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Picture-activated mood and creativity in online brainstorming: the roles of flexibility and persistence

Neslihan Nur Pehlivan^{1*}  and Hamit Coşkun² 

Abstract

Background This study examined how mood (positive or negative) and presentation format (picture or text) influence idea generation during online brainstorming. Creativity was assessed by the number of unique ideas (fluency, defined as the total number of non-redundant ideas) generated, with participants brainstorming ways to improve parks. The research drew on the dual pathway-to-creativity model, emphasizing flexibility and persistence as key factors in creativity.

Method The participants were randomly assigned to one of four conditions: two mood types (positive or negative) and two presentation formats (picture or text). Creativity was measured by counting unique, nonrepetitive ideas and evaluating flexibility (number of unique categories of ideas). Persistence was also analyzed, calculated as the ratio of unique ideas to unique categories. Statistical tests were used to examine the main and interaction effects of mood, presentation format, and persistence on idea generation.

Results The participants exposed to pictures generated more unique ideas than those exposed to text, highlighting the presentation format's impact on creativity. The positive mood participants outperformed the negative mood participants by generating more unique ideas and exhibiting greater flexibility, as measured by the number of distinct categories of ideas. Persistence played a moderating role, with high persistence in a positive mood condition leading to more unique ideas than medium or low persistence. However, there was no significant difference in idea generation between medium- and low-persistence participants in either mood condition.

Conclusions These findings are consistent with a possible mediating role of flexibility in the relationship between mood and creativity, as proposed by the dual pathway to creativity model. Exploratory analyses suggest that persistence may play a potential moderating role, with high persistence amplifying the effects of a positive mood on creativity. Future research should explore more visually engaging stimuli for online brainstorming and investigate the interplay of additional variables. The role of persistence as a mediator or moderator warrants further exploration.

Keywords Online brainstorming, Unique ideas, Creativity, Mood, Presentation format, Flexibility, Persistence

*Correspondence:

Neslihan Nur Pehlivan
neslihannurpehlivan@hitit.edu.tr

¹Hitit University, Çorum, Turkey

²Department of Psychology, Kocaeli Health and Technology University, Kocaeli, Turkey



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Introduction

Creativity, a cornerstone of human innovation, is defined as the ability to generate ideas, solutions or products that are both novel and appropriate [1, 2]. While originality—the uniqueness of ideas—is often considered the hallmark of creativity, fluency—the ability to generate numerous ideas—is widely recognized as a complementary measure of creative potential. Research suggests that generating many ideas increases the likelihood of discovering original and practical solutions [2, 3]. However, fluency alone has limitations as a measure of creativity, leading scholars such as Runco and Acar (2012) [4] to advocate for the inclusion of flexibility (diversity of ideas across categories) and originality in assessments for a more comprehensive evaluation.

This study used unique ideas as the primary creativity metric, as they are valued for their practicality and reliability in brainstorming research [5]. Unique ideas, defined as novel and nonredundant contributions, effectively capture the breadth of ideation while correlating with key creativity measures such as fluency, originality and flexibility [6, 7]. Identifying unique ideas involves eliminating repetitive and similar contributions, allowing the analysis to focus on the originality and distinctiveness of outputs. This approach is consistent with broader perspectives on creativity by emphasizing idea generation productivity and quality [3]. In addition to unique ideas, this study included flexibility (cognitive diversity) and persistence (depth of ideas) to provide a more nuanced assessment of creativity. Flexibility reflects the diversity of ideas across different categories, whereas persistence emphasizes the depth of exploration within a single category. Together, these metrics complement unique ideas to provide a holistic assessment of creative potential. Table 1 illustrates the interplay between these dimensions and how they collectively contribute to robust creativity assessments.

Brainstorming is a widely used method for fostering creativity, emphasizing generating numerous ideas without criticism. Introduced by Osborn (1953) [8], this technique is based on the premise that a greater quantity of ideas increases the probability of producing high-quality, creative solutions. Modern approaches, such as electronic brainstorming, have enhanced the method by

reducing production blocking and evaluation apprehension [9, 10]. Production blocking refers to interrupting idea flow when individuals have to take turns to contribute, which can reduce group creativity [10]. Evaluation apprehension is the fear of being judged by others, which may discourage people from sharing novel ideas [9]. The subfield of electronic brainstorming (EBS) has consistently demonstrated advantages over traditional face-to-face brainstorming, particularly in reducing evaluation apprehension, minimizing production blocking, and increasing idea fluency [9, 10]. Moreover, EBS allows for asynchronous and anonymous participation, which can foster a more psychologically safe environment for creative thinking. Despite these benefits, much of the research in this domain has focused on fluency as the primary outcome, with limited attention to how affective states and perceptual factors interact with online brainstorming environments (e.g [2, 11])... Our study aims to address this gap by examining how mood and presentation format jointly influence creative idea generation within an online EBS framework, thereby contributing to both creativity and online collaboration research. While these advancements often measure fluency, recent studies advocate for additional metrics, such as flexibility (diversity of ideas across categories) and originality, to better capture the depth and breadth of creative outputs.

Mood significantly influences creativity, shaping how individuals approach idea generation. A positive mood is generally associated with enhanced cognitive flexibility, broadening ideational pathways and fostering diverse thinking. In contrast, negative mood enhances persistence, encouraging sustained focus and depth in problem solving [12, 13]. Earlier studies support this view, demonstrating that mood shapes categorization strategies [14], and that positive and negative moods have dissociable effects on cognitive flexibility [15]. For example, Hirt, Devers, and McCrea (2008) [16] demonstrated that happy participants who experienced positive emotions exhibited increased cognitive flexibility and significantly increased creativity scores. These results underscore mood’s critical role in influencing ideational pathways and creative outcomes. In the present study, we focused on the valence dimension of mood (positive vs. negative). Other affective components such as activation (arousal) or motivational orientation [17] were beyond the scope of this research and are therefore discussed in the limitations section. While the Dual Pathway to Creativity Model emphasizes flexibility and persistence as two distinct cognitive routes to creativity, activation (arousal) is a crucial underlying mechanism determining which pathway is activated. According to De Dreu et al. (2008) [12], high activation levels facilitate flexibility in

Table 1 Correlations between unique ideas, flexibility, and persistence/deep ideas

	1	2	3
1. Unique Ideas	-	0.66**	0.70**
2. Flexibility	0.66**	-	−0.04
3. Persistence (Deep ideas)	0.70**	−0.04	-

**p* < .05
***p* < 0.001

a positive mood, whereas low to moderate activation in negative moods promotes persistent thinking. This conceptualization has been supported by Baas et al.'s (2008) [13] meta-analysis, which highlighted that both hedonic tone and activation jointly influence creativity outcomes. The meta-analysis by Baas et al. (2008) [13], which synthesized 25 years of research on mood and creativity, provides robust evidence for the dual impact of mood valence and activation level on creative performance. Their findings indicated that high-activation positive moods (e.g., happiness, elation) significantly enhance creativity, especially through increased cognitive flexibility. In contrast, low-activation negative moods (e.g., sadness) may not foster creativity unless accompanied by a high degree of task engagement or persistence. The meta-analysis also highlighted that mood effects vary across creative task types (e.g., divergent vs. convergent thinking) and are moderated by individual differences and contextual factors. These nuanced findings underscore the importance of considering valence, arousal, and regulatory focus in experimental manipulations of mood and creativity. De Dreu et al. (2008) [12] demonstrated that flexibility mediates the effect of positive mood on creativity, broadening ideational pathways. In contrast, persistence mediates the effect of negative mood, promoting sustained focus and depth in problem solving. This framework provides a foundational perspective, which our study builds upon by examining these pathways in an online brainstorming context. Flexibility supports the exploration of diverse perspectives, whereas persistence promotes deeper engagement with specific ideas. This finding is consistent with Hirt, Devers, and McCrea's (2008) [16] findings, which showed that positive mood enhances cognitive flexibility, thereby improving creativity. Although their study primarily measured creativity through originality scores, they reported a high correlation with fluency, supporting the validity of fluency as a creativity indicator. This study builds on this model to investigate how mood states affect creativity during brainstorming.

