Exploring the potential of AI Imagery Tools as Catalysts for Ideation

Sotirios Piliouras[1], Rob Saunders[1] and Anna Jordanous[2]

[1] Media Technology, Leiden University, Rapenburg 70, 2311 EZ, Leiden, The Netherlands
[2] University of Kent, Giles Ln, Canterbury CT2 7NZ, United Kingdom

Abstract. AI imagery has experienced significant advancements in both technological innovation and research endeavors in recent years. AI-powered imagery tools have exhibited an impressive capability in generating artificial digital images characterized by realism and aesthetic appeal. This study explores the potential of AI-imagery tools in enhancing the creative ideation processes of digital and 3D creatives. To empirically investigate this proposition, we conducted an experimental study involving individuals with expertise in creative domains. Our evaluation encompassed a comprehensive array of measurements including: i) Creativity evaluation, employing the Standardised Procedure for Evaluating Creative Systems (SPECS) ii) Inspiration Eliciting, iii) Self-reflection, iv) Future adoption, guided by the Unified Theory of Acceptance and Use of Technology (UTAUT). The results of our study indicated a prevalent disposition among participants towards the proposed methodologies and the incorporation of AI-imagery tools in their creative workflow. The significance of producing highly creative outcomes, as perceived by the participants, to facilitate and enhance the ideation process has been underscored. The study also highlights the desire for alignment of AI-tools with user input and a balance between surprise and control. Additionally, the research emphasizes the importance of adaptable AI-imagery tools that seamlessly integrate with traditional ideation methods while preserving artistic agency. In summary, the evidence presented in this study substantiates the positive reception of AI-imagery tools by creative professionals and underscores their potential for enhancing creativity and inspiration in the creative domain.

Keywords: AI · Computational Creativity · AI-imagery · Ideation · 3D Design

1 Research Background

1.1 AI imagery in the digital and 3D making process

1.1.1 AI imagery tools

In recent years, the domain of artificial intelligence (AI) image generation has witnessed significant developments in research activity and the development of

AI-driven imagery tools. The utilization of deep learning methodologies for the purpose of image generation, particularly when guided by textual descriptions, has undergone significant progress and innovation through the research of various techniques and technologies suchs as the Generative Adversarial Networks (GANs) [9], score-based generative models [35], the autoregressive language model GPT-3 [7] and style-based GANs (StyleGANs) [23]. While the principles of generating images through AI techniques have been subjects of study for several years [5], a transformative surge in both research endeavors and practical applications has materialized during the past 2 years. This newfound momentum has led to the emergence of several prominent AI-powered image models and tools such as DALL·E [3], Stable Diffusion [33] and Midjourney [28]. The impact of those tools resonates not only within the realms of computer science but also across diverse fields, from artistic endeavors to commercial applications, as they are becoming available to the broader public. This revolution underscores the rapid advancements and profound implications of AI imagery tools in contemporary society.

1.1.2 Advantages compared to other tools

AI imagery tools offer various advantages in contrast to traditional visual systems and generators. Foremost among these advantages is their capability to swiftly and flexibly produce artistic works, catering to artistic demands with higher speed and efficiency compared to other more conventional or traditional methods. In addition, AI imagery tools can provide benefits for the stimulation of creative exploration, opening new origins of artistic possibilities. There is empirical evidence supporting that AI-generated visual art has the potential to enhance creative performance by stimulating idea generation [18]. Moreover, AI tools leverage the intrinsic attributes of their underlying technology to provide artists with access to an expansive and diverse repository of artistic styles. This knowledge empowers artists to experiment across a broad spectrum of aesthetics and genres, offering a wide range of creative possibilities. A frequently debated attribute of AI tools is their evolving capacity to offer heightened levels of customization and "art-directability". While this feature was initially subject to limitations, recent iterations of AI tools (such as Midjourney [28] and Firefly [2]) have demonstrated significant advancements. Finally, an often recognized advantage of AI imagery tools is their high accessibility as they are easy to use, have a dynamic online community and can be utilized by individuals who may not have formal artistic training. In summary, AI imagery tools encompass a spectrum of strengths, notably including the facilitation of **creative exploration**, **time-efficiency**, **stylistic diversity**, **accessibility** and the rather emerging **customization**. Those strengths underscore the potency of contemporary AI techniques in redefining the creative process and fostering innovation in the generation of visual content. Moreover, they offer opportunities to research the transformative potential of AI in reinforcing human creativity and pushing the boundaries of what is achievable in the domain of digital arts.

