness	Published	Singapour
7	Bolin (2006)	312	Big five	Number of Ideas, Originality and Usefulness	Published	USA
8	Homan (2015)	202	Self-efficacy	Number of Ideas, Originality and Usefulness	Published	Germany
9	Kenworthy (2020)	168	openness, extraversion, conscientiousness, Need for cognition	Number of Ideas and originality	Published	USA
10	Gheorghe (2020)	159	Emotional intelligence	Number of Ideas, Originality and Usefulness	Published	Romania

11	Bechtoldt (2010)	108	Motivation	Number of Ideas, Originality and Usefulness	Published	Netherlands
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Coding

Data extraction from the included studies was recorded in “main coding sheet” tab. When available, the main correlations between personal factors and creative outcomes were recorded, along with intercorrelations between creative outcomes, the type of scale used, sample demographics and publication information. Moderator variables were coded for each study, in a separate column in the main coding sheet.

Analysis

We developed an Rmarkdown Script for the statistical analyses. The packages used are indicated in supplementary. Our main package for meta-analysis is psychmeta (Dahlke & Wiernik, 2019). We used pearson’s r as the main indicator of effect size. Whenever available, we used correlations obtained directly from authors of original papers. If only regression were available, we converted to correlation by using a transformation provided in the supplementary. If not possible, we asked the authors to provide a correlation or raw data. Correlations were corrected for attenuation by using the formula (Dahlke & Wiernik, 2020):

$$r_c = \frac{r_{obs}}{\sqrt{r_{xx'}} \sqrt{r_{yy'}}$$

Given the range of different outcomes for each category, we expected the heterogeneity in the sample to be relatively high. Thus, a random effect model was used for all the relationships. Split conditions due to moderators were collapsed to allow for comparison of the relationships. All conversions and coding decisions were documented. A meaningful association is expected as having a correlation of at least $r = .10$ (Cohen, 1988; Gignac & Szodorai, 2016; Schäfer & Schwarz, 2019). We documented all conversions and coding decisions. We included the original quotes and/or table/page numbers from the original

articles into the coding sheet to facilitate reproducibility. We plotted forest plots presenting the correlation for every relationship. We presented the relation with confidence intervals and the sample size of each study.

Statistical heterogeneity between studies was determined using an 80% credibility interval (as used in Borenstein et al., 2009; Wiernik et al., 2017). Wiernik and Kostal (2019), explained how the credibility interval performed better than the most used Q significance test. The main reasons are that the Q test is underpowered in most situations and that it confounds the sample size of studies and the magnitude of effect found in the studies. Finally, Paterson et al. (2016) indicated the threshold for credibility interval as an indication for moderator (e.g., corrected correlations $< .15$ as negligible, $.15-.24$ as small, $.25-.39$ as moderate, and $\geq .40$ as large). If there was indeed meaningful heterogeneity, we explored potential moderators. Our design for the analysis is shown in Table 3.

Table 3*Study design*

Question	Hypothesis	Sampling plan	Analysis plan	Rationale for deciding the sensitivity of the test for confirming or disconfirming the hypothesis	Interpretation given different outcomes	Theory that could be shown wrong by the outcomes
What is the relationship between personal factors and creativity outcomes in group setting?	A relationship between personal factors (big 5, emotional and cognitive traits) and creativity outcomes (originality, usefulness, number of ideas) in group setting exists.	Meta-analysis: we systematically collected all the data available in databases and asked for unpublished studies on Twitter and ResearchGate. We reported the sample size for every relationship.	We analyzed data with a psychometric meta-analysis using the psychmeta package (Dahlke & Wiernik, 2019). The effect size is Pearson's r corrected with internal consistency artifact distributions (alpha or composite reliability)	A meaningful association is having a correlation of at least $r = .10$ (lowest side of the credibility interval).	An association $> .10$ was interpreted as a meaningful association, an association $< .10$ was interpreted as no association or not enough data to draw conclusion based on the number of studies and participants involved. In both cases, the lack of evidence was only indicated and not interpreted.	Theories about creativity were mostly investigated as individual process. A lack of correlation would only indicate that this personal factor is less important in group setting than in individual creativity for this particular creative outcome.
What are the moderators of the relationships between personal factors and creativity outcomes in group setting?	Moderators: <ul style="list-style-type: none"> - Familiarity - Skill diversity - Group demography - Constraint - Type of task - Creative phase - Number of participants - Time - Leadership 	Meta-analysis: we systematically collected all the data available in databases and asked for unpublished studies on Twitter and Researchgate. We reported the sample size for every relationship.	We added to the model the moderator.	We reported the moderator in all levels and the combined effect. A moderator that moderates the effect is one whose 95% confidence intervals don't include 0 and the other level (such as the control group) do.	A moderator whose 95%CI does not include 0 and the control group includes 0 was interpreted as a meaningful moderator of the relationship.	Most of our moderators' hypotheses are exploratory hypotheses (Coursey et al., 2018). Thus, an absence of evidence was only seen as a hypothesis not to investigate further.