Information presentation format, particularly visual stimuli, also plays a crucial role in creativity. According to dual coding theory [18, 19], cognitive processing occurs through two distinct channels: the verbal system, which handles linguistic information, and the nonverbal system, which processes visual imagery. Visual stimuli, such as pictures, engage attention more effectively than text, enhancing memory retention and ideation. Baby pictures, specifically, evoke strong emotional responses and are highly attention-grabbing [20, 21]. While this study focuses on such emotionally salient imagery due to

its well-documented capacity to elicit affective responses and capture attention (e.g. [20]),, prior research has also employed a broader range of visual stimuli to prime creativity. For example, abstract art, symbolic images, and nature scenes have been shown to trigger divergent associations and open-ended thinking (e.g. [22,–24]),. Future research may compare these visual formats to better understand which features—emotional salience, ambiguity, or semantic richness—most effectively facilitate creative ideation. While Hirt, Devers, and McCrea (2008) [16] utilized film clips to manipulate mood, this study employs baby pictures as a novel emotional stimulus to examine their combined effects on creativity.

Studies also draw on various methods used to manipulate mood in experimental settings. These include recalling emotional events [22, 23], examining emotionally charged photographs [24], and watching short films or positive video programs [25, 26]. Among these, emotionally charged pictures, such as baby faces, have demonstrated unique effectiveness in eliciting strong emotional and cognitive reactions [27, 28]. Despite their known emotional impact, their influence on brainstorming performance remains underexplored. This research addresses this gap by examining how baby pictures and mood manipulations influence creativity.

Although previous studies have investigated the effects of mood and modality (e.g., visual vs. verbal input) on creativity, few have systematically examined their combined effects in the context of online brainstorming. Additionally, the role of persistence has typically been explored in relation to negative mood. This study extends prior research by testing whether high persistence amplifies creativity in positive mood contexts—especially within engaging, open-ended tasks. By integrating emotional priming through pictures and testing mood-modality interactions in a digital setting, our work contributes a context-specific extension to established models. This approach offers a context-specific contribution by exploring how affective and perceptual factors may jointly influence creative performance in a fully online setting—a topic that has begun to receive more attention but still warrants further empirical investigation, especially in post-pandemic educational and organizational contexts.

In summary, this study investigated the combined effects of mood (positive vs. negative) and presentation format (picture vs. text) on creativity in brainstorming. Building on the dual pathway-to-creativity model, we hypothesize that positive moods enhance flexibility and fluency, whereas negative moods promote persistence and depth. By incorporating baby pictures as emotional

stimuli, this research aims to clarify the mechanisms through which mood and presentation format influence idea generation. While the Dual Pathway to Creativity Model associates flexibility with positive mood and persistence with negative mood, our study extends this model by exploring the moderating effect of persistence in a positive mood condition. Although persistence has traditionally been linked to negative mood [12], emerging research suggests that positive mood can also facilitate persistent engagement, especially when the task is perceived as intrinsically interesting or goal-relevant [23, 29]. In such contexts, individuals may invest more cognitive effort and remain focused even under positive affect, particularly in open-ended tasks like brainstorming. Therefore, we explore whether persistence may operate not only as a function of negative affect, but also in certain positive affective contexts. This novel perspective highlights that persistence may not exclusively align with negative moods, as previously suggested, but can also enhance creative output in certain positive emotional contexts. These findings have implications for enhancing creativity in both educational and professional contexts, particularly in online brainstorming environments. Building upon Hirt et al.'s findings, this study examines the mediating role of flexibility in the mood-creativity relationship, further exploring the nuances of presentation format and its interactive effects on creative ideation.

In conjunction with the aims above, the aims of this research are listed below.

1. The first goal of this research is to explore how mood and presentation format affect creativity in a larger sample size. This study aims to elucidate the underlying mechanisms of how mood and presentation format influence creativity. By conducting this study with more participants through online processes, we seek to understand how different parameters affect the brainstorming process in an online setting. We are particularly interested in whether different parameters produce different results when the brainstorming method is applied online to participants in the distance education process. Additionally, we aim to replicate Çelebi's (2016) [30] findings with a larger sample size to determine if the results remain consistent. For example, Çelebi's thesis revealed that mood affects creativity and that persistence has a mediating role. Çelebi's study revealed that a positive mood increases creativity, with flexibility mediating the

relationship between presentation format and the number of unique ideas. However, the small sample size in Çelebi's research limited the generalizability of the findings, leading to results that may only apply to a specific group [31]. Furthermore, small samples may miss true effects because of insufficient statistical power [31]. According to Sedlmeier and Gigerenzer (1989) [32], small samples that cannot adequately represent individual differences and random fluctuations may hinder the clear establishment of cause and effect relationships. While the present study shares structural similarities with Çelebi's (2016) [30] design—particularly in manipulating mood and presentation format—it also offers notable extensions. Unlike the original study, we additionally report the number of unique ideas as an index of idea fluency (unique, non-repeat ideas), alongside flexibility. Furthermore, we employed mediation analysis to examine whether flexibility explains the relationship between mood and creativity—an analytical approach not utilized in the earlier study. Conducting the study in an entirely online setting, with a larger and more diverse sample, also allowed us to enhance ecological validity and investigate creativity in the context of virtual collaboration, which has become increasingly relevant in the post-pandemic era.

2. The second goal of this study was to determine how positive and negative moods affect creativity in an online brainstorming environment. Previous research has suggested that positive affect promotes cognitive flexibility and creative problem solving [13, 33]. According to the dual pathway-to-creativity model [12], the effect of positive mood on creativity depends on flexibility.
3. The third objective is to examine the impact of different presentation formats (picture text) on creativity in an online setting. Çelebi's study [30] revealed that the type of presentation affects creativity, with persistence mediating. Our study seeks to test whether this finding holds in an online environment.
4. Finally, we aim to test the dual pathway-to-creativity model on an online. This model suggests that positive mood enhances creativity through cognitive flexibility. We aim to elucidate whether this model holds in an online brainstorming context using a larger sample size.

Based on these goals, we propose the following hypotheses:

- H1: Participants in positive mood conditions generate more unique ideas than participants in negative mood conditions.
- H2: Participants in the picture condition generate more unique ideas than do participants in the text condition.
- H3: Participants who are presented with a positive mood picture generate more unique ideas than those in other conditions do.
- H4: Flexible thinking mediates the relationship between mood and the number of unique ideas.
- H5: Persistence mediates the relationship between mood and the number of unique ideas.

