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The relationship between anger and creative performance: a three-level meta-analysis

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ABSTRACT

A substantial body of empirical research has focused on the interaction between creativity and mood, yet the results regarding the impact of anger on creative performance are notably varied. To clarify the overall relationship between the two, a three-level meta-analysis employing a random effects model was conducted. This analysis reviewed 115 effect sizes from 2,413 participants, revealing that anger is significantly positively correlated with creative performance ($r = 0.184$, 95% CI [0.111, 0.254]). The strength of this correlation was found to be moderated by the general and malevolent facets of creativity, as well as the procedures used for mood induction. Specifically, anger appears to enhance creative performance, particularly when it is elicited through imaginative processes and directed towards malevolent facet of creativity. However, the link between anger and creative performance was not influenced by the type of creative task used, the reported creative outcome, or the time limitation of the task. These findings contribute to refining the theoretical frameworks of mood and creativity and highlight the practical implications of utilising anger to moderate creative performance.

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Meta-analysis; anger; creativity; malevolent creativity

1. Introduction

"Anger is a wind which blows out the lamp of the mind", noted Robert Green Ingersoll. Although commonly perceived negatively, anger can sometimes fuel the generation of groundbreaking creative ideas. Nobel Prize laureate Max Perutz reflected on his scientific breakthrough, stating, "The idea was sparked by my fury over having missed that beautiful structure myself" (Ferry, 2007, p. 148). The relationship between anger and creativity has been extensively researched. Some researchers found that anger can stimulate more creative thoughts (e.g. Johnson & Connelly, 2014; Russ & Kaugars, 2010), while others proposed that anger may hinder creativity (e.g. Fernández-Abascal & Díaz, 2013; Miron-Spektor et al., 2011). Given these inconsistent findings, conducting

a meta-analysis is essential to clarify the true impact of anger on creativity. While several meta-analyses have explored the link between mood and creativity, such as those conducted by Baas et al. (2008), who found that negative activating emotions hinder creativity, and Davis (2009), who reported similar findings, these studies blended various negative emotions together. This amalgamation might obscure the specific influence of anger on creativity. Therefore, investigating the distinct effects of anger on creativity is crucial for objectively and accurately understanding its role in cognitive activities. Moreover, this meta-analysis can refine theories about how emotions influence creativity and provide insights into how anger could be utilised to moderate creative performance.

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1.1. Anger and creativity

Anger, an affective response to survival threats or stress, is a primary emotion with adaptive functions across biological, psychological, and social dimensions (Novaco, 2016). It is characterised by hostility towards individuals or objects, stemming from intentional external obstructions, and is marked by high arousal and negative valence (Baas et al., 2008; Novaco, 2016). Creativity is widely acknowledged as a driving force behind scientific, technological, and cultural progress (Gabora & Kaufman, 2010). “General creativity” refers to creativity defined by originality and appropriateness, often framed as the ability to generate novel and effective ideas (Runco & Jaeger, 2012; Sternberg & Lubart, 1996; similar terms see Ceballos & Watt, 2023; Xu et al., 2023). However, creativity can also manifest in harmful ways, driven by antisocial motives such as deception, blackmail, and violence. This darker aspect of creativity, termed “malevolent creativity”, intentionally aims to produce harmful or immoral outcomes (Cropley et al., 2008, 2010; Harris et al., 2013). Despite extensive research exploring the link between emotions and creativity, existing studies do not reach a consensus on whether anger promotes or inhibits creativity.

Many studies suggest that anger can boost creativity. For example, De Dreu et al. (2008) found that inducing anger in participants before a brainstorming session increased their creative fluency and originality compared to inducing sadness or relaxation. Strassbaugh and Connelly (2022) investigated the effects of anger and anxiety on idea generation in creative tasks, discovering that anger led to more ideas and conceptual shifts compared to anxiety. Additionally, Cheng et al. (2021b) found that anger not only enhances general creativity but also significantly improves malevolent creativity, though the application of emotion regulation strategies might mitigate this effect.

However, Fernández-Abascal and Díaz (2013) reported that negative affect – whether sadness or anger – did not influence the generation of creative divergent thinking when moods were experimentally induced. A more pessimistic perspective suggests that anger can hinder creativity. For instance, in creative problem-solving tasks, participants exposed to an angry customer’s voice showed less success compared to those who heard a neutral voice (Miron-Spektor et al., 2011). More recently, researchers found that highly agreeable participants produced

less fluent and flexible ideas in a creative task when angered, as opposed to when experiencing a neutral emotion (Kao & Chiou, 2020).

1.2. Theoretical perspectives on the enhancing role of anger in creativity

Despite the complex relationship between anger and creativity, certain theories support anger’s positive effects on creativity. First of all, the dual pathway to creativity model posits that emotions influence creativity through two mechanisms: the cognitive flexibility pathway and the cognitive persistence pathway (Baas et al., 2008, 2013). The flexibility pathway involves employing broad cognitive categories (e.g. Eysenck, 1993; Mednick, 1962) and adaptively switching among different categories (e.g. Duncker, 1945; Smith & Blankenship, 1991). The persistence pathway emphasizes a systematic exploration of the problem space and in-depth examination of select categories (Newell & Simon, 1972; Nijstad et al., 2010). Both pathways require a certain level of cognitive activation to function effectively (e.g. Broadbent, 1972; De Dreu et al., 2011). Anger, known for its negative valence and activating properties (Baas et al., 2008), may contribute to the functional goal of removing obstructions (Frijda, 1986; Roseman et al., 1994). This process fosters more effortful and systematic thinking (Yang & Hung, 2015). Moreover, anger has been linked to increased cognitive persistence and task engagement in problem-solving contexts (Baas et al., 2011), potentially leading to better creative outcomes (Van Kleef et al., 2010).

Besides, the feelings-as-information theory (Schwarz & Clore, 1983) proposes that positive moods signal safety, motivating individuals to seek stimulation and incentives, such as engaging in enjoyable activities. Conversely, negative moods indicate problems, prompting individuals to focus on solving them (Friedman et al., 2007). This theory highlights the communicative role of emotions, suggesting they serve as indicators of environmental changes, influencing creative performance. Specifically, anger signals individuals that they can promptly address situations, often resulting in heuristic processing and rapid responses (Sambrano et al., 2021). For instance, Zhan et al. (2020) discovered that anger decreased reaction times, facilitating creative problem-solving. Moreover, individuals experiencing anger are often better equipped with creativity-relevant skills, such

as heuristics for idea generation and a work style marked by high energy and focused effort (Lubart & Getz, 1998).

1.3. Theories illustrating context-dependent effects of anger on creativity

The mood-as-input model (Martin & Stoner, 1996) suggests that moods provide individuals with information (Clore et al., 1994; Schwarz & Clore, 1988), and the relevance and impact of this mood-conveyed information depend on the context (Bransford & Johnson, 1972; Martin & Stoner, 1996). According to this model, an individual's current emotional state can shape their interpretation of and response to various situations, with the context determining how mood influences cognitive processing and creativity. Likewise, the motivational compatibility account (Friedman et al., 2007) proposes that mood states align with particular motivational orientations, impacting the effort exerted on creative tasks. According to this theory, tasks seen as enjoyable and light-hearted are likely to receive increased effort under positive moods, whereas tasks considered serious and significant are expected to elicit more effort in negative mood states.

The mood-as-input model primarily examines how mood valence directly impacts cognitive processes, while the motivational compatibility account explores how mood influences creativity through motivational orientations. Despite their different focal points, both theories emphasize the critical role of aligning mood valence with task demands. Bower (1981) and Forgas (1995) proposed that mood states enhance the retrieval and encoding of mood-congruent information, facilitating cognitive processes in harmony with the individual's current emotional state. Thus, when individuals experience anger, the associated neural and cognitive mechanisms become primed to more effectively encode information that resonates with this negative valence. Conversely, when the task at hand requires positivity, anger's influence may indeed hinder creative output.

1.4. Possible factors modulating the effects of anger on creativity

The observed inconsistencies in the relationship between anger and creativity suggest the presence of underlying moderating variables that have been overlooked or insufficiently explored in previous

investigations. Accordingly, this study aims to explore potential moderators that could influence how anger impacts creativity, proposing a set of moderating factors for further examination.