Does publication status influence the outcome of the relationship	Publication status influences the status of the relationship.	Meta-analysis: we systematically collected all the data available in databases and asked for unpublished studies on Twitter and Researchgate. We reported the sample size for every relationship.	We added to the model the moderator.	We reported the moderator in all levels and the combined effect. If there was a discrepancy between published articles and not published articles (one condition finds an effect and not the other), the hypothesis was confirmed.	If there is a discrepancy between published articles and not published articles (one condition finds an effect and not the other), we interpreted this as an influence of the publication status, leading to a possibility of publication bias.	The purpose of this moderator is to flag possible publication bias and no theory is involved.
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Publication Bias

To address possible publication bias, we corrected for sampling error and measurement error, as indicated in guidelines for psychometric meta-analyses (Schmidt & Hunter, 2015). Reliability was corrected using internal consistency artifact distributions (alpha or composite reliability) compiled from studies included in the present meta-analysis. A summary of weighted mean internal consistency can be found in supplementary.

Finally, we conducted a PET-PEESE analysis (Stanley & Doucouliagos, 2014) and a p-curve analysis (Simonsohn et al., 2014).

Results

Meta-analytic results are shown in Table 4. There were 25 combinations, and for 12 of them (48%), only one effect size was available, making it impossible to perform a meta-analysis. Of the studies available for meta-analysis, only three constructs suggest a positive non-zero relationship: the relationship between creative self-efficacy and the number of ideas generated ($\rho = .35$, 95%IC [.04, .67]) the originality of ideas ($\rho = .35$, [.09, .60]), and the usefulness of ideas ($\rho = .49$, [.33, .65]).

Table 4
Summary of Meta-Analysis findings

Personality trait	Creativity outcome	<i>k</i>	<i>N</i>	$\underline{r}$	<i>SDr</i>	<i>SDres</i>	$\underline{\rho}$	<i>SDrc</i>	<i>SD</i>	95% CI	80% CR
Openness	Number of ideas	4	879	.18	.15	.14	.22	.19	.17	[−.08, .52]	[−.05, .50]
	Originality	4	879	.00	.19	.18	.00	.24	.22	[−.38, .39]	[−.36, .37]
	Usefulness	1	267	.14	—	—	.18	—	—	[.03, .34]	[—, —]
Conscientiousness	Number of ideas	4	879	−.06	.15	.13	−.07	.17	.15	[−.35, .21]	[−.32, .18]
	Originality	4	879	−.10	.07	.03	−.12	.09	.03	[−.26, .02]	[−.17, −.06]
	Usefulness	1	267	−.09	—	—	−.11	—	—	[−.27, .04]	[—, —]
Extraversion	Number of ideas	4	879	.08	.13	.11	.10	.15	.13	[−.14, .33]	[−.11, .31]
	Originality	4	879	−.06	.08	.04	−.08	.09	.05	[−.23, .07]	[−.16, .00]
	Usefulness	1	267	−.12	—	—	−.15	—	—	[−.30, −.00]	[—, —]
Agreeability	Number of ideas	3	711	.03	.08	.05	.04	.10	.06	[−.22, .29]	[−.08, .15]
	Originality	3	711	−.02	.10	.07	−.03	.12	.09	[−.34, .28]	[−.20, .14]
	Usefulness	1	267	.06	—	—	.08	—	—	[−.08, .24]	[—, —]