1.1.3 Interpretation and Context

In addition to the myriad ethical concerns that pervade the landscape of AI, encompassing issues ranging from copyright infringement to identity theft and data manipulation [4], there exists a prominent discourse with regards to the evaluation and interpretation of AI-generated artworks [32]. This discourse, which has gained attention within both academic research and the media, addresses the intricate challenge of assessing and comprehending artistic visual creations generated through AI. Empirical research findings have indicated that individuals encounter significant difficulty when attempting to accurately discern artworks produced by AI. It was observed that individuals tend to attribute representational artworks to human creators while associating abstract artworks with machine-generated origins [15]. This observation underscores the complexities inherent in human perception and the difficulties of assigning authorship to a standalone piece of art. Furthermore, it is argued that current evaluation methods that are based on a product-centered view of creativity are not enough to fully assess the creativity of art synthesized with text-to-image generation systems. Instead, creativity interpretations should encompass a holistic consideration of the contextual elements that comprise the creator's process and the creative environment in which it unfolds [30]. This perspective recognizes that the essence of creativity within the domain of AI-generated art extends beyond the mere contemplation of final artistic outputs. It encompasses the dynamic interactions, choices, and contextual factors that shape the creative journey, thereby offering a more comprehensive and nuanced understanding of the creative process as facilitated by AI-driven technologies.

1.1.4 AI imagery in the 3D making process

The 3D content creation pipeline comprises a multitude of distinct stages which may vary depending on the nature and scope of a project. A representative enumeration of these discrete stages includes: i) **Concept development**: the inception and conceptualization of the 3D project. ii) **Modeling**: Creating the three-dimensional geometrical structures that constitute objects, characters, and environments within the digital space. iii) **Texturing**: Application of surface properties, such as colors, patterns, and materials, to the 3D models to enhance their visual realism and aesthetics. iv) **Rigging**: The establishment of skeletal frameworks and control systems within 3D models to enable animation and articulation, particularly for characters and creatures. v) **Animation**: The creation of dynamic and motion-driven sequences by manipulating 3D objects or characters over time. vi) **Lighting and Composition**: The orchestration of lighting sources, as well as the arrangement and framing of scenes to achieve desired visual effects and storytelling. vii) **Rendering**: The generation of 2D images or frames from the 3D scene, taking into account lighting, materials, and camera perspectives. viii) **Post-production**: The final stage involving editing,

compositing, special effects, and refinement of the rendered frames to produce the finished 3D content.

The emergence of AI-imagery has introduced a noteworthy interaction with 3D graphics, accompanied by a certain friction between these two distinct mediums. For years, 3D has stood as the only digital medium capable of crafting remarkably realistic depictions of imaginative scenarios, often earning its comparisons to photography and film-making. However, this has changed with the emergence of advanced AI-imagery models, introducing the era of hyper-realistic image generation that can be virtually indistinguishable from both conventional photography and 3D imagery. In this occasion, we believe that it is important to adopt a perspective that refrains from regarding AI-imagery as a disruptive force or a direct substitute of the more traditional 3D methods. Instead, we consider fruitful to explore the synergistic potential that can arise from the combination of these two creative domains. In the context of using AI in the 3D creation pipeline, we believe that the most promising applications are related to specific stages:

- **Concept development**: AI-generated images can be used as inspiration for creating initial concept sketches or designs for the 3D model or scene. A relevant app is Phygital+ that concentrates different AI tools for image and video generation in a moodboard-looking workspace [19]. We did not find AI applications or research that is directly occupied with this stage in the 3D making process.
- **Texturing**: AI can accelerate and enhance texture creation by automating the generation of realistic materials, patterns, or even assisting in the texturing process based on provided references. An example of such a tool is Poly where users can instantly generate materials and textures from text prompt [31].
- **Lighting**: AI can generate HDRI image maps or perform image analyis to analyze reference images and suggest lighting setups for the 3D scenes. Canvas is NVIDIA's application for HDRI map generation based on user-provided brushtroke landscapes [29].
- **Rendering**: AI-powered denoising tools can be used to remove noise and other artifacts from the rendered output, resulting in a cleaner and more polished final image.
- **Post-production**: AI-powered super-resolution upscaling tools can be used to increase the resolution of the final output, and AI-powered object removal tools can be used to remove unwanted objects or artifacts from an image or animation [5].