This research aims to provide a deeper understanding of the interplay between mood, presentation format, and idea generation in an online brainstorming context by addressing these hypotheses.

Methods

Participants and research design

The study used a 2 (Mood: positive vs. negative) $\times$ 2 (Presentation Format: picture vs. text) between-subjects experimental design. The research participants comprised 119 volunteer undergraduate students from a university in northwestern Turkey. Each participant was randomly assigned (the random assignment of participants to groups was performed through the software psytoolkit.org via the 'random' command. When each participant clicked on the research link, the software automatically randomly assigned them to a condition) to the study's 2 (mood: positive and negative) $\times$ 2 (presentation format: picture and text) factorial design conditions. The age range of the participants was 19–51 years ($M = 22.92$, $SD = 3.68$). The majority of the participants were female (78.2%).

A post-hoc power analysis was conducted using G*Power [34] to evaluate whether the sample size ($N = 119$) was sufficient to detect the observed effect. Based on an effect size of $\eta^2 = 0.17$ ($f = 0.45$), $\alpha = 0.05$, numerator degrees of freedom = 1, and denominator degrees of freedom = 115, the achieved power was calculated to be 0.99. This value indicates that the study had sufficient power to detect medium-to-large effects in the 2 (Mood) $\times$ 2 (Presentation Format) between-subjects factorial design.

Instruments



Diagram 1 Flow of the research process

Consent form: Participants were given a consent form that included explanations about the research and who was conducting the research, stating that participation in the research was voluntary and that they could leave any part of the research if they wanted to.

Neutralization task: The participants were instructed to attentively read an 86-word passage describing everyday life events and visualize the scenarios in the text. This task was designed to neutralize their current mood by engaging their imagination and shifting their focus towards the commonplace events described [35]. 12 sentences and 86 words in the text are not related to the research problem but are about neutral events (e.g., "I took the minibus and came home. When I got home, I put away what I bought. ").

Mood and presentation format manipulation: Four different conditions in the 2 (mood: positive-negative) $\times$ 2 (presentation format: picture-text) design affected the participants' creativity. These four different conditions included a happy baby picture (Mood: positive, Presentation format: Picture), an unhappy baby picture (Mood: negative, Presentation format: Picture), 'Imagine a happy baby' text (Mood: positive, Presentation format: Text) and 'Imagine an unhappy baby' text (Mood: negative, Presentation format: Text). The participants were given 1.5 min in each of the 4 conditions for the manipulation. During this time, the participants were asked to write their feelings and thoughts about the picture or text they were exposed to (e.g., for the picture condition, the command was 'Examine the picture above and write your feelings and thoughts about the picture in the blank box below (time: 1.5 min)'; for the text condition, the command was 'Write your feelings and thoughts about the baby you imagine in the blank box below (time: 1.5 min)').

The baby pictures used in the study were taken from publicly available images obtained through Google searches, ensuring high -quality and clear emotional expression to increase the reliability of the manipulations. From an initial pool of images, three independent judges rated the images based on happiness, sadness/unhappiness and cuteness via a 10-point Likert scale. The judges were selected for their psychology and emotional analysis expertise to ensure a systematic and unbiased evaluation process. The final selection included one happy picture and one sad/unhappy baby picture, chosen on the basis of the highest mean ratings across the

criteria and strong agreement between the judges (ICC (interclass correlation coefficient) > 0.8). Each participant was exposed to only one picture per condition (happy or sad). They had 1.5 min to view the picture and respond to the corresponding task. This design minimized variability and avoided any potential fatigue or carry-over effects.

Manipulation control: Immediately following the manipulation, the participants were directed to a 5-item, 11-point questionnaire to assess whether the manipulations were effective. In this form, the participants evaluated how interesting, attention-grabbing, vivid, happy, and unhappy the images they observed were. The authors developed the questionnaire and is provided in Supplementary Material (see Appendix 1).

Mood measurement: After the manipulation control, the participants' current mood was assessed. This form used an 11-point scale covering happiness, anger, calmness, anxiety, relaxation, sadness, surprise, fear and disgust. The authors developed the questionnaire and is provided in Supplementary Material (see Appendix 2).

Brainstorming Problem and Guidelines: Before the brainstorming session, the participants were shown a video explaining Osborn's (1953) [8] brainstorming method and a verbal explanation of the rules. The rules outlined in the video were as follows: (1) avoid criticism; (2) express every idea that comes to mind in writing; (3) generate as many ideas as possible; and (4) try to expand and integrate the concepts that come to mind. The participants were instructed to open and carefully watch this 2-minute video, which explained the rules of brainstorming. Then, they were instructed to 'Using the brainstorming rules, write down your ideas about "What can be done to improve parks (e.g., hiking park, aquapark, picnic park, amusement park, etc.)?" In 13 minutes, they were asked to generate ideas about the brainstorming problem (What can be done to improve parks?). The participants generated ideas about the brainstorming problem within the allocated time by making use of the brainstorming rules and expressing them in short sentences. The brainstorming task ("What can be done to improve parks?") was selected due to its familiarity and relevance to undergraduate students, which ensured ecological validity and facilitated spontaneous idea generation.

Creativity or performance measurement

Unique ideas; In this study, the number of unique ideas was used to measure creativity. Creativity was determined by the number of unique ideas generated in the literature [2, 3, 5, 36, 37]. In this study, fluency is operationalized as the total number of unique (non-redundant) ideas generated by each participant. To avoid confusion, we clarified that this measure reflects fluency, but for consistency we refer to it simply as unique ideas throughout the manuscript. This measure was previously referred

to as "unique ideas," but it more accurately reflects idea fluency [38]. The correlation or reliability coefficient between two judges for nonrepeated or unique ideas is 0.99. The number of nonrepeated ideas is considered as an indicator of creativity [5, 39].

Flexibility; Each unique idea generated was then coded according to predetermined categories according to the problem. Two independent reviewers assessed the extent to which the participants produced flexible thinking. To calculate the flexibility score, how many categories the ideas generated by the participants were spread over were calculated (e.g., if the participant generated ideas about landscaping and playgrounds to improve parks, flexibility was 2).

Persistence (deep ideas); On the other hand, the number of unique ideas generated was divided by the number of categories used (flexibility) (Unique idea/Number of categories-Flexibility = Number of deep ideas) to obtain the number of deep ideas [7]. While this ratio aims to reflect sustained idea generation within a constrained conceptual scope, we acknowledge its limitations. A high ratio may also reflect conceptual fixation rather than adaptive persistence. Additionally, the measure can be sensitive to small denominators, which may inflate variability. To address these concerns, we conducted supplementary analyses using the raw number of ideas within the most populated category and found similar patterns. To assess flexibility and deep thinking, the brainstorming problem was categorized according to the recommendations of experts and the database (e.g., landscaping, playgrounds, cleaning, etc.) in Çelebi's (2016) [30] thesis. In his thesis, Çelebi identified nine semantic categories for the ideas generated in improving parks. These categories, which we also used in this study, are as follows; cleaning-maintenance, environmental regulation, establishment of new areas in the park, fees, staff-related recommendations, events-activities, service-opportunities, and playgrounds.

Perceptual Measurements: Following the brainstorming session, the participants were presented with an 11-point, 9-item questionnaire to assess their performance of thinking as well as the task's characteristics. Using this form, the participants assessed the quantity and quality of the ideas they generated as well as the effort they put forth, the time spent, and how much the initial image of the baby they saw at the beginning motivated and encouraged flexible thinking in their idea generation during the brainstorming. Similar items from the perceptual measurements used in the study conducted by Gültepe et al. (2025) [40] were also employed in this research.