Neuroticism	Number of ideas	3	711	-.03	.05	.00	-.04	.06	.00	[-.18, .10]	[-.04, -.04]
	Originality	3	711	-.06	.19	.18	-.08	.25	.23	[-.69, .53]	[-.52, .35]
	Usefulness	1	267	-.07	—	—	-.09	—	—	[-.25, .07]	[—, —]
Social anxiety	Number of ideas	1	160	-.17	—	—	-.19	—	—	[-.36, -.02]	[—, —]
Emotional intelligence	Number of ideas	1	159	.01	—	—	.01	—	—	[-.18, .21]	[—, —]
	Originality	1	159	.09	—	—	.12	—	—	[-.08, .32]	[—, —]
	Usefulness	1	159	.05	—	—	.07	—	—	[-.14, .28]	[—, —]
Self-efficacy	Number of ideas	2	352	.30	.03	.00	.35	.04	.00	[.04, .67]	[.35, .35]
	Originality	3	461	.28	.08	.03	.35	.10	.04	[.09, .60]	[.27, .42]
	Usefulness	2	301	.39	.01	.00	.49	.02	.00	[.33, .65]	[.49, .49]
Epistemic motivation	Number of ideas	1	108	.48	—	—	.51	—	—	[.36, .66]	[—, —]
	Originality	1	108	.02	—	—	.02	—	—	[-.19, .23]	[—, —]
	Usefulness	1	108	.29	—	—	.33	—	—	[.14, .53]	[—, —]

Note: k = number of studies contributing to meta-analysis; N = total sample size; $\bar{r}$ = mean observed correlation; SD_r = observed standard deviation of r ; SD_{res} = residual standard deviation of r ; $\underline{\rho}$ = mean true-score correlation; SD_{rc} = observed standard deviation of corrected correlations (rc); SD = residual standard deviation of $\underline{\rho}$; CI = confidence interval around $\underline{\rho}$; CR = credibility interval around $\underline{\rho}$. Correlations corrected using artifact distributions.

Moderator Analyses

Due to the extremely small number of effect sizes, it was not possible to analyze all moderators. The table 5 summarizes the various moderator data.

In particular, only one moderator is significant, the effect of time ($\beta = 0.01$, $p = .01$) however, the β estimator is small and indicates that each minute spent in the creativity session increases the relationship between personal factors and creative outcomes by $r = .01$.

Additionally, the residual heterogeneity test is significant, indicating that other uncaptured moderators are at work ($Q = 382.19$, $p < .001$).

Table 5

Moderators of the link between personal factors and group creativity

Moderator	Information
Familiarity	$\beta = -0.06$, $p = 0.25$, no sign of an effect ($k = 52$).
Skill and Knowledge Diversity	Only one study used this moderator (i.e. Brophy, 1995).
Group Demography	Only one study with diverse participants (i.e. Homan, 2015).
Constraint	No study with constraint
Type of Task	No study with conjunctive tasks
Creative phase	Only one study reported an effect size for the convergent phase (i.e., Brophy, 1995).
Number of participants	$\beta = -0.01$, $p = .64$, no sign of effect ($k = 72$).
Time limit	$\beta = 0.01$, $p = .01$ weak but significant effect ($k = 60$).
Leadership	One study on transformational leadership, no study on transactional leadership
Publication status	All included studies are published.
Gender	$\beta = 0.00$, $p = .95$, no sign of an effect ($k = 62$).

Inter-correlations

The creative outcomes indicate an absence of relationship between the number of ideas and originality, 7 studies, $\rho = .31$, [- .30, .29], a positive relationship between the number of ideas and usefulness 2 studies, $\rho = .67$, [.670, .674], and originality and usefulness, 2 studies, $\rho = .47$ [.10, .85]. For the personality traits, 4 studies found a weak relationship between openness and extraversion $\rho = .18$, [.02, .33].