1.4.1. General and malevolent facets of creativity

The present study distinguishes between two facets of creativity: "general creativity" and "malevolent creativity". General creativity adheres to the traditional concept, emphasizing originality and suitability without specific benevolent or malevolent intent. On the other hand, malevolent creativity encompasses traditional characteristics of creativity but also includes a harmful aspect (Harris & Reiter-Palmon, 2015). Malevolent creativity is typically assessed using adaptations of general creativity tasks, such as the Malevolent Creativity Task (MCT), derived from the Realistic Presented Problem (RPP) (Agnoli et al., 2016; Runco et al., 2016; Xue et al., 2018). Malevolent creativity shares a close relationship with general creativity, as research suggests that general creativity positively predicts malevolent creativity. However, there are notable differences: general creativity has little to no correlation with aggression, whereas malevolent creativity shows a strong positive correlation with aggressive tendencies (Hao et al., 2016). Anger can heighten implicit aggressiveness, potentially amplifying malevolent creativity (Cheng et al., 2021b). The established link between anger and aggression (Anderson et al., 1996; Berkowitz, 1990) suggests that anger can obscure moral judgment and emotional evaluations of aggressive behaviours, making individuals more prone to generating harmful ideas compared to general creative thoughts. Therefore, we propose that anger has a more pronounced positive impact on malevolent creativity than on general creativity.

1.4.2. Creative task

In exploring the potential moderating role of creative tasks, we observed that many studies employed self-reported scales to measure creativity. Although self-reported creativity is a strong predictor of creative performance (Kinga et al., 2015), several studies indicate that the effects of the same factor differ between self-reported and objective creativity measures (e.g. Jankowska et al., 2019; LaFrance & Cuttler, 2017). Responses to subjective scales are often influenced by individuals' self-perceptions (Van Rosmalen et al., 2010), and individuals may not

be as creative as they believe themselves to be (Vogelgesang Lester et al., 2019). Given these reasons, and the susceptibility of self-report instruments to biases when measuring creativity (Anderson et al., 2017), this meta-analysis focuses on creative performance rather than self-reported creativity. We categorised tasks measuring creative performance into the following three categories. Divergent thinking tasks, which are open-ended and evaluate the ability to generate multiple solutions (Mumford, 2001), such as Guilford's (1967) Alternate Uses Task (AUT). Conversely, convergent thinking tasks involve identifying a single correct solution to a problem (Guilford, 1967; Simonton, 2003), exemplified by Mednick's (1962) Remote Associates Task (RAT). Problem-solving tasks, which require both divergent and convergent thinking, demanding solutions that are both original and effective (Cropley, 2006). Negative moods, especially those linked with uncertainty, have been found to correlate positively with cognitive stability (Goschke & Bolte, 2014; Tiedens & Linton, 2001) – a predictor of convergent thinking performance (Razumnikova, 2007). A propensity for negative affect has been associated with traits conducive to convergent thinking (Soroa et al., 2015). Furthermore, the feelings-as-information theory (Schwarz & Clore, 1983) suggests that anger, by conveying danger and urgency, could enhance heuristic and rapid responses that favour convergent thinking. Hence, we propose that anger, as a specific negative emotion, might be especially advantageous for completing convergent tasks.

1.4.3. Creative outcome

This factor is derived from the previous variable – creative task. For tasks related to convergent thinking, the outcome is identified as the eureka/insight component of creativity (Baas et al., 2008). For tasks related to divergent thinking, Guilford (1967) identified three key components: fluency refers to the ability to produce a large number of ideas; flexibility involves the ability to produce a variety of ideas or solutions; originality is the ability to produce unique or novel ideas. Emotions can have different effects on creativity depending on these outcomes. For example, Isen et al. (1987) highlighted that positive emotion can enhance creative problem-solving by increasing cognitive flexibility and broadening attention. Vosburg (1998) found that individuals in elevated moods propose a higher number of solutions, while those in negative moods exhibit lower fluency in divergent tasks. Fredrickson's broaden-and-build

theory (2001) suggests that positive emotions expand cognitive and behavioural repertoires, promoting original thinking. As far as we know, specific research comparing the roles of anger and neutral mood in different outcomes of creativity is limited. Hence, from the perspective of anger as the opposite of positive mood, and to align with the hypothesis of creative tasks, we propose that anger has a stronger positive relationship with the eureka/insight component (the outcome of convergent tasks) than with flexibility, fluency, and originality (the outcomes of divergent tasks).

1.4.4. Time limitation

Anger, known for its activating properties, depletes resources quicker compared to sadness (Baas et al., 2008; De Dreu et al., 2008). This study suggests that the available time for completing creative tasks – whether limited or unlimited – may significantly influence how anger affects creativity. Despite the contrasting valences of happiness and anger, both emotions are characterised by high activation and arousal. While happiness initially promotes creativity, it also leads to more significant performance declines over time due to resource depletion, unlike relaxation and serenity states (Baas et al., 2011). Supporting this, a meta-analysis by Baas et al. (2008) and empirical findings by Kaufmann and Vosburg (2002) demonstrated that the beneficial effects of happiness on creative performance weaken in tasks with longer durations compared to shorter ones. This phenomenon suggests a potential pattern where the effects of emotional arousal on creativity could vary depending on the task duration. Drawing on this premise, the inference that anger may have a similar effect on creativity under time constraints is grounded in the shared characteristic of high arousal between anger and happiness. Specifically, anger is hypothesised to enhance creativity more effectively in tasks with limited time compared to those with unlimited time.

1.4.5. Mood induction procedures

Distinct from non-experimental studies that examine the correlations between naturally occurring emotions and creativity, experimental investigations often employ mood induction procedures to elicit specific emotional states (Davis, 2009). Westermann et al. (1996) conducted a meta-analysis of 138 studies, highlighting 11 significant mood induction procedures and their varying effectiveness and validity. These procedures can influence cognitive and

motivational arousal levels. Additionally, there is substantial evidence that mood induction procedures can significantly impact emotional experiences and brain activation patterns (Christie & Friedman, 2004; Phan et al., 2004; Stemmler, 1989). Solso and Martindale (1981) suggest that moderate levels of arousal induced by mood induction procedures can facilitate creativity, whereas both extremely low and high arousal levels may hinder creative processes. To identify the most effective mood induction procedures for studying the relationship between mood and creativity, this meta-analysis incorporates a diverse array of techniques, including imagination exercises, feedback mechanisms, and film clips, among others.

1.5. The present study

Existing studies offer a complex and sometimes contradictory view of the relationship between anger and creativity, partly due to variations in mood states used as controls. To address this ambiguity, our study establishes a neutral mood as the baseline and collects experimental studies comparing creative performance under conditions of anger versus neutrality. Although correlational studies only show a relationship between naturally occurring anger and creative performance, they are included to provide a comprehensive view of anger's effects. To ensure clarity in study design, the effects of each study type were analysed separately in the data analysis. Guided by the following research questions, this study aims to address: (1) What is the general relationship between anger and creative performance? (2) What factors might moderate the influence of anger on creative performance?

Drawing from existing research and discussed theoretical frameworks, we propose the first hypothesis about anger's overall effects: Anger is expected to have a positive relationship with creative performance (H1). Given the potential for various factors to influence the anger-creativity link, we introduce a series of hypotheses concerning moderating variables: Anger will more substantially facilitate malevolent creativity than general creativity (H2a). Additionally, anger is expected to have a more pronounced positive effect on creativity in convergent thinking tasks (which result in eureka/insight outcomes) than in divergent thinking tasks (which result in flexibility, fluency, and originality outcomes) (H2b). Furthermore, in the context of time-constrained tasks, anger is hypothesised to boost creative

performance more significantly than in situations where time is unlimited (H2c). While recognising that different mood induction procedures may induce varying levels of arousal, this study acknowledges the absence of specific guidance from Westermann et al. (1996) on which mood induction procedures elicit moderate arousal. Therefore, instead of hypothesising, this aspect will be explored to understand how different mood induction procedures might impact the anger-creativity link.

This meta-analysis aims to explore the general relationship between anger and creative performance. It also provides fresh insights into theoretical frameworks such as the feelings-as-information theory and the mood-as-input model. Additionally, it seeks to bridge the gap between abstract theoretical concepts and practical applications. For example, in promoting general creativity, it involves dispelling negative biases toward anger and leveraging emotions to enhance cognitive performance. Conversely, in the context of malevolent creativity, it involves employing strategies to regulate anger and prevent the emergence of harmful ideas during innovation. This exploration sheds light on techniques for creative practice by effectively managing anger in daily life.

