# Investigating Co-creativity Interaction with AI-Imagery Tools for Ideation

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**Abstract.** This study explores the facilitation of ideation in the creative process through the interaction with AI-imagery tools. We developed a range of co-creative methodologies for ideation and evaluated them in an experimental study with creative experts. The creativity of the system was assessed using the SPECS method, while attitudes towards future adoption were evaluated using the UTAUT scale. Inspiration and self-reflection were also measured to assess the ideation impact to the participants. Results indicate a strong inclination among participants in adopting AI-imagery tools for ideation. Correlation between SPECS and UTAUT suggests the potential for predicting system acceptance and future adoption through creativity measurement scales. Interviews with participants underscored design considerations, such as maintaining balance between surprise and control and preserving the tool's artistic interpretation. This study highlights the positive reception of AI-imagery tools for ideation and underscores the potential of combining SPECS and UTAUT as an evaluation methodology for co-creative systems.

**Keywords:** AI-imagery · Human-AI interaction · Co-creativity · Ideation · Computational Creativity · Mixed Initiative Interaction · Digital Art

## 1 Ideation & AI-Imagery

Recent advancements in AI image generation have significantly impacted the digital art sphere by enabling the swift production of artistic works, offering access to diverse styles and stimulating creative exploration [11]. AI-imagery tools provide high levels of customization and accessibility, allowing individuals without formal artistic training to create visual content. This highlights the potential of these tools in facilitating innovation in the making of visual content and redefining the creative process. In this study, we focus specifically on ideation in creative Human-AI interaction. Ideation is the phase of the creative process that involves generating novel and surprising ideas for creative projects [12]. It encompasses brainstorming and conceptualizing solutions, often associated with divergent thinking, which entails producing diverse ideas in response to open-ended questions or problems [8,10]. We believe that the interplay between AI imagery and ideation presents a promising research avenue and we would like to highlight two focal points of interest below.

**Inspiration** The study of inspiration, despite its diverse usage in psychology, has faced limitations due to unclear definitions hindering its development. Thrash et al. [24] identified three core characteristics of inspiration: epistemic transcendence, evocation, and approach motivation, which are believed to drive the realization of creative ideas. Previous research suggests that inspiration plays a mediating role in influencing the impact of ideation and insight on the creative output. While inspiration eliciting scales are not widely addressed, empirically researched findings exhibit positive outcomes in terms of predictive validity [2]. Stimulating inspiration for ideation through AI interventions has been explored before with positive results, two examples are the Creative Sketching Partner [4] and the use of AI-imagery in craft education [25], among others [15,9,18].

**Feedback and Self-reflection** Previous research supports the significance of feedback in artistic endeavors, with empirical evidence showing a correlation between feedback quantity and art-sharing frequency [27]. Artists actively seek feedback during the ideation phase, to inform decision-making and enhance the quality of artistic output [29]. Additionally, feedback can further trigger self-reflection which according to Ellamil et al. [7] is integral to creativity and extends beyond deliberate analytical processes to include spontaneous and affective evaluations. It has been established that AI tools are effective in offering descriptive feedback [23], stylistic or affective feedback [28,19] and in referencing artistic styles [14] for visual art. This implies their potential to play the role of the feedback provider during the ideation process to trigger self-reflection.

**Hypothesis** AI-imagery tools present promising opportunities for creative exploration, inspiration elicitation, and feedback provision—key elements in the ideation phase of the creative process during Human-AI interaction. We hypothesize that the interaction with AI-imagery tools can enhance the ideation process, demonstrating them as effective co-creative tools for ideation.

## 2 Method

**Participants and procedure** To empirically assess our hypothesis, we conducted an experimental study with professional and amateur digital artists. We chose Midjourney as the AI-imagery system for its versatility and ease of use. We identified four methods that we believe harness AI-imagery's capabilities for ideation: (1) **Text2Img**, generating images from textual descriptions, aimed for creative exploration; (2) **Img2Text2Img**, involving image-to-text conversion followed by text-to-image generation to leverage AI feedback for artistic reflection (Fig. 1); (3) **Style Blending**, blending two different image inputs to inspire new perspectives; and (4) **Img&Text2Img**, combining text and image inputs for a more directed exploration. To further support self-reflection and continuity we asked participants to bring a selection of their previous work images that they could use in the Img2Text2Img and Blend methods. Participants were given a tutorial on Midjourney and were asked to follow the prescribed methods while

experimenting with the AI-tool. Finally, participants completed a questionnaire and participated in an interview for in-depth discussion of their experiences.