Procedure

Prior to data collection, Ethical Committee Approval for the study was obtained from the Bolu Abant İzzet

Baysal University Human Research Ethics Committee on 10/05/2023, with meeting date and decision number 04. The data for the research were collected online via Psytoolkit (3.4.2) [41] as the online data collection tool. The link to the online survey was distributed to participants through email addresses or WhatsApp groups. The online data collection tool randomly assigned each participant to one of four conditions. The flow of the process in the research process is shown in Diagram 1. Before the study began, the participants read the informed consent form, which contained details about the research topic, privacy policy, voluntariness principle, and the researchers' contact information.

The study continued with people who voluntarily agreed to take part in the research. Following the instructions in the online data collection tool, the participants were sequentially provided with the consent form, neutralization task, filler items, instant mood measurement, manipulation session for mood and presentation format, manipulation control, brainstorming rules, instructions, session, and perceptual measurements, all presented in a package.

The study was completed in approximately 20–25 min. After the measurements were completed, the participants were thanked for their participation and support, and the study was concluded.

Results

Neutralization control and instant mood measurement

The participants were given filler items, a neutralization task, and an instant mood measurement to neutralize their mood prior to the manipulation. The participants used a 5-point Likert scale to rate their emotions. The data were analyzed via a 2 (presentation format: picture and text) $\times$ 2 (mood: positive and negative) ANOVA design for instant moods. Analysis revealed that there was no significant difference in mood between the instant mood ($F(1, 115) = 0.13, p = .72, \eta^2 < 0.001$) and presentation formats ($F(1, 115) = 0.01, p = .92, \eta^2 < 0.001$). In addition, the average mood of all the participants ($M = 3.27, SD = 0.81$) was neutral. In addition, the interaction effect was also non-significant ($F(1, 115) = 1.27, p = .26, \eta^2 = 0.01$). As a result, the desired mood neutralization control was achieved prior to manipulation.

Manipulation control

To assess the effectiveness of the manipulations conducted in the study, participants were asked to evaluate the images they saw through a set of questions (vividness, interestingness, attention-grabbing, happy, unhappy) after the manipulation. The data obtained were analyzed via two-way ANOVA due to the homogeneity of variance.

The data were analyzed via a 2 (presentation format: picture and text) $\times$ 2 (mood: positive and negative) ANOVA design for vividness. The impact of mood on vividness was found to be significant, $F(1, 115) = 20.15, p < .001, \eta^2 = 0.15$. This result indicates a large effect size, suggesting that participants' mood had a substantial influence on how vividly they experienced or generated ideas. Specifically, participants in the positive mood condition ($M = 5.73, SD = 2.81, 95\% \text{ CI } [4.95, 6.51]$) experienced the stimuli more vividly than those in the negative mood condition ($M = 3.21, SD = 3.05, 95\% \text{ CI } [2.47, 3.94]$). However, the effect of presentation format ($F(1, 115) = 0.18, p = .67, \eta^2 < 0.001$) and the interaction effect ($F(1, 115) = 0.27, p = .61, \eta^2 < 0.001$) were not significant.

The data were analyzed via a 2 (presentation format: picture and text) $\times$ 2 (mood: positive and negative) ANOVA design for interest. The effect of mood on interest was significant, $F(1, 115) = 7.69, p = .01, \eta^2 = 0.06$. This corresponds to a medium effect size, indicating that mood moderately influenced how interested participants felt. Specifically, participants in the positive mood condition ($M = 3.48, SD = 3.15, 95\% \text{ CI } [2.75, 4.22]$) found the stimuli more interesting than those in the negative mood condition ($M = 1.89, SD = 2.38, 95\% \text{ CI } [1.20, 5.58]$). The presentation format also had a significant effect on interest, $F(1, 115) = 4.94, p = .03, \eta^2 = 0.04$. This represents a small to medium effect size, suggesting that the format in which the stimuli were presented had a modest impact on participants' interest. Participants in the text condition ($M = 3.36, SD = 3.15, 95\% \text{ CI } [2.62, 4.10]$) found the stimuli more interesting than those in the picture condition ($M = 2.00, SD = 2.44, 95\% \text{ CI } [1.30, 2.70]$). However, the interaction effect was not significant ($F(1, 115) = 0.05, p = .82, \eta^2 < 0.001$).

The data were analyzed via a 2 (presentation format: picture and text) $\times$ 2 (mood: positive and negative) ANOVA design for attention grabbing. Participants in the positive mood condition ($M = 5.38, SD = 3.03, 95\% \text{ CI } [4.58, 6.17]$) reported finding the stimuli more attention-grabbing than those in the negative mood condition ($M = 3.60, SD = 3.00, 95\% \text{ CI } [2.85, 4.36]$), $F(1, 115) = 9.78, p < .001, \eta^2 = 0.08$. This reflects a medium to large effect size, indicating that participants' mood had a meaningful impact on their perception of attentional salience. The effects of presentation format ($F(1, 115) < 0.001, p = .99, \eta^2 < 0.001$) and the interaction effect ($F(1, 115) < 0.001, p = .98, \eta^2 < 0.001$) on attention grabbing were not significant.

The data were analyzed via a 2 (presentation format: picture and text) $\times$ 2 (mood: positive and negative) ANOVA design for happiness and unhappiness. Participants in the positive mood condition ($M = 7.61,$

$SD=2.44$, 95% CI [7.12, 8.09]) evaluated the stimuli as significantly happier than those in the negative mood condition ($M=0.54$, $SD=1.04$, 95% CI [0.08, 0.99]), $F(1, 115)=421.54$, $p<.001$, $\eta^2 = 0.79$. This indicates a large effect size, showing that mood manipulation was highly effective in shaping participants' affective evaluations. The effects of presentation format ($F(1, 115)=0.01$, $p=.94$, $\eta^2 < 0.001$) and the interaction effect ($F(1, 115)=0.89$, $p=.35$, $\eta^2 = 0.01$) on happiness were not significant. Additionally, participants in the negative mood condition ($M=8.25$, $SD=1.96$, 95% CI [7.78, 8.73]) evaluated the stimuli as significantly unhappier than those in the positive mood condition ($M=1.39$, $SD=1.85$, 95% CI [0.89, 1.90]), $F(1, 115)=364.62$, $p<.001$, $\eta^2 = 0.76$. This indicates a very large effect size, further confirming the strong effectiveness of the mood manipulation in shaping participants' negative affective evaluations. The effects of presentation format ($F(1, 115)=1.25$, $p=.27$, $\eta^2 = 0.01$) and the interaction effect ($F(1, 115)<0.001$, $p=.95$, $\eta^2 < 0.001$) on unhappiness were not significant.