2. Method

2.1. Literature search

A comprehensive literature search was conducted to gather relevant studies on the relationship between anger and creativity. The search encompassed several databases: Web of Science, APA PsycInfo, APA PsycArticles, Psychology and Behavioral Sciences Collection, China National Knowledge Infrastructure (CNKI), China Science and Technology Journal Database, and Wanfang database. The search aimed to include both English and Chinese language articles.

For English articles, the search employed keywords related to creativity ("creativity", "creative", "divergent thinking", "innovation") and anger ("anger", "angry"). The search string used in international databases was: TS = (creativity OR creative OR divergent thinking OR innovation) AND TS = (anger OR angry). For Chinese articles, the keywords used were 创造, 发散思维, 远距离, and 新颖 for creativity, and 愤怒, 气愤, and 生气 for anger. The search formula for Chinese databases was: 主题 = 创造+发散思维+远距离+新颖 AND 主题 = 愤怒+气愤+生气. The search was conducted up to July 1, 2024, ensuring a comprehensive

collection of the most current research available on the topic.

2.2. Criteria for inclusion

Following established recommendations for meta-analytic research (Baas et al., 2008; Davis, 2009), four inclusion criteria were applied to select studies for this meta-analysis. First, included studies must feature at least one dependent variable measuring performance on creativity-related tasks, such as the Alternative Uses Task (AUT), Realistic Presented Problems (RPP) and Malevolent Creativity Task (MCT). It is important to note that studies using self-compiled or adapted scales to assess creativity, where outcomes are based on participants' subjective ratings on a 6 or 7-point scale (e.g. da Costa et al., 2018; Farmer et al., 2003), were not considered eligible. These scales rely heavily on self-report, and some findings suggest that individuals may not be as creative as they believe (Vogelgesang Lester et al., 2019). Additionally, Van Rosmalen et al. (2010) noted that responses to subjective scales are likely influenced by individuals' self-perceptions. Consequently, our study focuses exclusively on creative performance, excluding studies that use scales or self-report methods to assess creativity. Second, for inclusion, experimental studies must explicitly manipulate mood states, with a clear description of the anger induction procedures used. Comparisons of creativity performance between participants experiencing anger versus those in a neutral mood were necessary for study inclusion. Third, non-experimental studies were included if they measured naturally occurring mood states and examined the association between anger and creativity. This criterion aimed to enhance the dataset with a variety of findings, ensuring the meta-analysis's validity. Fourth, studies needed to provide adequate statistical details (e.g. mean, sample size, standard deviation, difference in means, correlation coefficients, *t*-values, *p*-values) to facilitate effect size calculation.

To mitigate publication bias and provide a comprehensive overview of the field, this meta-analysis included both unpublished studies and peer-reviewed articles, following the approach of previous studies (e.g. Byron & Khazanchi, 2011; Davis, 2009; Sells et al., 2024). The unpublished studies, including dissertations, were selected based on their scientific rigour and relevance to the research question, ensuring they met the same quality standards as published

materials. To avoid data duplication, each dissertation was checked for overlap with other studies included in the meta-analysis. Additionally, each study was assessed for methodological soundness during the quality assessment phase. Applying these rigorous criteria led to the inclusion of 23 articles, and the literature screening process is depicted in Figure 1.

2.3. Coding procedure

Following the guidelines suggested by Lipsey and Wilson (2001), a detailed coding scheme was developed to capture essential descriptors and characteristics of each study. Basic study descriptors included the study name, sample size, and necessary statistical data for calculating effect sizes (e.g. means, standard deviations, differences in means, correlations, *t*-values, *p*-values). Additionally, study characteristics that might moderate the relationship between anger and creative performance were categorised into three types of moderator variables: sample characteristics, publication characteristics, and assessment and research design characteristics (Zhang et al., 2024a).

2.3.1. Sample characteristics

This meta-analysis included two types of sample characteristics. Participants' age was categorised into minors (0–18 years) and adults (over 18 years). The region was classified as either Eastern or Western based on the participants' country of residence.

2.3.2. Publication characteristics

The publication characteristics examined were publication year, publication status, and literature quality. Both publication year and literature quality were treated as continuous variables. Publication status was coded as a binary variable (published or unpublished). Published status referred to articles in academic journals, while unpublished status encompassed master's and doctoral dissertations.

2.3.3. Assessment and research design characteristics

The assessment characteristics included general and malevolent facets of creativity, creative task, creative outcome, time limitation, and mood induction procedures. (a) General and malevolent facets of creativity. Creativity in the studies included in this meta-analysis was categorised into two types: general creativity and malevolent creativity. This classification was

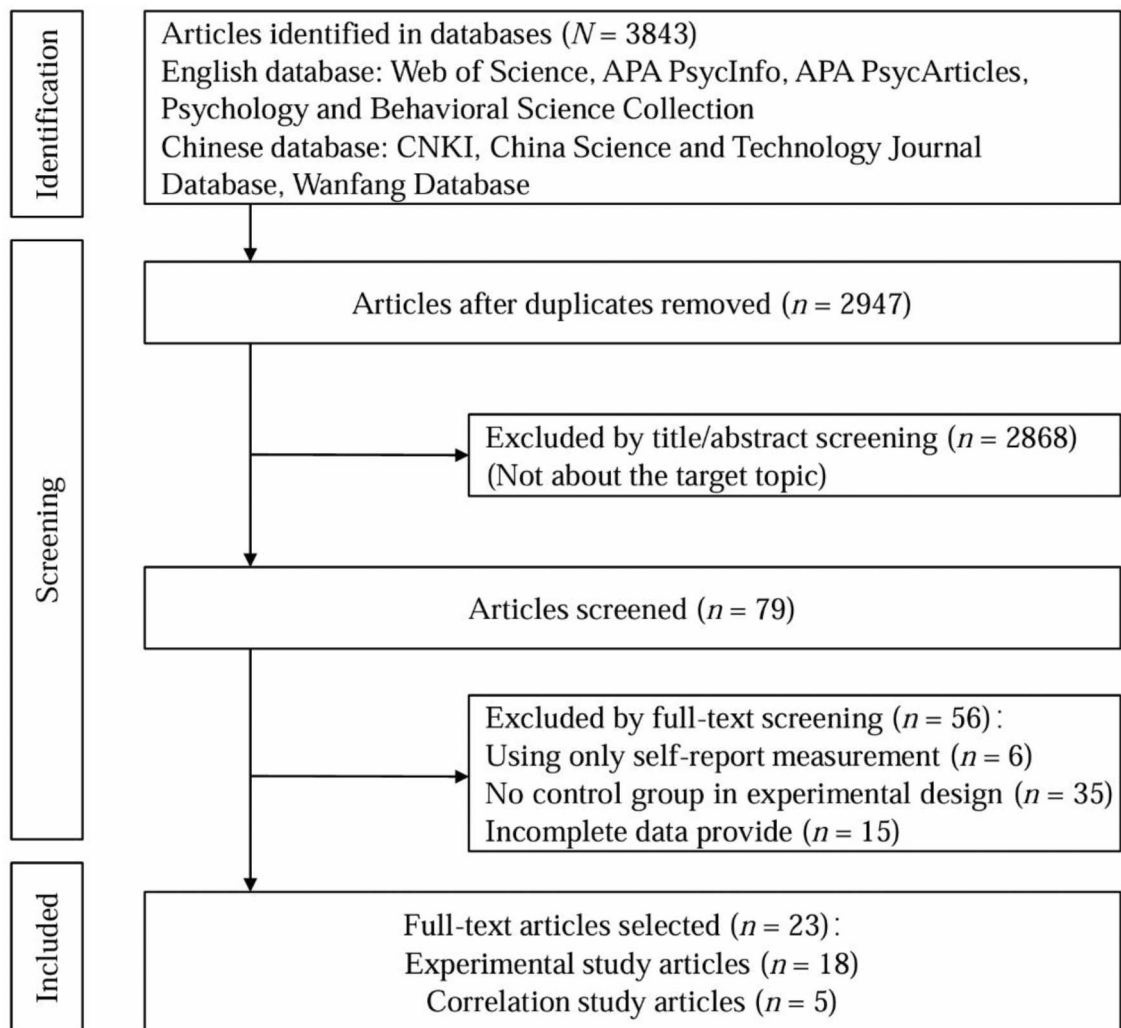


Figure 1. The literature screening process.