Table 7

Inter-correlations between creative outcomes, and between personal constructs

First Construct	Second construct	<i>k</i>	<i>N</i>	$\bar{r}$	SD_r	SD_{res}	$\bar{\rho}$	SD_{r_c}	SD_{ρ}	95% CI	80% CR
Number of ideas	Originality	7	1 390	-.01	.32	.31	-.01	.32	.31	[-.30, .29]	[-.46, .44]
Number of ideas	Usefulness	2	351	.67	.00	.00	.67	.00	.00	[.67, .67]	[.67, .67]
Originality	Usefulness	2	351	.47	.04	.00	.47	.04	.00	[.10, .85]	[.47, .47]
Self-Efficacy	Social Anxiety	1	160	-.49	—	—	-.49	—	—	[-.61, -.37]	[—, —]
Openness	Conscientiousness	4	879	.15	.17	.16	.15	.17	.16	[-.12, .42]	[-.11, .40]
Openness	Extraversion	4	879	.18	.10	.07	.18	.10	.07	[.02, .33]	[.06, .29]
Openness	Agreeability	3	711	.11	.14	.13	.11	.14	.13	[-.25, .47]	[-.13, .35]
Openness	Neuroticism	3	711	.01	.16	.14	.01	.16	.14	[-.38, .41]	[-.26, .28]

First Construct	Second construct	<i>k</i>	<i>N</i>	$\bar{r}$	SD_r	SD_{res}	$\bar{\rho}$	SD_{rc}	SD_{ρ}	95% CI	80% CR
Conscientiousness	Extraversion	4	879	.19	.24	.23	.19	.24	.23	[−.19, .58]	[−.19, .58]
Conscientiousness	Agreeability	3	711	.23	.19	.18	.23	.19	.18	[−.24, .71]	[−.11, .57]
Conscientiousness	Neuroticism	3	711	−.05	.36	.35	−.05	.36	.35	[−.93, .84]	[−.70, .61]
Conscientiousness	Need for Cognition	1	168	.42	—	—	.42	—	—	[.30, .55]	[—, —]
Extraversion	Agreeability	3	711	.19	.14	.12	.19	.14	.12	[−.15, .54]	[−.04, .43]
Extraversion	Neuroticism	3	711	−.11	.45	.44	−.11	.45	.44	[−.22, 1.00]	[−.94, .72]
Extraversion	Need for Cognition	1	168	.07	—	—	.07	—	—	[−.08, .22]	[—, —]
Agreeability	Neuroticism	3	711	−.02	.34	.33	−.02	.34	.33	[−.86, .82]	[−.64, .61]

Note: *k* = number of studies contributing to meta-analysis; *N* = total sample size; $\bar{r}$ = mean observed correlation; SD_r = observed standard

deviation of *r*; SD_{res} = residual standard deviation of *r*; $\bar{\rho}$ = mean true-score correlation; SD_{rc} = observed standard deviation of corrected

correlations (*rc*); SD_{ρ} = residual standard deviation of $\bar{\rho}$; CI = confidence interval around $\bar{\rho}$; CR = credibility interval around $\bar{\rho}$. Correlations

corrected using artifact distributions.

Power Analysis

We created a sunset plot in Figure 2 to display the statistical power of studies included in the meta-analysis. The average power is 13.5% and the replicability index 0% which means that we have no chance to reject H_0 when there is a true effect, and no chance at all to replicate one study (see Motyl et al., 2017 for R-index).

Figure 2

Power test of all studies

Reliability

Table 8 presents the mean reliability scale of all variables included. The reliability was high across all variables, between .75 and .91.

Table 8*Mean reliability scale*

Variable	Artifact	<i>k</i>	<i>N</i>	<i>m</i>	<i>sd</i>	<i>sd.res</i>
Need for cognition	qxi_irr	2	465	.866	.035	.031
	rxxi_irr	2	465	.751	.061	.055
Self-efficacy	qxi_irr	3	461	.908	.027	.023
	rxxi_irr	3	461	.825	.049	.042
Aggreableness	qxi_irr	2	402	.865	.047	.043
	rxxi_irr	2	402	.750	.080	.074
Extraversion	qxi_irr	3	570	.915	.020	.016
	rxxi_irr	3	570	.838	.036	.029
Conscientiousness	qxi_irr	3	570	.905	.026	.022
	rxxi_irr	3	570	.820	.046	.040
Neuroticism	qxi_irr	2	402	.864	.008	.000
	rxxi_irr	2	402	.747	.013	.000
Openness	qxi_irr	3	570	.877	.033	.029
	rxxi_irr	3	570	.769	.059	.051
Number of ideas	qxi_irr	6	1 401	.945	.047	.046
	rxxi_irr	6	1 401	.896	.089	.088
Originality	qxi_irr	7	1 313	.907	.074	.072
	rxxi_irr	7	1 313	.827	.133	.131
Usefulness	qxi_irr	4	676	.871	.047	.044
	rxxi_irr	4	676	.761	.086	.080