Performance measurements

Unique Ideas: We examined the effect of the study's main variables on the total number of unique ideas that participants generated during the brainstorming session. The interrater reliability (Cronbach's alpha) for the number of unique ideas between two independent judges was 0.99. The data were analyzed via a 2 (presentation format: picture and text) $\times$ 2 (mood: positive and negative) ANOVA design for the number of unique ideas. The effect of mood on the number of unique ideas was significant, $F(1, 115)=24.18$, $p<.001$, $\eta^2 = 0.17$. This reflects a large effect size, suggesting that participants' mood substantially influenced their creative output. Participants in the positive mood condition ($M=13.75$, $SD=6.82$, 95% CI [12.30, 15.20]) generated more unique ideas than those in the negative mood condition ($M=9.27$, $SD=3.91$, 95% CI [7.90, 10.64]). The presentation format also significantly affected the number of unique ideas, $F(1, 115)=6.65$, $p=.01$, $\eta^2 = 0.06$. This corresponds to a medium effect size, indicating that the way information was presented influenced participants' idea generation. Participants in the picture condition ($M=12.24$, $SD=5.91$, 95% CI [10.78, 13.70]) generated more unique ideas than those in the text condition ($M=10.41$, $SD=5.78$, 95% CI [8.86, 11.96]). The interaction effect of mood and presentation format on the number of unique ideas was not statistically significant, $F(1, 115)=0.21$, $p=.65$, $\eta^2 < 0.001$.

Flexibility: It is possible to categorize the ideas generated by individuals during a brainstorming session into specific categories. In a brainstorming session, flexibility is the quantity of unique categories in which ideas are

generated. Even though the number of generated ideas is the same, flexibility differences can arise because the ideas are associated with different categories. The data obtained by calculating how many unique categories each participant scanned (number of unique categories) were considered the count of flexibility [39]. The data were analyzed via a 2 (presentation format: picture and text) $\times$ 2 (mood: positive and negative) ANOVA design for flexibility. The analysis results indicate a significant effect of mood on the count of flexibility, $F(1, 115) = 25.34$, $p < .001$, $\eta^2 = 0.18$. This represents a large effect size, suggesting that participants' mood strongly influenced the diversity of categories in their idea generation. Participants in the positive mood condition ($M = 5.32$, $SD = 1.56$, 95% CI [4.94, 5.70]) generated more flexible ideas than those in the negative mood condition ($M = 4.06$, $SD = 1.33$, 95% CI [3.70, 4.42]). The effect of presentation format on flexibility was not statistically significant, $F(1, 115) = 2.95$, $p = .09$, $\eta^2 = 0.03$. The interaction effect of mood and presentation format on the degree of flexibility was not statistically significant, $F(1, 115) = 0.84$, $p = .36$, $\eta^2 = 0.01$.

Persistence or Deep Ideas: Deep thinking or persistence represents the number of ideas generated in a category. The data were analyzed via a 2 (presentation format: picture and text) $\times$ 2 (mood: positive and negative) ANOVA design for the number of deep ideas. The analysis revealed a marginally significant effect of mood on the number of deep ideas, $F(1, 115)=3.86$, $p=.05$, $\eta^2 = 0.03$, and a significant effect of presentation format, $F(1, 115)=4.27$, $p=.04$, $\eta^2 = 0.04$. These findings suggest that presentation format had a small but significant effect on how deeply participants engaged in idea generation, while mood approached significance and may still play a meaningful role in cognitive elaboration. Although the effect sizes were small ($\eta^2 = 0.03$ and $\eta^2 = 0.04$), they suggest that even subtle changes in affective state and presentation format can measurably influence the depth of ideation. Participants in a positive mood ($M=2.60$, $SD=1.03$, 95% CI [2.36, 2.84]) generated deeper ideas than those in a negative mood ($M=2.33$, $SD=0.79$, 95% CI [2.10, 2.55]). Similarly, participants in the picture condition ($M=2.59$, $SD=0.97$, 95% CI [2.37, 2.82]) produced deeper ideas than those in the text condition ($M=2.30$, $SD=0.83$, 95% CI [2.06, 2.54]). The interaction effect of mood and presentation format on the number of deep ideas was not statistically significant, $F(1, 115)=0.03$, $p=.87$, $\eta^2 < 0.001$.

Figure 1 shows the conditions' mean and standard deviation values in terms of unique, flexible, and deep idea counts.

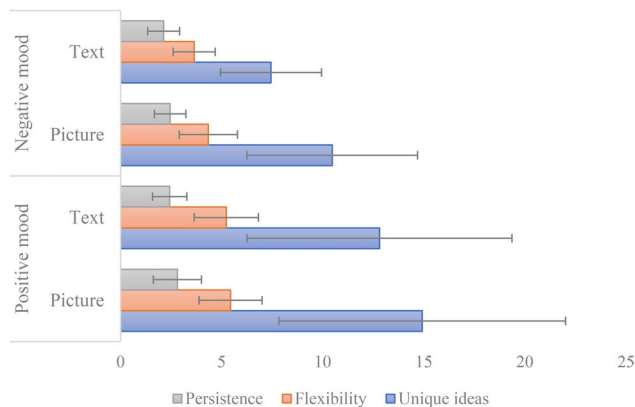


Fig. 1 The mean and standard deviation values of the conditions in terms of the number of unique, flexibility and deep ideas

Mediation analysis

In this study, the mediating role of flexibility in the effect of mood on the number of unique ideas was investigated. Hayes' (2013) [42] PROCESS macro v3.4 (Model 4) was used through SPSS 23 to test the mediating role of flexibility in the effect of mood on unique idea generation. This analysis examines the mediating variables that explain the relationship between the independent and dependent variables. Model 4 is a specific model for conducting simple mediation analysis and allows the testing of a single mediating variable that transfers the effect of the independent variable to the dependent variable. In this context, the analysis was carried out considering the significant variable relationships. The relationships between mood and the number of unique ideas ($r = .38$, $p < .001$), mood and flexibility ($r = .40$, $p < .001$) and flexibility and the number of unique ideas ($r = .66$, $p < .001$) were significant. The findings revealed that mood is a significant predictor of flexibility ($b = 1.25$, $t(117) = 4.74$, $p < .001$, 95% CI [1.21, 2.48]), and that flexibility is an important predictor of unique idea generation ($b = 3.29$, $t(66) = 4.46$, $p < .001$, 95% CI [0.73, 1.78]). While the relationship between mood and the number of unique ideas was significant ($b = 4.48$, $t(117) = 4.46$, $p < .001$, 95% CI [2.49, 6.47]), this relationship became nonsignificant when flexibility was added to the model (mediation model: Model 4, see Fig. 2) ($b = 1.63$, $t(116) = 1.85$, $p = .07$, 95% CI [-0.12, 3.38]). The analysis revealed a

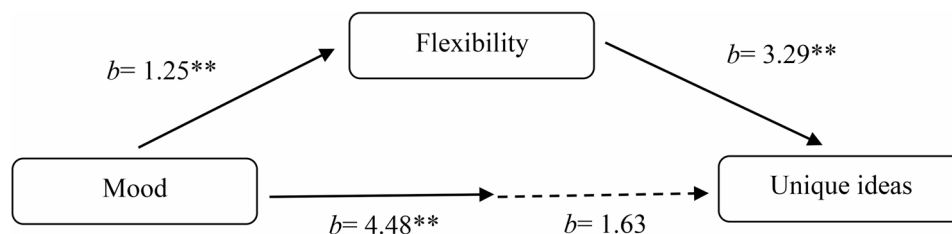


Fig. 2 The mediating role of flexibility in the effect of mood on the number of unique ideas $^{**}p < .001$, $p < .05$