based on descriptions and the assessment methods (e.g. AUT for general creativity, MCT for malevolent creativity) provided in the original articles. (b) Creative task. Creativity was assessed through various methods, categorised into four types for analysis. Tasks requiring the identification of a single correct solution, known as insight tasks, were classified under convergent thinking tasks. Tasks focusing on generating numerous ideas, such as AUT and brainstorming, were labelled as divergent thinking tasks. Problem-solving tasks require both divergent and convergent thinking, such as defined-solution tasks. (c) Creative outcome. For tasks related to convergent thinking, the outcome was coded as eureka (Baas et al., 2008). For tasks related to divergent thinking,

three key outcomes were identified: flexibility, fluency, and originality. Additionally, for malevolent creativity, there is an index that reflects the harmfulness of the idea, and this outcome was coded as harm. Outcomes that cannot be categorised into these categories were coded as others. (d) Time limitation. Studies with creative tasks completed within a set timeframe were labelled as limited, whereas those without specified time constraints were labelled as unlimited. (e) Mood induction procedures. For experimental studies, mood states were induced using standard procedures and coded as feedback, film, imagination, recording, or others. "Feedback" involves giving subjects positive or negative feedback on their performance to induce specific moods. "Film"

refers to using short scenes from a film to induce mood. “Imagination” involves inducing moods by having subjects imagine emotion-laden events. “Recording” means making subjects listen to a recorded conversation to induce mood (Westermann et al., 1996). For studies that did not employ mood induction, typically in non-experimental designs where mood occurs naturally and is not a manipulated variable, these studies are coded as none. The research design characteristic refers to the type of study design. (f) Study design. It was coded as either experimental or correlational.

To ensure coding accuracy, two independent coders reviewed the studies. An assessment of rater agreement revealed a high level of consensus, with an agreement rate of 93%. Any discrepancies were resolved by revisiting the original texts to reach a consensus. Table 1 provides a summary of the studies included in this meta-analysis.

2.4. Quality assessment

The quality of the studies included in this meta-analysis was rigorously evaluated using a rating scale developed by Zhang et al. (2019), which incorporates elements from the Jadad scale alongside expert recommendations. This scale has been widely utilised in meta-analytic research and is frequently cited (e.g. Han et al., 2020; Zhang et al., 2021, 2022). The scale comprises five specific evaluation items and criteria. First, studies were evaluated based on their sampling techniques. Random sampling, which helps minimise selection bias, was awarded 2 points. Non-random sampling received 1 point due to its weaker control over sampling bias. Studies without clear sampling descriptions received 0 points, indicating a lack of methodological detail. Second, the completeness of data collection was evaluated. A validity rate of 0.9 and above scored 2 points, reflecting high data integrity. Rates between 0.8 and 0.9 received 1 point, indicating moderate integrity. Rates of 0.8 and below scored 0 points, highlighting concerns about data completeness. Third, reliability was assessed using the Cronbach’s alpha coefficient for mood measurement tools. Tools with an alpha of 0.8 and above were deemed highly reliable, scoring 2 points. A range of 0.7–0.8 scored 1 point, and tools with an alpha below 0.7 or unreported reliability scored 0 points. Higher alpha values indicate more consistent and reliable measurement of mood states. Fourth, studies using well-established

creativity tasks (e.g. AUT, brainstorming) received the maximum of 2 points, as standardised tasks offer a more direct and replicable assessment of creativity. Studies using self-composed creative tasks or non-creative tasks were coded as 1 or 0, respectively. Fifth, the prestige of the publication outlet was used as an indicator of study quality. According to the Social Sciences Citation Index (SSCI) journals and Chinese Social Sciences Citation Index (CSSCI) > Peking University (PKU) core journals > general journals and unpublished papers, literature was scored as 2, 1, and 0 points respectively. This grading reflects the belief that journals undergoing rigorous peer review maintain higher research standards.

Each study’s total quality score ranged from 0 to 10, with higher scores indicating superior quality. Two independent raters conducted the review process, resolving any discrepancies through discussion. The inter-rater reliability, measured by the Kappa statistic, confirmed the consistency of the quality assessment.

2.5. Data analysis

Correlation coefficients (r) were chosen as the effect size index in our meta-analysis due to their widespread use and ease of interpretation (e.g. Baas et al., 2008; Byron & Khazanchi, 2011; Cao, 2021; Deng & Zhang, 2011; Schutte & Malouff, 2020). We applied Fisher’s r -to- z transformation (Fisher, 1921) to convert the effect-size estimate from each association into an ES_z score, correcting for skewness in the sampling distribution of r (Lipsey & Wilson, 2001). And ES_z was converted back to Pearson’s r for better interpretability (Field, 2001; Lipsey & Wilson, 2001).

Traditional univariate meta-analysis assumes all effect sizes are independent, meaning each primary study should include only one effect size (Assink & Wibbelink, 2016; Lipsey & Wilson, 2001). Extracting multiple effect sizes from the same study can exaggerate results in univariate meta-analysis (Assink et al., 2015). In contrast, a multi-level meta-analysis can handle multiple effect sizes from the same study by accounting for their lack of independence (Konstantopoulos, 2011). Given the various creative outcomes reported, we extracted multiple effect sizes from the same study. The three-level model was used to account for three sources of variance in the present meta-analysis: Level 1 takes into account the sampling variance of the effect sizes; Level 2 takes into account the variance between effect sizes from the same

Table 1. Summary of studies included in meta-analysis.

Study name	es.id	N	Age	Region	Published year	Published status	Literature quality	GC/MC	Creative task	Time limitation	MIPs	Creative outcome	Study design	Fisher' z	r
Chen et al. (2014)	1	52	minor	Eastern	2014	P	7	GC	DT	L	film	flex	experimental	0.203	0.201
	2	52	minor	Eastern	2014	P	7	GC	DT	L	film	flu	experimental	0.230	0.226
	3	52	minor	Eastern	2014	P	7	GC	DT	L	film	ori	experimental	0.120	0.119
	4	52	minor	Eastern	2014	P	7	GC	DT	L	film	flex	experimental	0.000	0.000
	5	52	minor	Eastern	2014	P	7	GC	DT	L	film	flu	experimental	−0.209	−0.206
Cheng et al. (2021a)	6	52	minor	Eastern	2014	P	7	GC	DT	L	film	ori	experimental	−0.090	−0.090
	7	72	adult	Eastern	2021	P	10	MC	DT	L	imagination	flu	experimental	0.324	0.314
	8	72	adult	Eastern	2021	P	10	MC	DT	L	imagination	flu	experimental	0.499	0.461
	9	72	adult	Eastern	2021	P	10	MC	DT	L	imagination	flu	experimental	0.372	0.356
	10	72	adult	Eastern	2021	P	10	MC	DT	L	imagination	harm	experimental	0.366	0.351
	11	72	adult	Eastern	2021	P	10	MC	DT	L	imagination	harm	experimental	0.288	0.280
	12	72	adult	Eastern	2021	P	10	MC	DT	L	imagination	ori	experimental	0.424	0.400
	13	72	adult	Eastern	2021	P	10	MC	DT	L	imagination	ori	experimental	0.578	0.521
	14	72	adult	Eastern	2021	P	10	MC	DT	L	imagination	ori	experimental	0.420	0.397
	15	68	adult	Eastern	2021	P	10	GC	DT	L	imagination	flu	experimental	0.389	0.371
Cheng et al. (2021b)	16	68	adult	Eastern	2021	P	10	MC	DT	L	imagination	flu	experimental	0.559	0.507
	17	68	adult	Eastern	2021	P	10	MC	DT	L	imagination	harm	experimental	0.304	0.295
	18	68	adult	Eastern	2021	P	10	GC	DT	L	imagination	ori	experimental	0.426	0.402
	19	68	adult	Eastern	2021	P	10	MC	DT	L	imagination	ori	experimental	0.569	0.515
De Dreu et al. (2008) study1	20	29	adult	Western	2008	P	8	GC	DT	L	imagination	flex	experimental	0.064	0.064
	21	29	adult	Western	2008	P	8	GC	DT	L	imagination	flu	experimental	0.276	0.269
	22	29	adult	Western	2008	P	8	GC	DT	L	imagination	ori	experimental	0.319	0.308
De Dreu et al. (2008) study2	23	29	adult	Western	2008	P	8	GC	DT	L	imagination	others	experimental	0.310	0.301
	24	20	adult	Western	2008	P	8	GC	CT	UL	imagination	eureka	experimental	0.297	0.289
	25	20	adult	Western	2008	P	8	GC	CT	UL	imagination	eureka	experimental	0.000	0.000
Fernández-Abascal and Díaz (2013)	26	20	adult	Western	2008	P	8	GC	CT	UL	imagination	eureka	experimental	0.321	0.310
	27	134	adult	Western	2013	P	7.5	GC	DT	L	others	others	experimental	−0.057	−0.057
Huang (2023) study1	28	72	adult	Eastern	2023	U	8	MC	DT	L	imagination	flu	experimental	0.738	0.628
	29	72	adult	Eastern	2023	U	8	MC	DT	L	imagination	flu	experimental	0.114	0.114
	30	72	adult	Eastern	2023	U	8	MC	DT	L	imagination	flu	experimental	0.525	0.481
	31	72	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	0.794	0.661
	32	72	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	0.046	0.046
	33	72	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	0.406	0.385

(Continued)

Table 1. Continued.