**Fig. 1.** Two examples of the Img2Text2Img technique. The middle image is the original digital artwork and the grids on the sides the ones generated by Midjourney. The text interpretations provided by Midjourney where: i) left image grid: "a man with flowers on his finger, in the style of sculptural chaos, hyper-detailed rendering, glass sculptures, light black and crimson, biomorphic forms, mimicking ruined materials", ii) right image grid: "a sculpture of an insect, in the style of dark pink and emerald, photorealistic detail, floral explosions, dark silver and red, intertwining materials, organic formations"

**Evaluation and Analysis** Given the absence of established evaluation instruments specifically designed for ideation and visual media, we developed a questionnaire that considers the identified dimensions of ideation, aiming to collectively address our hypothesis (Appendix). We also conducted a semi-structured interview that used the questionnaire as a conceptual framework in order to allow participants to discuss their experience in a more free format. The interview included emotional responses to Midjourney's feedback, as well as, critiques and suggestions for tool enhancement, thus uncovering a range of perspectives beyond the questionnaire's scope. The analysis involved descriptive statistics, one-sample t-tests and correlation analysis among sections and questions. The qualitative data from the interviews were analyzed to identify patterns and outliers, providing deeper insights into participants' experiences and perspectives. A synthesis of quantitative and qualitative findings aimed to establish connections between the two data strands. We would like to further analyze our choices for the developed questionnaire evaluation method:

**Relevance** We evaluated the alignment between the input provided by participants and the output generated by the AI tool. We formulated seven questions to assess the relevance of images (Q2.1), ideas (Q2.2), textures (Q2.3), forms (Q2.4), color palettes (Q2.5), composition (Q2.6) and similarity in appearance

(Q2.7) between input and output. This assessment was considered crucial to confirm that a shared language and mutual understanding was established between the tool and the user.

**Creativity evaluation with SPECS** As creativity lies as a central element of ideation, we considered important to assess the creative potential identified by participants in the generated images. We adapted the Standardized Procedure for Evaluating Creative Systems (SPECS) to align with the context of our research [13]. We focused on three key aspects that we found the most relevant to the described aspects of ideation, *Originality*, *Value*, and *Variety, Divergence & Experimentation*. We aimed for simplicity and conciseness in our questions and explanations to minimize bias [5].

**Ideation Response: Inspiration and Reflection** We aimed to measure the eliciting of inspiration and reflection, two pivotal components of the cognitive process during ideation. To measure the eliciting of inspiration, we modified a questionnaire proposed by Bottger et al. [2] to align with the artistic context. We condensed the questionnaire while ensuring its suitability within our specific domain of artistic inquiry. For reflection, we devised questions focused on participants' evaluation, analysis, and introspective self-reflection related to their artworks created during the experimental process and the textual and image feedback provided by the AI tool.

**Future adoption with UTAUT** Given that our proposed system serves as a tool, we aimed to investigate its prospective adoption for ideation. We employed the Unified Theory of Acceptance and Use of Technology (UTAUT) proposed by Venkatesh et al. [26], which aims to predict individuals' behaviors regarding technology adoption. From the UTAUT framework, we selected six fundamental determinants to ascertain intention and usage patterns: *Performance Expectancy*, *Effort Expectancy*, *Social Influences*, *Facilitating Conditions*, *Behavioral Intentions*, and *Usage Behavior*. We adjusted the framework to align with the specific context of an AI-powered imagery tool designed to facilitate ideation processes, drawing inspiration from prior empirical applications of UTAUT [1,6].