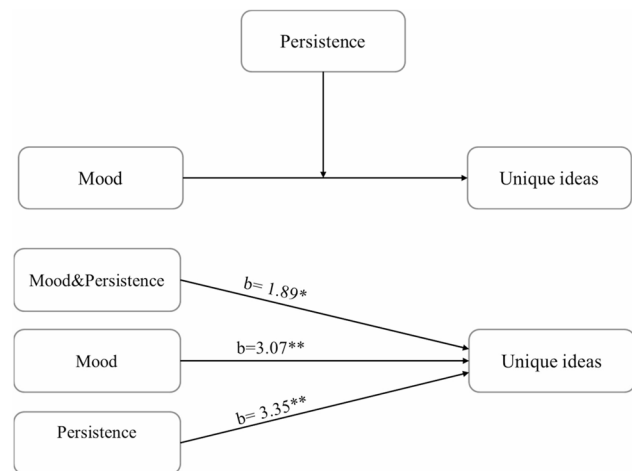


Fig. 3 Moderator role of persistence between mood and number of unique ideas $^{**}p < .001$, $p < .05$

significant indirect effect of flexibility on the relationship between mood and the number of unique ideas ($b = 2.85$, 95% CI [1.54, 4.38]). This finding showed that flexibility was a mediating variable in the effect of the mood on the number of unique ideas (see Fig. 2). Mediation analysis for deep ideas was not performed because other variables did not meet the required criteria (such as no significant relationship between the variables).

Moderator analysis

Examining the effect of mood and persistence on the number of unique ideas We conducted a moderator analysis to examine the role of mood persistence in predicting the number of unique ideas. The findings showed that mood and persistence (deep ideas) significantly interacted with the number of unique ideas and had a moderating role (see Fig. 3).

The significance of the difference between conditions in the low, average, and high depth percentiles of the regulatory variable's distribution was tested via slope analysis to investigate this interaction in more detail (Hayes, 2013) [42]. The analysis indicated that the difference at low persistence was not significant, $b = 1.62$, $t(115) = 1.60$, $p = .11$, 95% CI [-0.39, 3.63]. In contrast, at medium persistence, the difference was significant, $b = -3.35$, $t(115) = 4.68$, $p < .001$, 95% CI [1.93, 4.77], and at high persistence,

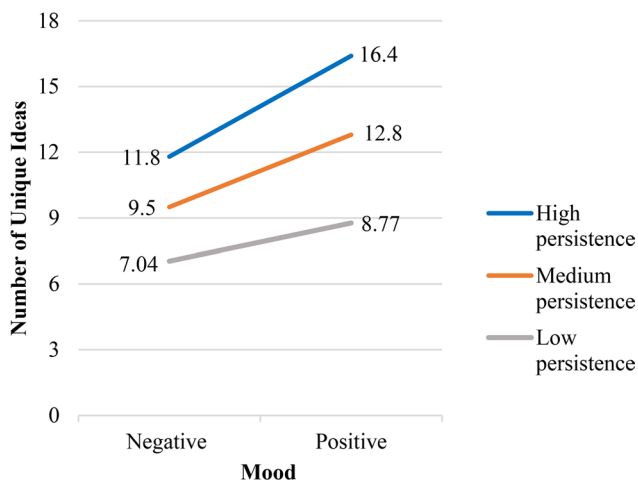


Fig. 4 The conditional effects of low, medium, and high levels of persistence on mood and number of unique ideas

$b = 5.04$, $t(115) = 4.91$, $p < .001$, 95% CI [3.04, 7.14]. This finding showed that the impact of mood on idea generation increased as deep ideas or persistence increased. In other words, medium and high levels of persistence increase idea generation in positive moods. A negative mood enhances unique idea generation when persistence is at its highest level. The graph with the results is presented below (see Fig. 4).

Perceptual measurements

At the end of the study, self-reported items and the main variables of the study were compared.

The effect of mood on the number of ideas generated was significant, $F(1, 115) = 4.50$, $p = .04$, $\eta^2 = 0.04$. This represents a small effect size, suggesting that participants' mood had a modest yet statistically significant impact on their overall idea fluency. Participants in the positive mood condition ($M = 6.68$, $SD = 2.11$, 95% CI [6.12, 7.24]) generated more ideas than those in the negative mood condition ($M = 5.87$, $SD = 2.11$, 95% CI [5.35, 6.40]), indicating that even subtle changes in affective state can influence creative productivity. However, the effect of presentation format ($F(1, 115) = 0.69$, $p = .41$, $\eta^2 = 0.01$) and the interaction effect ($F(1, 115) = 1.44$, $p = .23$, $\eta^2 = 0.01$) were not significant.

Mood did not exert a meaningful influence on the quality of ideas, $F(1, 115) = 0.83$, $p = .37$, $\eta^2 = 0.01$. Neither presentation format, ($F(1, 115) = 0.34$, $p = .56$, $\eta^2 = 0.00$), nor its interaction with mood, $F(1, 115) = 0.21$, $p = .65$, $\eta^2 < 0.001$, showed any reliable effects.

Participants' liking of the brainstorming task was unaffected by mood, $F(1, 115) = 0.34$, $p = .56$, $\eta^2 < 0.001$. Similarly, the effect of presentation format ($F(1, 115) = 0.12$, $p = .73$, $\eta^2 < 0.001$) and the interaction effect ($F(1, 115) = 0.05$, $p = .82$, $\eta^2 = 0.00$) were also not significant.

No significant variation emerged in ratings of the task's interestingness depending on mood, $F(1, 115) < 0.001$, $p = .95$, $\eta^2 < 0.001$. Likewise, presentation format ($F(1, 115) = 0.08$, $p = .78$, $\eta^2 < 0.001$) and the interaction effect ($F(1, 115) = 0.30$, $p = .58$, $\eta^2 < 0.001$) were not significant.

Although mood approached significance in predicting reported effort ($F(1, 115) = 2.98$, $p = .09$, $\eta^2 = 0.03$) the effect was not conclusive. Presentation format ($F(1, 115) = 0.03$, $p = .86$, $\eta^2 < 0.001$) and the interaction ($F(1, 115) = 2.59$, $p = .11$, $\eta^2 = 0.02$) similarly did not yield reliable outcomes.

Participants' perceptions of their speed during brainstorming were not influenced by mood, $F(1, 115) = 0.24$, $p = .63$, $\eta^2 < 0.001$. Consistent with this, neither presentation format ($F(1, 115) = 0.32$, $p = .57$, $\eta^2 < 0.001$) nor the interaction effect ($F(1, 115) = 0.98$, $p = .32$, $\eta^2 = 0.01$) produced significant findings.

The effect of mood on perceived time spent was not significant ($F(1, 115) = 0.04$, $p = .84$, $\eta^2 < 0.001$). The effect of presentation format was also not significant ($F(1, 115) = 0.85$, $p = .36$, $\eta^2 = 0.01$). However, the interaction effect was significant ($F(1, 115) = 7.03$, $p = .01$, $\eta^2 = 0.06$). In the negative mood condition, the text stimulus ($M = 6.20$, $SD = 3.00$, 95% CI [5.02, 7.39]) elicited a greater perception of time compared to the image stimulus ($M = 5.24$, $SD = 2.91$, 95% CI [4.28, 6.20]), whereas in the positive mood condition, the image stimulus ($M = 6.60$, $SD = 2.96$, 95% CI [5.42, 7.79]) resulted in a greater perception of time than the text stimulus ($M = 4.61$, $SD = 3.11$, 95% CI [3.55, 5.68]). Participants in the negative mood condition reported longer perceived time with text stimuli than with pictures, whereas the opposite was true in the positive mood condition. This suggests that the combination of mood and modality shaped not only creative performance but also the subjective experience of time during the task.