Note. qxi_irr is the Restricted reliability index (indirect RR) and rxxi_irr is the Restricted reliability coefficient (indirect RR).

Publication bias

The PET-PEESE analysis was not significant (PET: $t = 1.95$, $p = .06$; PEESE: $t = 1.85$, $p = .07$). In particular, the average correlation found by the PET test is $r = -.17$ $[-.40, .06]$ and by the PEESE test $r = -.06$ $[-.18, .06]$ which indicates an effect size close to 0 with a tendency to be rather negative.

The p-curve test indicates a presence of evidence, no lack of evidence, statistical power of .93% $[0.88, 0.97]$ and a mean effect size of $r = .45$. However, in the case where there are few effect sizes and strong heterogeneity, the p-curve test is not reliable (van Aert et al., 2016)

Regarding the cumulative analysis, it was not possible to perform it because of the too small number of studies included in the analysis (< 20).

Discussion

Personal Factors Related to Creativity in Group Setting

This meta-analysis investigated the link between personal factors and group creativity. The results are limited, given the very few numbers of studies included with their corresponding effect sizes. We found support for only one relationship, positive, between self-efficacy and the three creativity outcomes, the number, originality and utility of ideas.

These results, although disappointing, are not so surprising. In 2018, Coursey and colleagues wrote (p.2-3): “Whereas many studies have examined the role of individual differences in individual creativity, relatively few have examined the role of individual differences in group and team creativity.”. A little further on, they concluded (Coursey et al., 2018, p.26): “We have provided an overview of how individual difference factors may influence group creativity. Much of this is based on the literature concerning individual differences in individual creativity. It is presumed that there will be some degree of similarity between the effects observed for individuals and groups.”

Our systematic review confirms the indication that the majority of studies are based on individual creativity, as we found only 11 studies to include in a meta-analysis. Focusing on the creativity side, out of the 758 articles selected with a setting of a criterion requiring the exact term "group" or the exact term "team" to be mentioned, 160 studies concerned individual creativity, creative personality, perception of being creative, creative potential or creative intelligence. Furthermore, when selecting the most used indicators in the creativity literature, as number, originality and usefulness of ideas, we found that the majority of studies did not measure group creativity with these indicators.

72 studies measured perceived creativity, whether by other team members or by the manager. In the majority of these studies, creativity was measured by Zhou and George's (2001) 13-item scale, an example of which is "the team/team member suggests new ways to achieve goals or objectives" or "the team/team member often has new or innovative ideas". The scale has not been psychometrically evaluated and there seems to be no evidence of a link between the scores on this scale and the actual creativity of individuals. We have not found any studies that measured both perceived creativity with this scale and group creative outcomes. In addition to this measure, about 20 studies measured 'general team performance', asking a question about creativity in this performance, or about creative decision making in a team, but then measuring only the choice made by the team. On the other hand, direct measures of creativity were much rarer. We analyze it as being caused by the requirement of having experts in the creative area who can code ideas according to the indicators used (numbers, originality, and usefulness of ideas). Finally, despite the selection criteria, 181 results were not about creativity or did not measure it, the word "creativity" being mentioned in the introduction or discussion of the study.

Although in smaller degrees, there are a number of studies that manipulate individual factors, for example by measuring personality traits prior to experimentation, and by creating

groups by separating individuals according to their level (low or high) on a personality trait. Others measured optimism, individualism, temperament, depression, envy, critical thinking, self-construct... In total, these exclusion criteria concern 136 studies. It would be possible to conduct an experimental meta-analysis on the subject, which would not measure the relationship between individual factors and group creativity but the impact of a particular personality trait on group creativity. However, the results could be as disparate as in this meta-analysis, as the other exclusion criteria would apply. Indeed, these studies also include measures of perceived creativity, measures of individual creativity and qualitative studies. Thus, it is not clear that a meta-analysis of this type would provide enough effect sizes to conduct a consistent analysis.