## 3 Results

Nineteen participants took part in the study. The duration of the experiments ranged from approximately 50 to 90 minutes, influenced by the time participants would spent on completing the provided methods.

**Questionnaire Results** We conducted one-sample t-test analyses on the average scores of the questionnaire sections with 3 as the test value. Results revealed positive deviations for all sections; Relevance, SPECS, Inspiration, Reflection and UTAUT. Table 1 summarizes participants' mean scores across the summarized questionnaire variables, with all results found statistically significant. Raincloud plots for Inspiration, Reflection and UTAUT are visible in Fig. 2 (a)-(c). Despite violations of normality for individual questions, certain items stood out in terms of mean value and standard deviations. For instance, Q3.3

**Table 1.** The average scores and one sample t-test results for participants' responses in the averaged sections of: i) Relevance, ii) SPECS, iii) Ideation Response, iv) UTAUT. The results are averaged from a Likert scale with ranging values between 1 and 5. Significant at alpha of 0.001.

| Section | Variable | Mean | SD | t | p |
|---|---|---|---|---|---|
| Relevance | **Relevance Averaged** | 3.78 | 0.51 | 6.57 | <.001* |
| SPECS | **SPECS Averaged** | 3.93 | 0.73 | 5.58 | <.001* |
| | Originality | 4.04 | 0.66 | - | - |
| | Value | 3.91 | 0.79 | - | - |
| | Variety, Divergence & Experimentation | 3.84 | 0.62 | - | - |
| Ideation Response | **Inspiration** | 4.12 | 0.75 | 6.49 | <.001* |
| | **Reflection** | 3.65 | 0.62 | 4.59 | <.001* |
| UTAUT | **UTAUT Averaged** | 3.79 | 0.56 | 6.15 | <.001* |
| | Performance Expectancy | 3.87 | 0.88 | - | - |
| | Effort Expectancy | 3.79 | 0.65 | - | - |
| | Social Influences | 3.50 | 0.71 | - | - |
| | Facilitating Conditions | 3.90 | 0.77 | - | - |
| | Behavioural Intentions | 3.90 | 0.98 | - | - |
| | Usage Behaviour | 2.92 | 0.82 | - | - |

in the originality subsection of SPECS (Mean = 4.26, SD = 0.56) and Q4.3 in the reflection section (Mean = 4.16, SD = 0.69) demonstrated notable scores. Only *Usage Behavior*, a sub-category of UTAUT, stood out with a mean score of 2.92, indicating a neutral inclination among participants for regular use. All other variables exhibited mean scores ranging from 3.5 to 4.12.

Spearman's correlation analysis was conducted to examine relationships among questionnaire scales. Notable statistically significant correlations were found between SPECS and Reflection (0.689), Inspiration (0.829), and UTAUT (0.851). The scatter plot for the highest correlation, between SPECS and UTAUT, can be seen in Fig. 2 (d). All reported correlations underwent normality validation via the Shapiro-Wilk test for multivariate normality.

**Interview Findings** Participants generally expressed positive sentiments about their engagement with the AI tool, including enjoyment, surprise, and inspiration. Some participants also noted a sense of calmness due to the open-ended nature of the task. However, some reported diminishing surprise over time, attributing it to repetitive outputs or their own interaction approach. Negative emotions included fear of sharing personal work with the AI and disappointment when the AI failed to align with expectations. Disappointment was more pronounced when there was a perceived disconnect between the AI's comprehension and the creator's vision of their works.

> "At first I saw this really interesting idea of making my work into a sunglasses campaign and was excited! I was flattered. But the images