Mood had no significant effect on the perceived motivational impact of the initial baby image ($F(1, 115) = 0.03$, $p = .86$, $\eta^2 = 0.00$). Presentation format ($F(1, 115) = 0.03$, $p = .86$, $\eta^2 < 0.001$) and the interaction effect ($F(1, 115) = 0.39$, $p = .53$, $\eta^2 < 0.001$) were likewise nonsignificant.

Similarly, mood did not influence perceived flexibility encouragement of the baby image ($F(1, 115) = 0.06$, $p = .81$, $\eta^2 < 0.001$). Neither presentation format ($F(1, 115) = 0.66$, $p = .42$, $\eta^2 = 0.01$) nor interaction effect ($F(1, 115) = 0.02$, $p = .90$, $\eta^2 < 0.001$) showed significant effects.

Discussion

During online brainstorming sessions, this research investigated how mood (positive or negative) and presentation format (picture or text) affect creative idea generation—operationalized as the number of unique ideas and the degree of cognitive flexibility. While creativity is

broadly defined as the combination of novelty and appropriateness, this study focused specifically on ideational novelty (unique, non-redundant ideas), without assessing appropriateness or originality. The results offer significant insights into the elements that contribute to generating the number of unique ideas.

In the present research, the impact of mood (positive and negative) and presentation format (picture and text) on creative idea generation was examined in an online brainstorming context. Participants in the positive mood condition produced more unique ideas, showed greater flexibility, and demonstrated slightly more persistence than those in the negative mood condition (H1 accepted). This finding aligns with prior studies indicating that positive mood enhances ideational performance, particularly through increased cognitive flexibility (e.g. [13, 16, 33, 43, 44]),. Our findings are also in line with early evidence showing that mood shapes categorization strategies [14] and more recent work demonstrating dissociable effects of positive and negative moods on cognitive flexibility [15]. These studies support the interpretation that positive mood enhances creative output primarily through increased flexibility. For instance, Mohd Yusof (2016) [45] reported that designers in a positive mood generated more original and diverse ideas. In the current study, participants exposed to a happy baby picture also reported feeling happier than those who viewed a sad image, which was reflected in their higher output of non-redundant ideas. It is important to emphasize, however, that creativity was not assessed in its full definition—which includes originality and appropriateness—but was approximated through ideational novelty and flexibility. Additionally, self-reporting measured mood, which may be influenced by individual interpretation or recall bias. Future studies should consider complementing self-reports with behavioral or physiological indicators to enhance the reliability of affective state assessments.

With respect to the presentation format, participants exposed to visual stimuli (pictures) produced a higher number of unique ideas and demonstrated greater persistence—operationalized as the depth of idea generation within categories—compared to those exposed to text-based stimuli (H2 accepted). This finding is consistent with previous studies suggesting visual materials can stimulate ideation and enhance engagement. For example, Listyani (2019) [46] found that pictures and comics support idea generation and serve as sources of inspiration in narrative construction. Similarly, Agwu and Ogochi (2019) [47] reported improved student performance when visual imagery was integrated into teaching. Additional studies have highlighted that images are often more attention-grabbing than text alone [48], and that illustrated materials can foster ideational diversity, especially in special education contexts [49]. Osterweis

(1968) [50] also emphasized the potential of pictures to evoke personal associations and stimulate ideation. However, it is important to note that the current study did not directly assess engagement with the visual stimuli, which may have influenced the outcomes. Future research should consider incorporating objective engagement metrics—such as eye-tracking or time-on-task measures—to better understand how visual presentation contributes to ideational novelty and depth.

The online setting of the current study is particularly relevant given the growing reliance on remote collaboration and education. Conducting the brainstorming task online allowed broader participant access but may also have influenced engagement levels and attention allocation. Unlike in-person sessions, online tasks may suffer from reduced immersion or external distractions, which could dampen the effectiveness of mood induction or stimulus salience. At the same time, online platforms offer unique opportunities for scalability, accessibility, and data automation, making them increasingly important for creativity research. Future studies could explore how different digital environments—e.g., interactive whiteboards, real-time collaboration tools, or video-based tasks—affect the generation of unique and original ideas in educational and organizational settings.

This study demonstrates that flexibility mediates the relationship between mood and the generation of unique ideas (H4 accepted). In other words, positive mood enhances cognitive flexibility, facilitating the production of a greater number of non-redundant ideas. This finding aligns with the dual pathway to creativity model, which proposes flexibility and persistence as two distinct cognitive routes to creative output [12]. Importantly, the present study used the number of unique ideas as a proxy for creative idea generation, rather than directly assessing originality or appropriateness, which are central to more comprehensive definitions of creativity. While this differs from the model's original focus on originality, our findings suggest that flexibility also plays a mediating role in generating novel ideas as measured by uniqueness. Previous research has documented a strong correlation between unique idea fluency and originality scores [6, 51], indicating that individuals who generate more unique ideas also tend to produce more original ones. Nonetheless, it is important to note that these are related but distinct constructs, and their overlap does not imply equivalence. Furthermore, prior studies have consistently shown that positive affect enhances cognitive flexibility. For instance, Biss, Hasher, and Thomas (2010) [52] found that individuals in a positive mood demonstrated greater flexibility in thought processes, which likely contributed to the observed effect in our study. Similarly, Hirt, Devers, and McCrea (2008) [14] showed that positive mood states increased both flexibility and creativity (as

measured by originality). By highlighting flexibility as a mediator between mood and unique idea generation, this study contributes to a more nuanced understanding of how affective states influence ideational novelty (indirect effect: $b = 2.85$). Given the sample size and the exploratory nature of the mediation and moderation analyses, these findings should be interpreted with caution. Future studies with larger samples and pre-registered designs must confirm these effects.

Another exploratory finding was that persistence may moderate, rather than mediate, the relationship between mood and the number of unique ideas (H5 rejected). This diverges from De Dreu et al. (2008) [12], who theorized that persistence is more likely under negative mood due to increased task focus. However, in the present study, the task may have been engaging and sufficiently meaningful to elicit persistent cognitive effort even in positive mood conditions. Specifically, positive mood appeared to amplify the effect of persistence—operationalized as the depth of idea generation within categories—on ideational output. This finding contrasts with earlier research, which typically associated persistence with negative mood states [12]. It is possible that the brainstorming task used in this study (e.g., generating ideas to improve parks) was inherently engaging and emotionally neutral or pleasant, thereby encouraging sustained focus even under positive affect. While persistence is thought to require more sustained cognitive effort than flexibility, our findings suggest that it can still support the production of novel, non-redundant ideas, particularly under favorable affective conditions. However, as the present study did not assess originality or appropriateness, the role of persistence should be interpreted cautiously and within the bounds of ideational novelty only. Future research should investigate the conditions under which persistence contributes to different dimensions of creativity—particularly when originality or elaboration is formally assessed—and whether its role shifts depending on task type or affective intensity. These findings imply that persistence may not be exclusively driven by negative affect, but can also emerge in positive affective states under appropriate motivational conditions.