It is important to acknowledge that the integration of AI within the 3D content creation pipeline extends beyond the previously delineated stages, encompassing a more extensive array of potential applications. One area of relevance is the modeling stage, particularly in the domain of text-to-3D model generation. While it is essential to recognize the extend of AI's involvement in various aspects of the 3D content creation process, the focus of this paper is specifically

on AI-imagery tools. Finally, from the aforementioned stages we are further going to focus on the concept development and more specifically on the ideation process, in the following section.

1.2 AI imagery and Ideation

1.2.1 Ideation in the creative process

Ideation, in the context of the creative process, refers to the ability to formulate novel and surprising ideas for the creative act [20]. It is a crucial stage where individuals or teams brainstorm, explore, and conceptualize concepts or solutions to a problem. The concept of ideation is most frequently associated with the practice of divergent thinking. [14]. Divergent thinking represents a cognitive aptitude characterized by the ability to produce a wide array of diverse ideas when confronted with an open-ended question or problem [17]. Divergent thinking is regarded as a reliable marker of creative aptitude, everyday imaginative expression, and plays an essential role in the creative process [14].

1.2.2 The generator/AI and the evaluator/artist

The process of ideation has been found to be related to several factors that are also associated with creativity, including the process of evaluation. Ellamil et al. studied the creativity as a twofold process that is characterized by a generative component facilitating the production of novel ideas and an evaluative component enabling the assessment of their usefulness [13]. Their findings indicated that while the generation of novel ideas was mostly related to the medial temporal lobe, creative evaluation extended beyond deliberate analytical processes to include more spontaneous and affective evaluative processes. In the study by Serafin et al. on dynamic evaluation during the ideation process, artists assessed the quality of drawings at various stages of the art creation process. It was found that artists could quickly gauge the quality of emerging art, possibly because they had a general idea or sense of the overall structure in mind. [34]. This higlights the importance that evaluation can have during the ideation process and the artists' ability to competently evaluate the creative value of an image. Furthermore, it can be seen as an an ability to effectively decide if an image has useful elements during the ideation process. This could be associated with the commonly recognized ability of AI-imagery to effortlessly produce multiple and diverse image results. In other words, AI's presumed ability as a tireless divergent thinker could be paired with the human artists' ability for evaluation to guide the generative process to their inspirational benefit.

1.2.3 Inspiration

Event though it is diversely used in psychology, the study of inspiration has been limited in its development due to several factors including unclear

definitions and inconsistencies and a lack of foundational research to validate key constructs [38]. Inspiration is believed to drive the realization of creative ideas. Thrash et al. concluded that inspiration can be described by three core characteristics that define it and distinguish it from other states: i) ***epistemic transcendence***: gaining awareness of new or better possibilities) ii) ***evocation***: becoming inspired by something in particular and not attributing responsibility to oneself for becoming inspired iii) ***approach motivation***: feeling compelled to bring a new idea or vision into fruition [37]. Previous research suggests that inspiration can be used to anticipate the level of creativity in the final product. In other words, the expectation is that inspiration plays a mediating role in influencing the impact of creative ideation and insight on the eventual creative output [38]. Inspiration eliciting scales are not frequently addressed in literature; however, there are empirically researched findings on the measurement of inspiration that exhibit positive outcomes in terms of both experimental and predictive validity [6].

The process of stimulating inspiration during ideation has been a subject of research within the framework of sketching for fostering design creativity [24,10]. Kim et al. evaluated a co-creative design system that provided inspirational images based on conceptual similarity during sketching for a design task. Their study revealed that the AI model had a notable impact on enhancing the novelty, variety and quantity of ideas generated throughout the ideation process [24]. Further studies have explored the use of AI interventions or AI co-creative partners to raise inspiration in the context of creative tasks with positive results [16,39,26]. Even though we did not find a specific study regarding AI-powered imagery tools for enhancing inspiration for digital creatives, the overall success of AI systems in various relevant domains is highly promising in their potential role to stimulate and support inspiration in the general context of creativity.

1.2.4 Feedback from the "fellow creative"

Numerous AI-driven image generation systems have evolved beyond mere generation capabilities, exhibiting the additional functions of image description and feedback provision. Prior research has delved into the use of AI tools to provide detailed descriptions and referencing artistic styles for a wide spectrum of visual art pieces, encompassing photographs, images, and paintings [36,22]. Remarkably, contemporary AI-powered imagery tools, exemplified by Midjourney, employ methodologies to offer both descriptive and stylistic feedback to creators. Furthermore, even though most easily accessible AI-tools lack features that support more depth in their description, ongoing research underscores the potential of AI systems to transcend mere descriptiveness, thereby facilitating the articulation of affective feedback and sentiment-based evaluations [42,27].