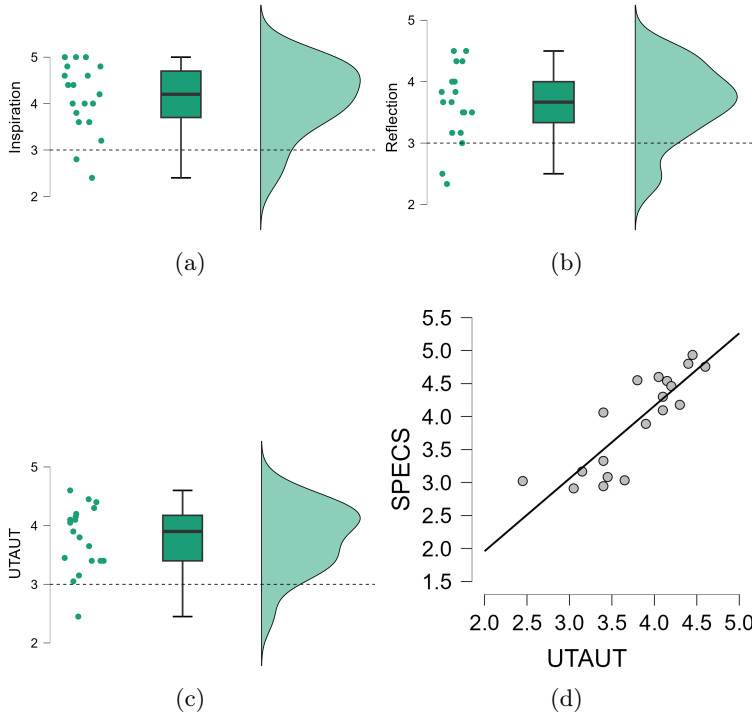


**Fig. 2.** (a),(b),(c) Raincloud plots for the averaged variables of Inspiration, Reflection and UTAUT. The dotted lines indicate the test value of the one sample t-test which corresponds to the "Neither agree nor disagree" response in the Likert scale. We can see the overall positive inclination of participants in all variables, (d) Scatter plots between SPECS and UTAUT that had a significant positive correlation of 0.851.

> afterwards were boring. I was disappointed and felt almost insulted, like the software is not getting my work."

> "It annoyed me that when blending, it chose the non-interesting aspects of both images. Not the ones that I would have chosen."

Participants expressed a positive disposition towards utilizing AI-imagery tools for ideation, with a willingness to incorporate them into their creative workflows. While some participants preferred using these tools at later stages of the creative process, such as prototyping or preparing pitching materials, others saw potential in utilizing AI for sketching their ideas or making a moodboard. Concerns regarding control over the tool's functions and outcomes were raised, along with the potential habituation to AI tools at the expense of traditional methods. Participants also appreciated any errors or inaccuracies produced by AI, considering them as valuable surprising elements for ideation. Some expressed a desire for less refined outputs to allow for more experimentation and manipulation.

"I noticed that sometimes it makes mistakes. I asked to generate a bird with a human face, but it generated a human with a bird head. I found this interesting. It wasn't what I expected but I think in the end I like it better. If it would only give what I want, I wouldn't find it so interesting."

"Results were too polished, without leaving room to experiment. Those were the least inspiring images, immediately looking too commercial."

## 4 Discussion

In this paper we identified some key concepts that are believed to play a pivotal role in the ideation process [24,27,16,29]. Our questionnaire findings reveal a statistically significant positive disposition of participants in all those concepts of creativity (SPECS), inspiration and reflection. Overall, these findings support the main hypothesis of the research, indicating that AI imagery tools can successfully contribute to the ideation stage of the creative process. Hence, they highlight a promising avenue for further exploration in this area.

UTAUT was also employed to comprehensively evaluate AI-imagery as a tool for ideation. Participants scored 3.90 in Behavioural Intentions, indicating a likelihood of using and recommending the tool in the future for ideation purposes. They gave the same high score in Facilitating Conditions, reinforcing the notion that AI-imagery is perceived as an accessible technology. However, participants expressed a neutral response of 2.92 regarding Usage Behaviour. These results suggest that while AI-imagery technologies are accessible and effective in facilitating ideation tasks, they are far from ready to become an artist's primary tool for ideation. We believe this is a logical finding because: i) we used a general-purpose AI tool that is not tailored to specifically support ideation, ii) AI-imagery techniques are based on stochastic processes that lack valuable aspects that a collaborative agent could have to support co-creation. Their persona, as described by Moruzzi et al. [20] cannot support a provoking style of contribution or engage the user by making suggestions and taking initiatives.