Out of the 11 studies included, 1 is from 2019, 3 are from 2020, a sign that personality factors and group creativity are being investigated. In this sense, it is possible that this meta-analysis came a bit too early compared to the studies on the subject.

Time limit

The moderator analysis revealed a possible weak effect of time on the relationship, as each minute spent in the creativity session increases the relationship between personal factors and creative outcomes by $r = .01$. However, given the limitation of the data, we could not test the hypothesis on cognitive closure. Most of the studies included in the analysis had a time constraint between 5 and 10 minutes, and for these studies, the moderation analysis revealed not effect. The effect of time limit was found for the studies comparing 10 and 20 minutes. In this case, the relationships were systematically stronger for the 20 minutes than for the 10 minutes condition. This finding suggests that a longest session leads to a stronger possibility for participants to express their individuality in their group creative tasks, at least until 20 minutes. We are limited in the generalizability of our findings, as the relationships were only found for 5 effects relating self-efficacy and originality/usefulness.

Future Research Directions

The results of this meta-analysis may help to improve the field of research linking creativity and personality.

First, we built on the assumptions of Coursey et al. (2018) and improved current knowledge by systematically quantifying the data on the subject. We found that the data was limited. Very few studies measure group creativity. Most studies measure perceived creativity, through questionnaires and surveys, and some studies make their own measures of creativity, according to their own criteria. It would be possible to improve our knowledge of group creativity by using standardized creativity methods and protocols, using direct measures, especially as in the majority of the studies included, inter-expert reliability was very good, indicating that the perception of creativity is shared among the experts.

Regarding personal factors, we found that only one had sufficient number of effect sizes to conduct an analysis: self-efficacy. This is not surprising, as self-efficacy is one of the most widely used individual factor in psychology. For example, the book *Self-efficacy: The exercise of control* (Bandura, 1997) is cited 108 314 times on Google scholar (December 2022). The other social, cognitive, and emotional factors seem to be less studied or not studied in a correlational way. Surprisingly, many studies reported some personality traits, but not all. In the same way that some researchers use their own way of measuring creativity, others only partially measure personality (sometimes measuring types and not traits, or a single trait). This treatment of personal factors limits the possibilities of aggregating data in meta-analysis. The field could be improved by using standardized personality questionnaires and reporting all data points necessary.

Several studies have measured the relationship between individual factors and group creativity, but as they did not report information essential for a meta-analysis, we could not include them. Of the 11 studies included, we requested the information for 6 of them. 8

additional studies could not be included because we were unable to contact the authors, thus, with them, we could have nearly double the number of studies included. The field of the research could be improved by systematically sharing the raw data and the analysis conducted. In addition to benefit of the aggregation into a meta-analysis, this would allow for the conduct of individual participant data (IPD) meta-analyses (van Aert, 2022).

A traditional meta-analysis is done at the group level - in other words, by asking the question "how do average group personal factors correlate with average group creativity?" An IPD meta-analysis can answer a more precise question: "how does an individual's personality trait in this group correlate with his or her creativity in the group?". This question cannot be answered without data at the individual level.

The power of the studies was very low, around 13.5%. The number of participants seems quite high (see Table 2), but the correlations seem to be extremely low, which requires an extremely high number of participants to show an effect, if the effect exists. Again, reporting the raw data at the individual level would increase the precision of the measurement, improving the power of the study without the need to dramatically increase the number of participants.

The studies included were conducted in the USA, UK, China, Germany, Singapore, the Netherlands, and Romania. More importantly, many of the studies were performed on students doing group projects. It is preferable to conduct these studies in other contexts, mainly with non-WEIRD, non-student samples. The many moderators that we tried to highlight were not investigated enough or were not investigated at all. We recommend that researchers methodically record all the data relating to the context of the exercise, in particular the time allocated to participants, the type of task, the number of participants per group, and the individual characteristics of the participants (demographics, type of recruitment, randomization of the participants in groups or not, etc.).