The significance of feedback within the realm of artistic endeavors has been a subject of research in the past. This research has underscored the impact that feedback exerts on artists' proclivity to disseminate their artistic creations, with empirical evidence indicating a direct correlation between the quantity of feed-

back received and the frequency of art-sharing activities [41]. Notably, Krishna et al. have indicated that artists tend to actively seek more feedback during the initial phases of their creative journey, particularly when they are in the process of exploring and evaluating various artistic alternatives [25]. Simultaneously, it has been posited that creators who choose to share their works-in-progress exhibit distinct patterns of engagement when contrasted with those who unveil completed works. Specifically, individuals who opt to share incomplete artistic expressions tend to demonstrate lower levels of both behavioral and emotional engagement, while they display a heightened degree of cognitive engagement [43]. This divergence in engagement dynamics accentuates the ideation stage of the creative process as a particularly opportune stage to solicit feedback. Doing so at this critical juncture could pave the way for constructive brainstorming and facilitate informed decision-making, thereby enhancing the overall quality and refinement of the artistic output.

Feedback plays a pivotal role within the creative process, serving as a fundamental and highly sought-after component, that could be proven effective during the ideation phase. At the same time, the capability of AI to provide comprehensive, tripartite impressions — comprising **descriptive**, **stylistic** and **affective** feedback — of an image highlight its potential to effectively provide art material interpretations. This multifaceted approach allows one to envision AI as a companion on the creative journey, akin to a "fellow creative collaborator" endowed with the capacity to provide an interpretative perspective on ones artwork.

1.3 Problem Statement

We have seen that AI-imagery tools exhibit several advantages when compared to other more conventional image making methods. Additionally, they present a certain friction with the field of digital and 3D making that could potentially be used, along with its other advantages, to form a collaborative relation in the creative process. At the same time, there appears to be an existing research gap in the use of AI-generated imagery to enhance the ideation process of digital and 3D creatives. Most pertinent studies predominantly center on AI imagery as a practical tool for achieving creative outcomes. However, our specific interest lies in exploring its capacity as a creativity support tool for nurturing creativity during the pre-production phase. Consequently, we aim to direct our inquiry away from the assessment of the final products generated by AI image generators and, instead, delve into the influence these images may have on the creative and imaginative faculties of artists. This gives rise to our central research question:

Can AI imagery tools contribute to the ideation stage in the creative process of digital and 3D creatives?

In pursuit of addressing this fundamental inquiry, our research aims to undertake a comprehensive exploration of the multifaceted roles that AI-imagery tools could play in the creative process. This entails an investigation into the various dimensions of AI's capabilities, encompassing its role as a catalyst for divergent

thinking, inspiration and its ability to provide useful feedback. Our primary objective is to unravel how these diverse capabilities of AI can be practically integrated into the creative process, particularly when collaborating with digital and 3D creatives for ideation tasks. This empirical inquiry seeks to investigate the practical dynamics and real-world applications of AI-imagery tools as they interplay with the cognitive processes and creative endeavors of human artists. Through a systematic examination of these interactions, we aspire to advance our understanding of AI's role in enhancing creativity, ideation, and artistic expression.

2 Method

To empirically assess our hypothesis, we executed an experimental study involving human participants. The preparation and execution of this experiment involved a structured series of methodological steps:

- **AI-Imagery Software Research**: This involved a review of the current landscape of AI-imagery software, examining their capabilities and functionalities. This investigation served as a foundation for our research.
- **Methodological Framework Development**: We proceeded to delineate a methodological framework tailored to the specifics of our research inquiry. This encompassed the careful selection of AI-imagery methodologies aligned with our research objectives.
- **Participant Guidance Materials**: This included the creation of tutorial materials, outlining the steps and procedures that participants were required to follow. In the context of this briefing process, it was important to ensure the provision of an intuitive and informative introduction of the AI-powered imagery tools to the participants [11]. The primary objective was the mitigation of cognitive biases, aiming for a high level of impartiality in their subsequent engagements with these tools.
- **Instrumentation Preparation**: After researching the existing scales related to our research question we crafted a questionnaire comprising of modified or newly made sections and the interview materials.