With those reasons in mind, we advise future studies to focus on developing customized interfaces and interactions that specifically facilitate the needs of ideation. For example, to resolve the trade-off between the conflicting need for surprise and control expressed by the participants, the tool could include a temperature slider that would allow for granting autonomy to experience surprise only when deemed useful. Additionally, qualitative insights revealed that negative emotions were attributed to the perceived inability of the system to interpret the images from the participants' artistic perspective, impacting their perceived ideation potential. This matter of creative interpretation that relates to the stochastic nature of AI-imagery technologies necessitates a shift toward a more process-oriented approach, as opposed to a solely final product-oriented one [21]. To enable AI-tools to effectively comprehend the perspective of an artist, they may need to be endowed with memory functionalities and engage in extended co-creation periods with the artist. Another approach could be the incorporation of Reinforcement Learning from Human Feedback (RLHF) techniques, as

proposed by Casper et al. [3]. The essence of this proposition lies in leveraging RLHF techniques to refine and adapt the underlying machine learning models, allowing them to better align with the inherently abstract and elusive nature of artistic interpretation. Finally, neurosymbolic modeling techniques could be employed to merge the stochastic nature of AI-imagery technologies with logical frameworks [22]. This approach could enable the integration of beneficial behaviors in co-creation, such as playfulness [17].

The methodological approach of this study involved the incorporation of both SPECS and UTAUT within the context of a survey targeting end-users rather than computational system creators and experts. This methodological deviation provided new insights that extend beyond the immediate empirical results. Specifically, our findings indicate the efficacy of SPECS as a potential predictor of positive user responses when engaged with the UTAUT questionnaire. The significant correlation found between the two models, with a coefficient of 0.85, implies that when users express high levels of positive evaluation regarding the creative outputs derived from their interaction with a computational system, this concurrently elevates the likelihood of their acceptance of the system and their intention to employ it in the future. This evidence hints at the potential for operationalizing the forecast of acceptance and future system adoption through the evaluation of computational creativity, particularly through the application of the SPECS scale. While promising, it is important to underscore that this insight necessitates further investigation to validate its robustness and explain its broader implications within the domain of computational creativity research.

## 5 Conclusion

We believe that there are two key-findings to take from this study, while noting the limitation of a modest pool of participants. The first finding, which is empirical and directly relates to our hypothesis, is the positive reception of AI-imagery tools for ideation purposes during Human-AI interaction. Both quantitative and qualitative results indicate participants' favorable attitudes towards the creativity, inspiration, and potential future adoption of these tools. We therefore believe that AI-imagery tools for ideation is a promising field for further research. Future studies could focus on making tailored interfaces to the ideation task and develop evaluation scales that specifically target co-creativity and ideation. The second finding is methodological and relates to our choice to integrate both SPECS and UTAUT in our evaluation. The high statistically significant correlation found between them provides valuable insights into the predictive power of computational creativity evaluation for user acceptance of co-creative tools. Further research would be needed to verify this insight with more participants and examine its validity in other domains as well. This study raises understanding on the potential of AI-imagery tools in facilitating ideation in the creative process and to open, and contribute, to conversations in the evaluation of co-creative tools. We show the value of integrating both SPECS and UTAUT in the evaluation of the creative process during Human-AI interaction.

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# A Appendix: Questionnaire

**1. Introduction**

Q1.1 What is your age? (<18,18–30,31–45,46–60,60+)
Q1.2 How many years have you worked with a 3D software? (0–2,3–4,5–6,7–8,8+)
Q1.3 How often do you work with 3D related content (Rarely, Once a month, Once a week, Multiple times per week, Multiple times per day)
Q1.4 How often do you use 3D software for your professional occupation? (Rarely, Once a month, Once a week, Multiple times per week, Multiple times per day)
Q1.5 How would you rate your experience with AI-imagery tools? (I have never used them, I used them once or twice, I used them once in a while, I use them quite often, I use them on a daily basis)

*To what extent do you agree with the following statements related to your interaction with Midjourney during this experiment? (Strongly Disagree, Somewhat Disagree, Neither agree not disagree, Somewhat Agree, Strongly Agree):*

**2. Relevance**

Q2.1 Interacting with Midjourney produced relevant images to my prompt images.