Interestingly, the study did not find a significant interaction effect between mood and presentation format on the number of unique ideas (H3 rejected). One possible explanation for this null finding is that the visual and textual stimuli, while differing in format, may have been comparable in terms of vividness and emotional salience, thereby reducing any potential differential impact. Additionally, the online nature of the study might have further attenuated the effectiveness of the stimuli due to reduced immersion or variability in participant environments (e.g., distractions, screen size, or attention levels). These factors may have limited the ability of either format to distinctly

influence idea generation. Future studies should consider using more immersive or emotionally arousing materials—such as dynamic visuals or interactive media—particularly when conducted in online settings, to more effectively capture the potential interaction between mood and presentation format on ideational novelty.

Although the present study examined fluency (as the number of unique, non-redundant ideas) and flexibility (as category diversity), it did not assess originality, which is a core component of creativity alongside appropriateness and novelty. As such, the findings should be interpreted as reflecting ideational productivity and diversity, rather than creativity in its full, multidimensional sense. This omission limits the extent to which conclusions can be drawn about the originality or usefulness of the ideas generated. Future research would benefit from incorporating direct measures of originality—either through trained human raters or automated scoring systems such as SemDis or Open Creativity Scoring [38]—to provide a more comprehensive and valid assessment of creative output.

Another important limitation concerns the manipulation of mood. The current study focused solely on the valence dimension of affect (i.e., positive vs. negative mood), without considering other key components such as activation level (arousal) or motivational orientation (e.g., approach vs. avoidance). Omitting activation in mood manipulations may obscure how moods exert their effects through either cognitive pathway. Including activation is particularly important in experimental designs to clarify whether observed effects stem from mood valence, arousal, or their interaction. Additionally, moods are often associated with broader motivational orientations that may further explain their divergent effects on creativity [13, 17]. According to the dual pathway to creativity model [12, 13], highly activating positive emotions are particularly effective in enhancing cognitive flexibility, while low-activation negative emotions may foster persistence. Likewise, findings by Gasper and Middlewood (2014) [53] show that emotions like elation and boredom—though both positive or neutral in valence—differ in activation and motivational tendencies and yield divergent effects on associative thinking. The absence of activation-based manipulation in this study limits the ability to fully interpret how mood influenced ideational novelty and diversity. Future research should aim to disentangle the individual and interactive roles of valence, arousal, and motivational direction by systematically manipulating these dimensions, especially when assessing their effects on different facets of idea generation.

Another important limitation involves the interpretation of the picture versus text condition. While these conditions were conceptualized as a simple manipulation of presentation format (visual vs. verbal), they likely differ along additional dimensions such as emotional vividness,

semantic richness, and concreteness. For instance, visual stimuli—especially baby faces—are often more emotionally engaging and concrete than brief text descriptions. These features may have influenced participants' affective or cognitive responses beyond the intended format manipulation. Therefore, the effects attributed to the presentation format should be interpreted with caution, as they may also reflect content-based confounds. Future studies should better isolate format from content-related variables to strengthen internal validity.

Additionally, the homogeneity of the sample—consisting mainly of female undergraduates from a single Turkish university—may limit the generalizability of the findings to broader populations. In addition, the baby stimuli used in this study depicted an infant with light-colored eyes, fair skin, and blond hair, which may not represent the diversity of appearances in the Turkish cultural context. These features might have influenced participants' affective responses, and future research should employ more culturally diverse stimuli to improve generalizability. Cultural values, educational status, and developmental factors may influence how individuals respond to mood and brainstorming tasks. Furthermore, although the study was conducted post-pandemic, lingering effects of remote education or stress might have shaped participants' engagement. Future research should seek to replicate these findings in professional, multicultural, and non-student samples to enhance ecological validity.

In the context of remote education, various parameters in online brainstorming have been shown to produce different outcomes. One notable distinction between the present study and that of Çelebi (2016) [30] is the role of persistence. While Çelebi reported a mediating effect, the current study found that persistence moderated the relationship between mood and unique idea generation. We recognize the limitations of the ratio-based persistence metric, particularly in cases of low category counts or idea fixation, and recommend that future research explore alternative or complementary indicators of persistent cognitive engagement. At the same time, both studies identified positive mood and visual presentation format (i.e., pictures) as factors that enhance ideational output. Consistent with Çelebi's findings, the current study also found that flexibility mediated the relationship between mood and the number of unique ideas. Importantly, using a larger sample and a fully online design in the present research strengthens the generalizability of these findings and supports the robustness of certain effects initially observed by Çelebi. However, as in previous paragraphs, it is important to note that creativity was approximated through ideational novelty and diversity, rather than assessed in its full multidimensional form.

Finally, although a post-hoc power analysis indicated adequate power to detect medium-to-large main effects,

the sample size may have been insufficient to detect smaller interaction or indirect effects, which are common in mood and creativity research. Future studies should consider larger samples to enhance the sensitivity and robustness of moderation and mediation analyses.

Implications and future directions

The findings of this study have several practical implications. Educators and managers can utilize positive mood-inducing strategies and visual aids to enhance creativity in educational and professional settings. Furthermore, understanding the roles of flexibility and persistence in creativity can help design more effective brainstorming and problem-solving activities.

Limitations of using the number of unique ideas as a measure must also be acknowledged. Using the number of unique ideas as the sole measure of creativity can overlook the qualitative aspects of idea originality and appropriateness. While the number of unique ideas captures the breadth of ideation, it does not necessarily reflect the depth or innovative quality of the ideas generated. Therefore, future research may aim to combine the number of unique ideas with other creative measures for a more comprehensive creativity assessment.

Future research should continue to investigate the interplay between mood, presentation format, and creativity, considering the limitations of online platforms. Identifying characteristics and situations that foster cognitive flexibility and persistence is crucial. Additionally, exploring whether persistence functions as a potential mediator or moderator in different contexts will provide a deeper understanding of its role in creative processes. Future studies should investigate the boundary conditions under which positive mood can facilitate persistence, such as task engagement, personal relevance, or perceived challenge.

While our study builds on well-established theories—such as the Dual Pathway to Creativity Model and dual coding theory—it does not claim conceptual novelty in the broad sense. Rather, it contributes to the literature by examining how mood and modality interact in the specific context of online brainstorming, a setting that has become increasingly relevant post-pandemic. Moreover, by exploring the moderating role of persistence under positive mood—an area less frequently tested—this study offers a nuanced extension to prior findings on mood-creativity dynamics.

In conclusion, this study reinforces the importance of positive mood and visual presentation in enhancing creativity. It also highlights the need for further research into the mechanisms underlying these effects, particularly the roles of flexibility and persistence. By elucidating these factors, we should better harness the power of creativity in various domains.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s40359-025-03523-0>.

Supplementary Material 1

Supplementary Material 2

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Authors' contributions

NNP wrote the main manuscript, prepared the figures and completed the statistical analyses. HC reviewed the manuscript. All authors read and approved the final manuscript.

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Data availability

The data and materials used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Prior to data collection, ethical approval for the study was obtained from the Bolu Abant İzzet Baysal University Human Research Ethics Committee on May 10, 2023 (Meeting Date and Decision Number: 04). The study was conducted by the Declaration of Helsinki, with informed consent obtained from all participants. The participants who joined the study via an online platform, consent was obtained by requiring them to check a consent box before beginning the study. Informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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