Study name	es.id	N	Age	Region	Published year	Published status	Literature quality	GC/ MC	Creative task	Time limitation	MIPs	Creative outcome	Study design	Fisher' z	r
Huang (2023) study2	34	72	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.735	0.626
	35	72	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.040	0.040
	36	72	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.307	0.298
	37	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	flu	experimental	0.618	0.550
	38	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	flu	experimental	0.443	0.416
	39	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	flu	experimental	0.052	0.052
	40	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	flu	experimental	0.124	0.123
	41	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	flu	experimental	0.105	0.105
	42	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	flu	experimental	0.070	0.070
	43	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	flu	experimental	0.672	0.586
	44	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	flu	experimental	0.498	0.460
	45	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	−0.092	−0.092
	46	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	0.688	0.597
	47	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	0.500	0.462
	48	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	0.032	0.032
	49	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	0.269	0.262
	50	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	−0.107	−0.107
	51	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	0.134	0.133
	52	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	0.485	0.451
	53	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	0.898	0.715
Johnson and Connelly (2014)	54	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	harm	experimental	0.000	0.000
	55	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.675	0.588
	56	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.659	0.578
	57	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.167	0.166
	58	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.060	0.060
	59	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.066	0.066
	60	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.000	0.000
	61	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.674	0.587
	62	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.470	0.438
	63	32	adult	Eastern	2023	U	8	MC	DT	L	imagination	ori	experimental	0.174	0.173
Kao and Chiou (2020)	64	43.4	adult	Western	2014	P	6	GC	PS	UL	feedback	ori	experimental	0.131	0.130
	65	43.4	adult	Western	2014	P	6	GC	PS	UL	feedback	ori	experimental	0.064	0.064
	66	43.4	adult	Western	2014	P	6	GC	PS	UL	feedback	ori	experimental	0.058	0.058
	67	43.4	adult	Western	2014	P	6	GC	PS	UL	feedback	ori	experimental	0.023	0.023
Li (2021))	68	43.4	adult	Western	2014	P	6	GC	PS	UL	feedback	ori	experimental	−0.252	−0.247
	69	128	adult	Eastern	2020	P	10	GC	DT	L	imagination	flex	experimental	−0.026	−0.026
Mi (2013)	70	128	adult	Eastern	2020	P	10	GC	DT	L	imagination	flu	experimental	−0.034	−0.034
	71	128	adult	Eastern	2020	P	10	GC	DT	L	imagination	ori	experimental	−0.085	−0.085
Li (2021))	72	490	minor	Eastern	2021	U	5.5	MC	DT	L	none	flu	correlational	0.338	0.326
	73	490	minor	Eastern	2021	U	5.5	MC	DT	L	none	ori	correlational	0.268	0.262
Mi (2013)	74	42	adult	Eastern	2013	U	4	GC	DT	UL	film	flex	experimental	0.048	0.048

Miron-Spektor et al. (2011) study1	75	42	adult	Eastern	2013	U	4	GC	DT	UL	film	flu	experimental	0.113	0.112
	76	42	adult	Eastern	2013	U	4	GC	DT	UL	film	ori	experimental	−0.010	−0.010
	77	36	adult	Western	2011	P	8	GC	CT	L	recording	eureka	experimental	−0.250	−0.245
Miron-Spektor et al. (2011) study2	78	61.4	adult	Western	2011	P	8	GC	CT	L	recording	eureka	experimental	−0.049	−0.049
Miron-Spektor et al. (2011) study3	79	79.4	adult	Western	2011	P	8	GC	CT	L	recording	eureka	experimental	0.037	0.037
Perchtold-Stefan et al. (2020)	80	105	adult	Western	2020	P	9	MC	DT	L	none	flu	correlational	0.182	0.180
Perchtold-Stefan et al. (2022a)	81	105	adult	Western	2020	P	9	MC	DT	L	none	ori	correlational	0.245	0.240
	82	81	adult	Western	2022	P	9	MC	DT	L	feedback	harm	experimental	0.245	0.240
Perchtold-Stefan et al. (2022b)	83	60	adult	Western	2022	P	9.5	MC	DT	L	recording	flu	correlational	−0.030	−0.030
Russ and Kaugars (2010)	84	60	adult	Western	2022	P	9.5	MC	DT	L	recording	harm	correlational	0.010	0.010
	85	60	adult	Western	2022	P	9.5	MC	DT	L	recording	ori	correlational	−0.090	−0.090
	86	60	adult	Western	2022	P	9.5	MC	DT	L	recording	harm	correlational	−0.010	−0.010
	87	40	minor	Western	2010	P	8	GC	DT	UL	others	flex	experimental	0.118	0.117
	88	40	minor	Western	2010	P	8	GC	DT	UL	others	flu	experimental	0.117	0.116
Shi (2017)	89	40	minor	Western	2010	P	8	GC	DT	UL	others	ori	experimental	−0.006	−0.006
	90	48	adult	Eastern	2017	U	7	GC	DT	L	film	flu	experimental	0.125	0.124
	91	48	adult	Eastern	2017	U	7	GC	DT	L	film	ori	experimental	0.305	0.296
Strasbaugh and Connelly (2022)	92	48	adult	Eastern	2017	U	7	GC	DT	L	film	others	experimental	−0.410	−0.388
	93	128	adult	Western	2022	P	10	GC	DT	L	none	flex	correlational	0.040	0.040
	94	128	adult	Western	2022	P	10	GC	DT	L	none	flu	correlational	0.080	0.080
Weber et al. (2014)	95	128	adult	Western	2022	P	10	GC	DT	L	none	ori	correlational	−0.100	−0.100
	96	90	adult	Western	2013	P	8	GC	DT	L	none	flex	correlational	0.030	0.030
Wu (2021)	97	90	adult	Western	2013	P	8	GC	DT	L	none	flu	correlational	0.030	0.030
	98	227	adult	Eastern	2021	U	6	MC	DT	L	others	flu	experimental	−0.310	−0.300
	99	227	adult	Eastern	2021	U	6	MC	DT	L	others	flex	experimental	0.536	0.490
Yang and Hung (2015)	100	227	adult	Eastern	2021	U	6	MC	DT	L	others	flu	experimental	0.354	0.340
	101	40	adult	Eastern	2015	P	10	GC	CT	L	imagination	eureka	experimental	0.297	0.289
Yao et al. (2019)	102	30	adult	Eastern	2019	P	6	GC	DT	L	imagination	flex	experimental	0.590	0.530
	103	30	adult	Eastern	2019	P	6	GC	DT	L	imagination	flex	experimental	0.027	0.027
	104	30	adult	Eastern	2019	P	6	GC	DT	L	imagination	flu	experimental	1.004	0.763
	105	30	adult	Eastern	2019	P	6	GC	DT	L	imagination	flu	experimental	0.048	0.048
	106	30	adult	Eastern	2019	P	6	GC	DT	L	imagination	ori	experimental	0.474	0.442
	107	30	adult	Eastern	2019	P	6	GC	DT	L	imagination	ori	experimental	0.000	0.000

(Continued)

Table 1. Continued.