2.1 AI-imagery techniques for ideation

In preparation for our experiment, we conducted comprehensive research into AI-imagery tools, aiming to explore various ideas and techniques applicable to the ideation process of 3D creatives. Initially, we explored the scope of available tools at the time, including Stable Diffusion [33], DALL-E 2 [3], Midjourney [28], and Firefly [2], to ascertain the diverse capabilities offered by these software options. After careful consideration, we opted to utilize Midjourney for our experiment. This choice was made due to its optimal balance of versatility in techniques, ease of learning, and accessibility during the experimental phase. Our experimentation with Midjourney encompassed a thorough exploration of

its command functionalities and the possibilities it offered for using both personal and external images as input. For the experiment, we concluded to four distinct techniques that we believe resonate the most with the ideation process as found in literature, each of which we labeled as follows:

- **Text2Img**: The generation of image outputs from textual descriptions as input. This is the most commonly found technique in AI-imagery tools, allowing to make use of their generation variety and diversity capabilities. The Midjourney command used is "imagine".
- **Img2Text2Img**: This technique involves two stages: i) the generation of textual descriptions from an image input (Img2Text) ii) the use of Text2Img with the textual descriptions gotten in the previous step. This way, the AI-imagery tool gives a textual interpretation of an image, that comprises of a descriptive and stylistic part, which is then re-used as textual input to generate a new image. This is the technique where we want to make use of AI's feedback capabilities for reflection on the artist's work and art-making process. Unfortunately, as of now Midjourney does not systematically include affective interpretations in its feedback. The Midjourney commands used are "describe" and "imagine". An example of this technique can be seen in Figure 1.
- **Style Blending**: The generation of image outputs from two different image inputs. The result is a blend of the input images. This technique could be seen as a mix of combinatorial and divergent creativity processes, that could provide new inspiring perspectives to artists related to their own or other artists' work. The Midjourney command used is "blend".
- **Img&Text2Img**: The generation of image outputs from textual and image inputs. This technique has similar ideation benefits with the style blending technique, with the difference that due to the textual input it potentially allows more control and creative direction over the generated image. The Midjourney commands used is "imagine" with combined text and image input.

In the course of our research, we also engaged in exploratory investigations involving image alterations. These alterations encompassed techniques such as grayscale conversion, the application of visual noise, and selective cropping of images to isolate specific elements. Our experimentation indicated that these image alterations introduced meaningful changes to the outputs, rendering them as potentially valuable techniques. In the design of our experiment, we opted to provide participants with a brief mention of these image alteration techniques. However, we refrained from mandating their incorporation into the experimental process. This choice was made to prevent the introduction of undue complexity or the diversion of focus from the core techniques mentioned earlier.

2.2 Participants and procedure

To empirically investigate our hypothesis and evaluate the efficacy of the proposed techniques, we conducted an experimental study involving both profes-

Fig. 1. The Img2Text2Im technique. The middle image is the original 3D artwork and images on the side the ones generated by Midjourney. The text interpretations provided by Midjourney where: i) for the images on the left: "a man with flowers on his finger, in the style of sculptural chaos, realistic hyper-detailed rendering, glass sculptures, light black and crimson, colorful biomorphic forms, mimicking ruined materials, aries moross –ar 45:56", ii) for the images on the right: "a sculpture of an insect, in the style of dark pink and dark emerald, fantastical contraptions, photorealistic detail, floral explosions, dark silver and red, intertwining materials, organic formations –ar 45:56"

sional and amateur digital and 3D creatives. Participants were selected utilizing a convenience sampling approach, characterized by the inclusion criterion of possessing prior expertise in the domain of 3D graphics creation and visual content generation. No additional specific inclusion criteria were imposed. Our targeted sample size for this study was approximately 20 participants, reflective of our endeavor to achieve a balance between statistical significance and the pragmatic constraints inherent to our research design.