Interpretations and Implications

One should be cautious in drawing a relationship between perceived creativity and actual creativity. For example, Pretz and McCollum (2014) did not find evidence for a relationship between self-rated and expert-rated creativity ($r = -.07$). Professionals wishing to improve group creativity should use objective measures of creativity, or expert observations, rather than relying on personal or peer measures. This could be done through a common definition of originality and usefulness, followed by a pre-test rating by peers. To this objective, it is possible to define an intra-class correlation threshold for which the correlation is high enough to indicate that observers are homogeneously rating the originality and usefulness of ideas (typical thresholds are between 0.75 and 0.90, Koo & Li, 2016). Intraclass correlation is a type of correlation performed on groups of data, unlike Pearson correlation which operates on pairs of data (it is also called interclass correlation); however, the formulas used for both types of correlation are similar.

If the intra-class correlation is sufficient, then observers can continue to evaluate ideas. If the correlation is not sufficient, then it is necessary to find the cause of this lack of relationship, which may be related to a misunderstanding of the objective, a difficulty in understanding the originality or usefulness of the ideas in relation to the creativity theme, or a difference in the appreciation of the ideas. After the exchange, the experts will carry out the analysis on a new sample until the intra-class correlation is sufficient to score all the ideas.

It seems important to increase attention of researchers and professionals to individual differences in group creativity. Although it is difficult to make recommendations based on the meta-analysis results, the hypotheses stated remain possible. Fostering openness to new ideas, paying attention to factors that promote group dynamics (extraversion, agreeableness, low neuroticism, high emotional intelligence, low social anxiety, and low need for closure), and

making sense of the common goal (motivation, need for cognition) remain possible avenues for improving creative outcomes in groups.

In particular, a conclusion can be made about creative self-efficacy. Indeed, self-efficacy was the only factor to show a positive relationship with group creative outcomes in the meta-analysis. A first limitation to this relationship is that creative self-efficacy is not easy to develop. Several recent studies have failed to improve it (Capron Puozzo & Audrin, 2021; Ohly et al., 2017). However, these studies had an extremely small sample size ($n = 69$ and $n = 23$ respectively).

It is also possible that there are several types of creative self-efficacy. In particular, Hughes et al. (2018) suggested that there are creative leaders and individuals who are more focused on a creativity support function. This leader/supporter distinction could be related to personality traits, but their relationship remains to be investigated.

The final finding concerns the environment associated with creativity. In this meta-analysis, only one moderating effect appears to be different from chance, namely time. This is a moderator that has been the subject of many studies on individual and team creativity. In particular, almost a third of the best ideas in terms of originality are generated in the first 5 minutes, and after 15 minutes, less than 10% of the ideas are of very good quality, while 50% of them are judged as bad (Reining & Briggs, 2008). It is possible that personal factors that promote persistence on task (e.g., motivation, conscientiousness, sense of self-efficacy) also promote the possibility of having original ideas longer, a hypothesis that remains to be tested. Furthermore, in terms of the relationship between constructs, one study (Jung et al., 2015) indicated that people who generate the most ideas also come up with better quality ideas, with quality defined as an average between originality and usefulness. Another application of this type of study for professionals is to build on the most creative individuals to improve the overall creativity of all participants, regardless of their personal factors.

Conclusion

This meta-analysis was an attempt to understand the relationship between individual factors and group creativity. It shows a link between self-efficacy and indicators of group creativity with a low level of evidence, and a small and positive moderation effect of time. During the search phase, we found that the majority of studies concern individual creativity, and studies concerning group creativity do not directly measure creativity, but the perception of creativity by an internal or observing member of the group. Direct measures of creativity (number of ideas generated, originality and usefulness) appear to be anecdotal, and the results found seem to mostly indicate a lack of relationship. Self-efficacy, a well-known individual factor in improving performance and learning (Bandura, 1997), is positively associated with all of the group creative outcome measures. In other words, it would appear that groups that feel they have the capacity to be creative are indeed creative, whether in terms of the number, originality, or usefulness of the ideas generated by these groups.

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