Study name	es.id	N	Age	Region	Published year	Published status	Literature quality	GC/MC	Creative task	Time limitation	MIPs	Creative outcome	Study design	Fisher's z	r
Zhan et al. (2020) study1	108	60	adult	Eastern	2020	P	10	GC	CT	UL	feedback	eureka	experimental	0.237	0.233
Zhan et al. (2020) study2	109	40	adult	Eastern	2020	P	10	GC	DT	L	film	others	experimental	0.215	0.212
Zhang et al. (2024b)	110	40	adult	Eastern	2020	P	10	GC	DT	L	film	flu	experimental	0.220	0.217
	111	40	adult	Eastern	2020	P	10	GC	DT	L	film	ori	experimental	0.214	0.211
	112	40	adult	Eastern	2020	P	10	GC	DT	L	film	flex	experimental	0.151	0.150
	113	105	adult	Eastern	2024	P	10	MC	DT	L	others	flu	experimental	0.174	0.173
	114	105	adult	Eastern	2024	P	10	MC	DT	L	others	harm	experimental	0.773	0.649
	115	105	adult	Eastern	2024	P	10	MC	DT	L	others	ori	experimental	0.583	0.525

Note. es.id, identification of the effect size; N, sample size; Published status, P = published, U = unpublished; GC/MC, general and malevolent facets of creativity (GC, General creativity; MC, Malevolent creativity); Creative task, DT = divergent task, CT = convergent task, PS = problem solving task; MIPs, mood induction procedures; Creative outcome, flex = flexibility, flu = fluency, ori = originality, harm = harmfulness; Time limitation, L = limited, UL = unlimited.

sample, allowing effect sizes to vary within studies; and Level 3 takes into account the variance between studies, allowing effect sizes to vary between studies (Hox et al., 2017; Van den Noortgate et al., 2013).

The specific steps for data analysis are as follows. First, the observation of magnitude and direction of the association between anger and creative performance was achieved by estimating the overall mean effect size. Second, the log-likelihood-ratio test was applied to determine heterogeneity at levels 2 or 3 (Assink & Wibbelink, 2016). Finally, if there was significant heterogeneity in effect sizes within or between studies, we continued to conduct moderated analyses for sample, publication, and assessment and research design characteristics. The metafor package (Viechtbauer, 2010) for the R software environment (version 4.4.0) was used to conduct the statistical analyses for this meta-analysis.

Publication bias, the tendency for studies with significant results to be published more readily than those with non-significant findings (Rothstein et al., 2005), can skew the perceived efficacy of interventions or relationships in research. This meta-analysis addresses publication bias by including a broad range of sources, such as peer-reviewed articles and unpublished dissertations. Furthermore, to ascertain the reliability of our meta-analysis outcomes, we employed several statistical methods to evaluate publication bias, including funnel plots, Egger's regression test (Egger et al., 1997), and Begg and Mazumdar rank correlation test (Begg & Mazumdar, 1994).

3. Results

3.1. Study characteristics

The present meta-analysis included 115 effect sizes derived from 28 independent studies (23 articles), encompassing a total of 2,413 participants. These studies were published between 2008 and 2024. Two independent raters assessed the quality of the literature, achieving a Kappa value of 0.695, which indicates good agreement according to Orwin and Vevea (2009). The quality scores of the included studies ranged from 4 to 10, with a mean (*M*) of 8.161 and a standard deviation (*SD*) of 1.604.

Both continuous and categorical variables were examined. For continuous variables, the number of effect sizes for both publication year and literature quality were 115. For categorical moderator variables, the effect sizes were distributed as follows: age

(minors: 11; adults: 104), region (Eastern: 84; Western: 31), publication status (published: 68; unpublished: 47), general and malevolent facets of creativity (general creativity: 53; malevolent creativity: 62), creative task (convergent thinking task: 8; divergent thinking task: 102; problem solving task: 5), creative outcome (eureka: 8; flexibility: 12; fluency: 34; originality: 37; harm: 20; others: 4), time limitation (limited: 100; unlimited: 15), mood induction procedures (feedback: 7; film: 16; imagination: 66; recording: 7; others: 10; none: 9) and study design (correlational: 13; experimental: 102).

3.2. Overall relation between anger and creative performance

A random-effects model was employed to calculate the overall relationship between anger and creativity. The results indicated a significant positive association between anger and creativity, with an effect size of $ES_z = 0.186$, $SE = 0.037$, $t(114) = 4.917$, $p < .001$, and a 95% confidence interval $CI = [0.112, 0.260]$. The analysis also revealed substantial heterogeneity, $Q_E(114) = 584.712$, $p < .001$. For interpretative clarity, we transformed this effect size back to Pearson's r using an inverse version of Fisher's r -to- z formula. The association between anger and creative performance was found to be $r = 0.184$, 95% $CI = [0.111, 0.254]$.

The log-likelihood ratio test revealed significant heterogeneity in both within-study variance (Level 2) ($p < .001$) and between-study variance (Level 3) ($p < .001$). Consequently, the three-level model provided a significantly better fit compared to the two-level model. The variance components at the sampling level (Level 1), within-study level (Level 2), and between-study level (Level 3) were 20.01%, 52.62%, and 27.37%, respectively. According to Hunter and Schmidt (1990), heterogeneity is substantial if less than 75% of the variance is due to sampling variance. In our study, the 20.01% variance attributed to sampling suggests that exploring potential moderators is meaningful. Therefore, we conducted moderation analyses to investigate whether the relationship between anger and creative performance was influenced by the aforementioned variables.

3.3. Moderator effects for the association between anger and creative performance

Table 2 presents the results of the moderation analyses. Region significantly moderated the relationship

between anger and creative performance, $F(1, 113) = 9.462$, $p = .003$. Specifically, this relationship was stronger among Eastern participants ($r = 0.263$, $p < .001$) compared to Western participants ($r = 0.063$, $p = .003$). Publication year also emerged as a significant moderator, $F(1, 113) = 7.889$, $p = .006$, with more recent studies showing a stronger association between anger and creative performance. Furthermore, the analysis revealed a significant moderating effect of the general and malevolent facets of creativity, $F(1, 113) = 12.360$, $p < .001$. Anger was more closely related to malevolent creativity (MC) ($r = 0.041$, $p = .012$) than to general creativity (GC) ($r = 0.306$, $p < .001$). Mood induction procedures also significantly moderated the relationship, $F(5, 109) = 3.995$, $p = .002$. Specifically, when anger was induced through imagination, the association with creative performance was significantly stronger ($r = 0.315$, $p = .042$).

However, we did not find significant moderator effects for participants' age ($F(1, 113) = 0.285$, $p = .594$), publication status ($F(1, 113) = 0.768$, $p = .383$), literature quality ($F(1, 113) = 0.944$, $p = .333$), creative task ($F(2, 112) = 1.040$, $p = .357$), creative outcome ($F(5, 109) = 0.700$, $p = .625$), time limitation ($F(1, 113) = 1.240$, $p = .268$), and study design ($F(1, 113) = 1.341$, $p = .249$).

3.4. Publication bias

The funnel plot revealed that effect sizes were concentrated above the graph and evenly distributed on both sides of the total effect (Figure 2). Egger's regression results were not statistically significant (two-tailed $p = 0.522$), and the intercept was 0.284 with a 95% $CI [0.137, 0.431]$. For the rank correlation test, Kendall's tau with continuity correction is -0.062 with two-tailed $p = 0.328$. In summary, the consistent findings across various tests indicate the absence of significant publication bias in this meta-analysis, supporting the credibility and robustness of the current study's results.

3.5. Supplementary analysis

Due to the differences between general creativity and malevolent creativity, particularly in the creative tasks used and creative outcomes reported, we conducted a supplementary analysis focusing solely on the relationship between anger and general creativity. The overall relationship between anger and general

Table 2. Moderator analysis of all the potential variables.