Before commencing the experiment, participants were instructed to bring a selection of images representing their prior work, encompassing completed and in-progress projects (ranging from 5 to 10 images per participant). Subsequently, participants were granted access to a Midjourney account, either through their personal computers or computing resources provided by the research team. They were then subjected to a tutorial session introducing the basics of Midjourney and the list of proposed techniques for ideation. Participants were encouraged to freely experiment with the AI imagery tool, employing the prescribed methodologies as well as engaging in self-initiated interactions utilizing the proposed techniques. Upon concluding their interactions with Midjourney, participants were directed to complete a structured questionnaire, which served as an instrument for the systematic collection of data. Subsequently, a follow-up interview was conducted with each participant, giving the opportunity for in-depth exploration and discussion of their experiences. The duration of the experiment exhibited variance depending on the time each participant dedicated to their interaction with the system. The overall time investment for participants ranged

from 40 minutes to 1 hour and 20 minutes, accommodating the individual preferences and exploration during the experiment.

2.3 Evaluation

The evaluation of the participants' interaction with the AI tools comprised of a questionnaire and a semi-structured interview. The questionnaire was revolved around four key dimensions: i) the perceived alignment between the inputs provided and the outputs generated by the system ii) the computational creativity qualities of the images produced during the experiential process iii) the stimulation of reflection and inspiration responses iv) the participants' inclinations towards adopting such AI-powered tools into their future activities. The full questionnaire can be seen in Appendix A. The interview had a more flexible structure and content, yet it revolved around the same core themes as the questionnaire.

2.3.1 Relevance

Our initial objective was to evaluate the extent to which the input provided by participants was found to align with the output generated by the AI. The tool not only generates content but also interprets and incorporates textual and visual input that is provided to it. Therefore, we consider this assessment crucial as it fosters a sense of acknowledgment and consistent utilization of their previous contributions within the context of the AI imagery tool. Consequently, establishing a shared language and mutual understanding between the tool and the user is of paramount importance. In this section, we have formulated seven questions to measure the relevance of: i) Images, ii) Ideas, iii) Textures, iv) Forms, v) Composition, vi) Color palettes, vii) Similarity in appearance. These questions aim to assess the participants' feeling of alignment and aknowledgment of the AI's responses in relation to the specific aspects mentioned above.

2.3.2 Creativity evaluation and SPECS

Subsequently, our objective was to assess the creative potential identified by participants in the images generated through their interaction with the AI tool. This step held significant importance in understanding the extent to which participants valued the creative outcomes of their engagement and, indirectly, the creative influence exerted by this interaction. To achieve this, we adapted the Standardized Procedure for Evaluating Creative Systems (SPECS) to align with the specific context of our research [21]. SPECS offers a structured framework for evaluating the fundamental elements of creativity, as empirically derived from discussions on human and computational creativity. From these foundational components, we chose to emphasize three key aspects that resonated most strongly with the qualities of the AI tool and techniques we employed, as well as with the ideation process: i) Originality, ii) Value, and iii) Variety, Divergence, and Experimentation. In terms of adapting the evaluation scale, we aimed for simplicity and conciseness in our questions. One crucial consideration was how to

refer to the AI tool itself. While various terms such as "AI system" or "AI tool" could have been employed, we opted to directly employ the term "Midjourney" to minimize the introduction of any potential bias [11].

2.3.3 Ideation Response: Inspiration and Reflection

The subsequent phase aimed to quantify the influence on participants' ideation processes in a more immediate manner and measure their response to their experience with the AI tool. As deduced from our review of relevant literature, two pivotal components associated to this cognitive process are the elicitation of inspiration and reflection. To measure the stimulation of inspiration, we modified an empirically validated questionnaire originally proposed by Bottger et al. to align more appropriately with the artistic context underpinning our research [6]. This adaptation involved condensing the questionnaire while ensuring its suitability within our specific domain of artistic inquiry. Regarding the reflection aspect, we devised a set of questions focused on the evaluation, analysis and reflection processes of the participants related to their artworks created both before and during the experimental process. These questions were produced to assess the extent to which participants responded to the feedback, comprising both images and textual input, provided by the AI tool and to measure the degree to which participants engaged in introspective self-reflection as a consequence of this feedback.

2.3.4 Future adoption and UTAUT

The final section of the questionnaire focused on measuring the participants' inclination for embracing and adopting the AI-tool for ideation activities in the future. For this purpose we used the Unified Theory of Acceptance and Use of Technology (UTAUT) [40]. UTAUT seeks to understand and predict individuals' intentions and behaviors when it comes to adopting and using technology. It integrates various elements from different technology acceptance models to provide a unified and holistic perspective on the factors that influence technology adoption. In our empirical study, we leveraged six fundamental determinants derived from the UTAUT framework to ascertain intention and usage patterns. These determinants were: Performance Expectancy, Effort Expectancy, Social Influences, Facilitating Conditions, Behavioral Intentions, and Usage Behavior. Drawing inspiration from prior applications of UTAUT in empirical investigations, we adjusted the framework to align with the specific context of an AI-powered imagery tool designed to facilitate ideation processes [1,12].