Q2.2 Interacting with Midjourney produced relevant ideas to my prompt images.
Q2.3 Interacting with Midjourney produced images with textures relevant to my prompt images.
Q2.4 Interacting with Midjourney produced images with forms relevant to my prompt images.
Q2.5 Interacting with Midjourney produced images with colour palettes relevant to my prompt images.
Q2.6 Interacting with Midjourney produced images with compositions relevant to my prompt images.
Q2.7 Interacting with Midjourney produced similar-looking images to my prompt images.

**3. Creativity Evaluation**

Q3.1 Interacting with Midjourney prompted novel ideas.
Q3.2 Interacting with Midjourney produced novel images.
Q3.3 Interacting with Midjourney produced surprising images.
Q3.4 Interacting with Midjourney produced novel transformations of my prompt images.
Q3.5 Interacting with Midjourney produced images that demonstrated sufficient depth to be interpreted at different levels or in different ways.
Q3.6 Interacting with Midjourney produced high-quality images.
Q3.7 Interacting with Midjourney produced aesthetically pleasing images.
Q3.8 Interacting with Midjourney produced useful images.
Q3.9 My experience of working with Midjourney added value for my work.
Q3.10 Interacting with Midjourney produced inventive images.
Q3.11 Interacting with Midjourney produced surprising transformations of my prompt images.
Q3.12 Interacting with Midjourney produced diverse transformations of my prompt images.

**4. Inspiration and Reflection**

Q4.1 This experience made me reflect on my work.
Q4.2 This experience provided me with new insights related to my existing work.
Q4.3 This experience provided me with new possibilities for future work.
Q4.4 This experience helped me to analyse my work better.
Q4.5 This experience helped me to evaluate my work better.
Q4.6 This experience helped me make new connections between my work and other people's work.
Q4.7 My imagination was stimulated.
Q4.8 My horizon was broadened.
Q4.9 I unexpectedly and spontaneously got new ideas.
Q4.10 I felt an urge to create new art / designs.
Q4.11 I felt inspired.
Q4.12 How often did this happen? (Not often at all, Somewhat often, Quite often, All the time)
Q4.13 How deeply or strongly did this happen? (Not strongly at all, Somewhat strongly, Quite strongly, Very strongly)

**5. Adapted UTAUT** *For the following questions, imagine that an AI-imagery tool would be integrated into your favourite 3D software and that you could use it during your casual workflow. With that scenario in mind, please state to what extent you agree with the following statements. (Strongly Disagree, Somewhat Disagree, Neither agree not disagree, Somewhat Agree, Strongly Agree)*

***Performance Expectancy***

Q5.1 I would find AI-imagery tools useful in the ideation stage of my work. Using AI-imagery tools would enable me to accomplish my ideation activities more quickly.
Q5.2 Using AI-imagery tools would increase my productivity in the ideation stage. If I would use AI-imagery tools, I would increase my chances of performing better at my ideation activities.

***Effort Expectancy***

Q5.3 I expect that learning to use AI-imagery tools would be easy for me.
Q5.4 I expect that I would find it easy to get AI-imagery tools to do what I want it to do.

***Social Influences***

Q5.5 If people that are important to me would use AI-imagery tools, it would influence me to use them as well.
Q5.6 If people who influence my behaviour were thinking positively of AI-imagery tools, it would persuade me to use them.

***Facilitating Conditions***

Q5.7 I feel I have the resources necessary to use AI-imagery tools.
Q5.8 I feel I have the knowledge necessary to use AI-imagery tools.

***Behavioural Intentions***

Q5.9 I predict that I would use AI-imagery tools in the future for ideation.
Q5.10 I would recommend AI-imagery tools to my colleagues/friends for ideation.

***Usage Behaviour***

Q5.11 I would consider myself a regular user of AI-imagery tools for ideation.
Q5.12 I would do most ideation tasks by using AI-imagery tools.