Moderator Variables	#ES	$F(df1, df2)^a$	p^b	Level 2 Variance	Level 3 Variance	ESz [95% CI]	r [95% CI]	$t(df)$	p^c
(1) Sample Characteristics									
a. Age	115	$F(1, 113) = 0.285$	.594	0.038***	0.020**				
Adults	104					0.193 [0.114; 0.272]	0.191 [0.114; 0.265]	4.818 (113)	<.001
Minors	11					0.131 [−0.181; 0.442]	0.130 [−0.179; 0.416]	−0.534 (113)	.594
b. Region	115	$F(1, 113) = 9.462$	.003	0.037***	0.011*				
Eastern	84					0.269 [0.189; 0.349]	0.263 [0.187; 0.336]	6.664 (113)	<.001
Western	31					0.063 [−0.150; 0.276]	0.063 [−0.149; 0.269]	−3.076 (113)	.003
(2) Publication characteristics									
a. Published year	115	$F(1, 113) = 7.889$	.006	0.038***	0.012*	0.019 [0.006; 0.033]	0.019 [0.006; 0.033]	2.809 (113)	.006
b. Published status	115	$F(1, 113) = 0.768$	.383	0.038***	0.020**				
Published	68					0.166 [0.080; 0.253]	0.164 [0.080; 0.248]	3.811 (113)	<.001
Unpublished	47					0.240 [−0.014; 0.495]	0.235 [−0.014; 0.458]	0.876 (113)	.383
c. Literature quality	115	$F(1, 113) = 0.944$	.333	0.038***	0.020***	0.022 [−0.023; 0.067]	0.022 [−0.023; 0.067]	0.971 (113)	.333
(3) Assessment and research design characteristics									
a. GC/MC	115	$F(1, 113) = 12.360$	<.001	0.038***	0.009				
General creativity	53					0.041 [0.024; 0.185]	0.041 [0.024; 0.183]	2.561 (113)	.012
Malevolent creativity	62					0.316 [0.116; 0.516]	0.306 [0.115; 0.475]	3.516 (113)	<.001
b. Creative task	115	$F(2, 112) = 1.040$	.357	0.038***	0.019**				
Convergent task	8					0.094 [−0.119; 0.307]	0.094 [−0.118; 0.298]	0.875 (112)	.384
Divergent task	102					0.209 [−0.231; 0.650]	0.206 [−0.227; 0.572]	1.005 (112)	.317
Problem solving task	5					0.010 [−0.610; 0.629]	0.010 [−0.544; 0.557]	−0.411 (112)	.682
c. Creative outcome	115	$F(5, 109) = 0.700$	.625	0.040***	0.017**				
Eureka	8					0.094 [−0.325; 0.513]	0.094 [−0.314; 0.472]	−0.728 (109)	.468
Flexibility	12					0.191 [0.035; 0.347]	0.189 [0.035; 0.334]	2.431 (109)	.017
Fluency	34					0.215 [−0.109; 0.540]	0.212 [−0.109; 0.493]	0.283 (109)	.778
Originality	37					0.210 [−0.117; 0.538]	0.207 [−0.116; 0.491]	0.225 (109)	.823
harm	20					0.235 [−0.119; 0.590]	0.231 [−0.118; 0.530]	0.443 (109)	.659
Others	4					−0.002 [−0.460; 0.456]	−0.002 [−0.430; 0.427]	−1.268 (109)	.207
d. Time limitation	115	$F(1, 113) = 1.240$	.268	0.038***	0.018**				
Limited	100					0.205 [0.126; 0.284]	0.202 [0.125; 0.277]	5.131 (113)	<.001
Unlimited	15					0.094 [−0.183; 0.371]	0.094 [−0.181; 0.355]	−1.114 (113)	.268
e. MIPs	115	$F(5, 109) = 3.995$	.002	0.040***	0.005				
Feedback	7					0.094 [−0.114; 0.302]	0.094 [−0.114; 0.293]	0.899 (109)	.371
Film	16					0.075 [−0.386; 0.535]	0.075 [−0.368; 0.489]	−0.152 (109)	.880
Imagination	66					0.326 [−0.106; 0.758]	0.315 [−0.106; 0.640]	2.055 (109)	.042
Recording	7					−0.053 [−0.549; 0.444]	−0.053 [−0.500; 0.417]	−1.007 (109)	.316
Others	10					0.232 [−0.239; 0.702]	0.228 [−0.235; 0.606]	1.041 (109)	.300
none	9					0.132 [−0.339; 0.603]	0.131 [−0.327; 0.539]	0.285 (109)	.776
f. Study design	115	$F(1, 113) = 1.341$	.249	0.039***	0.018**				
Correlational	13					0.096 [−0.075; 0.268]	0.096 [−0.075; 0.268]	1.116 (113)	.267
Experimental	102					0.207 [−0.154; 0.568]	0.204 [−0.153; 0.514]	1.158 (113)	.249

Note. #ES = number of effect sizes; df = degrees of freedom; Levels 2 variance = variance between effect sizes extracted from the same study; Levels 3 variance = variance between studies; ESz =

Fisher's z ; r = Pearson's correlation; 95% CI = 95% confidence interval; GC/MC = general and malevolent facets of creativity; MIPs = mood induction procedures.

^aOmnibus test of all regression coefficients in the model.

^b p -value of the omnibus test.

^c p -value of the t -test.

* $p < .05$. ** $p < .01$. *** $p < .001$.

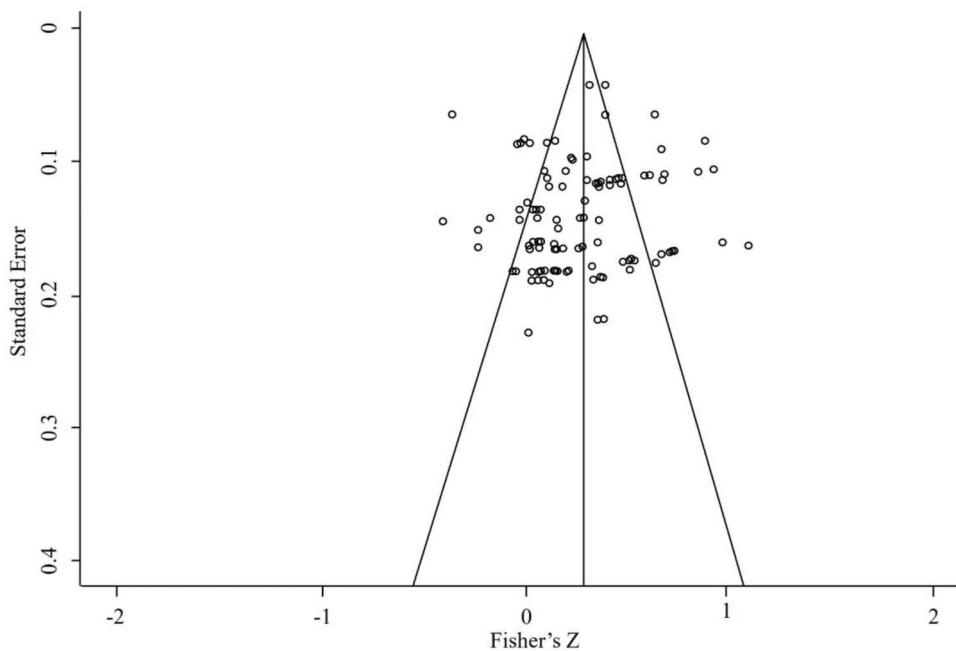


Figure 2. Funnel plot of overall studies.

creativity remained significant ($ES_Z = 0.102$, $SE = 0.037$, $t(52) = 2.756$, $p = .008$, 95% $CI = [0.028, 0.176]$), with significant heterogeneity ($QE(52) = 127.930$, $p < .001$). Converted to Pearson's r , the relationship between anger and general creative performance was $r = 0.102$, 95% $CI = [0.028, 0.174]$. The log-likelihood ratio test revealed significant heterogeneity in within-study variance (Level 2) ($p = .016$) and marginally significant heterogeneity in between-study variance (Level 3) ($p = .076$). The variance components were 39.54% at the sampling level (Level 1), 35.19% at the within-study level (Level 2), and 25.28% at the between-study level (Level 3).

However, significant moderator effects were not found for participants' age ($F(1, 51) = 0.221$, $p = .640$), region ($F(1, 51) = 2.440$, $p = .125$), publication year ($F(1, 51) = 0.723$, $p = .399$), publication status ($F(1, 51) = 0.531$, $p = .469$), literature quality ($F(1, 51) = 0.185$, $p = .669$), creative task ($F(2, 50) = 0.234$, $p = .793$), creative outcome ($F(5, 47) = 0.843$, $p = .526$), time limitation ($F(1, 51) = 0.013$, $p = .910$), mood induction procedures ($F(5, 47) = 1.662$, $p = .162$), and study design ($F(1, 51) = 0.755$, $p = .389$).

4. Discussion

The present study conducted a three-level meta-analysis of 28 independent studies (115 effect sizes

from 2,413 participants) to examine the overall relationship between anger and creativity, as well as potential moderating variables. A significantly positive correlation between angry mood and creative performance ($r = 0.184$, $p < .001$) was identified in this study. When focusing only on general creativity, the overall effect remained significant ($r = 0.102$, $p = .008$), supporting hypothesis 1. According to the dual pathway model, creativity is not enhanced by subdued moods, whether positive or negative; rather, activated moods of both valences can foster creativity (De Dreu et al., 2008). Positive emotions enhance creativity by increasing cognitive flexibility and inclusiveness, while negative emotions like anger promote creativity through greater persistence. Lench and Levine (2008) specifically noted that anger is associated with persistence. Individuals experiencing anger may exert extra effort to overcome challenges and achieve goals (Carver, 2004; Frijda, 1987; Levine, 1996), potentially benefiting creative performance. Moreover, anger is associated with a high level of approach motivation (Carver, 2004). Approach motivation typically involves less attention to negative information and easier shifting of attention away from such information (Derryberry & Reed, 1994). This suggests that anger can activate approach motivational systems, encouraging efforts to overcome goal-related obstacles (Frijda, 1987; Harmon-

Jones, 2004; Harmon-Jones et al., 2006). Such activation is likely to result in beneficial outcomes for creativity, such as the generation of novel ideas. Furthermore, maintaining cognitive activation is crucial in creative endeavours for engaging cognitive systems and sustaining goal-related attention and effort (Byron et al., 2010; Gilet & Jallais, 2011). As a high-arousal state, anger enhances cognitive activation and resource allocation to the task at hand, thereby boosting creative performance. Additionally, anger is associated with the activation of a wider semantic network (Gilet & Jallais, 2011), facilitating novel connections between concepts and improving creative output (Friedman & Forster, 2010).

For the moderating role of facets of creativity, we found that anger enhances malevolent creativity performance more than general creativity, thus supporting Hypothesis 2a. This observation is consistent with the mood-as-input model (Martin & Stoner, 1996) and the motivational compatibility account (Friedman et al., 2007), which imply that specific mood states can influence cognitive processing and creative output. The alignment between the negative nature of anger and the objectives of malevolent creativity tasks – both centred on themes of harm, attack, and malice – implies a motivational compatibility that boosts performance in malevolent creativity (Wang, 2013). Moreover, the link between anger and aggression (Anderson et al., 1996; Berkowitz, 1990) offers additional insight into why anger might specifically enhance malevolent creativity, which entails employing creative thinking to intentionally inflict harm (Crompton et al., 2008; Plucker et al., 2004). Furthermore, anger can disrupt cognitive processes, such as moral reasoning and judgment, potentially resulting in impaired ethical decision-making (Anderson & Bushman, 2002). An angry mood might rationalise aggressive behaviours, inadvertently encouraging misguided emotional responses. This increase in aggression predisposes individuals to adopt harmful perspectives more readily (Anderson & Bushman, 2002). As individuals become more aggressive, they are likely to generate more novel, albeit harmful, ideas, thereby demonstrating heightened levels of malevolent creativity (Cheng et al., 2021b).

Creative task and creative outcome did not moderate the anger-creativity link when considering both general and malevolent creativity together, or when focusing only on general creativity. This means that the creative dimensions, whether convergent (eureka) or divergent (which includes flexibility,

fluency, and originality), did not influence anger's effect on creative performance. Hence, hypothesis 2b, which proposed that anger would facilitate creativity more in convergent thinking tasks, is not supported by our study. This observation can be interpreted from two perspectives. Firstly, while emotions undoubtedly influence cognitive processes, cognitive processes can also modulate emotional states, suggesting a dynamic interplay between mood and cognition (Bar, 2009; Gray, 2004; Gross, 2002; Salovey et al., 2002). Akbari Chermahini and Hommel (2012) found that engagement in creative tasks alters individuals' moods, with divergent thinking tasks leading to more positive emotions and convergent thinking tasks resulting in less positive emotions. This mood variability during creative tasks could reduce anger's facilitative role in convergent thinking tasks. Secondly, Fischer and Hommel (2012) observed increased task-component switching costs in the convergent-thinking group compared to both the divergent-thinking group and a neutral-control group. This suggests that the effects of anger on convergent thinking tasks might be too subtle to detect, overshadowed by the inherent demands of the tasks themselves. Correspondingly, outcomes of creative tasks also failed to significantly influence the anger-creative performance link.

The moderating role of time limitation is not significant, indicating that anger's effect on limited-time tasks is not superior to its effect on unlimited tasks. Thus, hypothesis 2c is not supported. According to Baas et al. (2011), anger induces a less systematic and structured approach to creative tasks, initially resulting in superior creative performance. However, this advantage diminishes quickly due to quicker resource depletion, leading to a more pronounced decline in creativity over time for individuals experiencing anger. A comprehensive review of mood literature by Morris (1989) highlighted that the effects of experimentally induced moods could persist for up to 30 min. Given that most creativity tasks in the analysed studies (e.g. Chen et al., 2014; Fernández-Abascal & Díaz, 2013) lasted less than 30 min, whether time-constrained or not, this may account for the lack of significant differences observed in the impact of anger on creativity across different task durations.

The study emphasized mood induction methods as a significant moderating variable, despite the absence of a prior hypothesis regarding this factor. However, when considering only general creativity,

the moderating role of mood induction procedures on creative performance was not significant. Therefore, we provide a limited explanation for this finding. First of all, imagination may be an effective procedure to induce anger. Scholars such as Dougherty et al. (2004) and Kross et al. (2009) have observed that imagination techniques, by providing precise control over the intensity and timing of emotional arousal, are especially effective and preferred by researchers for emotion induction. Secondly, anger induced by imagination might play a more critical role in specific types of creative tasks or in generating malevolent creativity but has less impact on general creativity. Thirdly, mood induction methods generate asymmetrical effects on positive versus negative emotions, with stronger intensities observed for the latter (Green et al., 2003). Therefore, while imagination emerges as the preferred method for eliciting anger to enhance creative performance, especially malevolent creativity, this conclusion is specifically limited to the context of anger and may not apply to other emotions or cognitive processes.

When comparing all the moderating analyses in the full model (which includes both general creativity and malevolent creativity) and the GC model (which includes only general creativity), the moderating roles of region and publication year are significant in the full model but insignificant in the GC model. Upon examining the composition of the included studies in the present meta-analysis, we found that the ratio of effect sizes for general creativity from the East to the West is 29:24. In contrast, the ratio of effect sizes for malevolent creativity from the East to the West is 54:7. The average publication year for studies on general creativity is 2015, while the average publication year for studies on malevolent creativity is 2022. This discrepancy regarding region and publication year may be attributed to the booming research on malevolent creativity in Eastern regions in recent years.

5. Limitations and future research directions

The article identifies several limitations that suggest avenues for further research. Firstly, this study focuses on basic mood anger with a limited number of studies. Future studies could include anger-related secondary emotions such as aggression and hostility to gain a more comprehensive understanding of the role of these similar moods in creativity.

Furthermore, future studies could include a new control group, for example, comparing anger and sadness. Both are negative moods, but anger is high-arousal while sadness is low-arousal. This approach could provide a control to validate the findings of this study and potentially reveal new insights within negative moods. Secondly, this study includes both general creativity and malevolent creativity. However, the measurement methods for malevolent creativity are not as mature as those for general creativity, and currently only include divergent tasks. We encourage the development of new methods to measure various dimensions of malevolent creativity. Thirdly, our research focused on verbal creativity. Future research could explore the impact of emotions on different creative formats, comparing verbal, visual, and musical creativity. Lastly, although we conducted a thorough search, we only included English and Chinese articles. For a more comprehensive analysis, collaboration with studies in other languages is encouraged in future research.

Author contributions

Liangyu Xing, Yikuan Kan, and Ning Hao were instrumental in conceptualising the project and formulating the research strategy. Liangyu Xing and Wenyu Zhang, along with Yikuan Kan, conducted the literature review and were responsible for coding the variables. Data analysis was collaboratively carried out by all authors, who also engaged in thorough discussions regarding the findings. The manuscript was written by Liangyu Xing and Wenyu Zhang, with Ning Hao contributing significantly to the drafting and revision of the text.

Data availability statement

The data that support the findings of this study are openly available in Open Science Framework ([doi:10.17605/OSF.IO/2Q6JW](https://doi.org/10.17605/OSF.IO/2Q6JW)).

Disclosure statement

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*References marked with an asterisk indicate studies included in the meta-analysis

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