2.3.5 Semi-structured Interview

For the interview phase, a specific set of predefined questions and structure was deliberately avoided. Instead, the conducting researcher adhered to the measurement scales outlined earlier for the questionnaire as a conceptual framework. Concurrently, the researcher observed participants' interactions with the AI tool and took into account their responses from the questionnaire. Within

this flexible interview framework, the researcher selected questions and areas of inquiry, often based on participants' notable responses, whether exceptionally high or low, on specific questionnaire items. In such instances, participants were encouraged to expound upon their responses, providing deeper insights into their experiences. Furthermore, participants were prompted to provide additional information regarding their emotional states during their interactions with the AI tool. This encompassed their overall emotions throughout the interaction process, as well as specific moments when Midjourney's feedback elicited noteworthy emotional responses, be it excitement or disappointment. Additionally, participants were invited to expand upon their expert perspectives as creatives, offering a generalized critique of the tool and articulating any preferences for alterations or enhancements they wished to see. This aspect of the interview aimed to harness participants' domain expertise to bring up novel perspectives and unrestricted opinions that might not have been considered within the structured questionnaire. Summarizing, this semi-structured interview phase was intentionally devised to delve deeper into dimensions that are challenging to analyze via the questionnaire. It afforded the latitude for open discussions concerning participants' emotional states during their AI-tool interactions and leveraged participants' artistic expertise to surface unrestricted expressions of opinion and innovative viewpoints that may not have been previously expressed.

2.4 Data analysis

Our analytical approach commenced with an initial assessment of the questionnaire data, getting descriptive statistics of the results. In the subsequent phase, we evaluated our hypothesis through a statistical analysis of the quantitative outcomes obtained from the experiment. This examination included an exploration of the average scores within each section and the conduction of one sample T-tests with test value of 3 as the neutral value in the 5 Likert-scale. Subsequently, we searched for any statistically significant correlations among various sections and questions. Following the quantitative analysis, we analyzed the qualitative data obtained from the interviews. Our objective here was to identify patterns and outliers within the qualitative data, to gain deeper insights into the participants' experiences and perspectives. Finally, we did a synthesis of the quantitative and qualitative findings, aiming to establish connections and congruence between the two strands of data. This process enabled us to derive a holistic perspective on the experiment's outcomes, thereby enhancing our understanding of the relationship between the quantifiable results and the experiential insights provided by the participants.

In the context of results aligned with our hypothesis, we anticipate that participants will identify an experience with the tool that: i) led to creative outputs that are relevant to their work, ii) triggered reflection on the artist's work and creative process, iii) activated moments of inspiration, and finally, iv) that the participants think positively of this tool for a future use for ideation.

Table 1. The average scores and one sample T-test results for participants' responses in the averaged sections of i) Relevance ii) SPECS (consisting of Originality, Value, and Variety, Divergence and Experimentation) iii) Ideation Response (consisting of Inspiration and Reflection) iv) UTAUT (consisting of Performance Expectancy, Effort Expectancy, Social Influences, Facilitating Conditions, Behavioural Intentions, and Usage Behaviour). 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	-	-

3 Results

Nineteen people participated in this study, with all of them having previous experience of making 3D and digital art. The duration of the experiments varied from approximately 50 to 90 minutes, higlhy depending on the amount of time that participants would take to freely experiment with the AI-imagery tool.

3.1 Questionnaire Results

Table 1 presents the mean scores obtained from participants' responses to a series of questions, each rated on a 5-point Likert scale, ranging from 1 to 5. A score of 3 on this scale reflects a neutral or indifferent response. Overall, participants exhibited a predominantly positive disposition across all assessed variables. Notably, Usage Behavior stands as an exception, with a mean score of 2.92, indicating a neutral to slightly negative inclination among participants. In contrast, the remaining variables demonstrated mean scores ranging from 3.5 to 4.12.

To delve deeper into these findings, we performed one-sample t-test analyses on the average scores of the various sections with 3 as the test value. The relevance variable exhibited statistically significant deviation from a neutral opinion (Mean = 3.78, SD = 0.51; $t(18) = 6.57, p < 0.001$). The results of

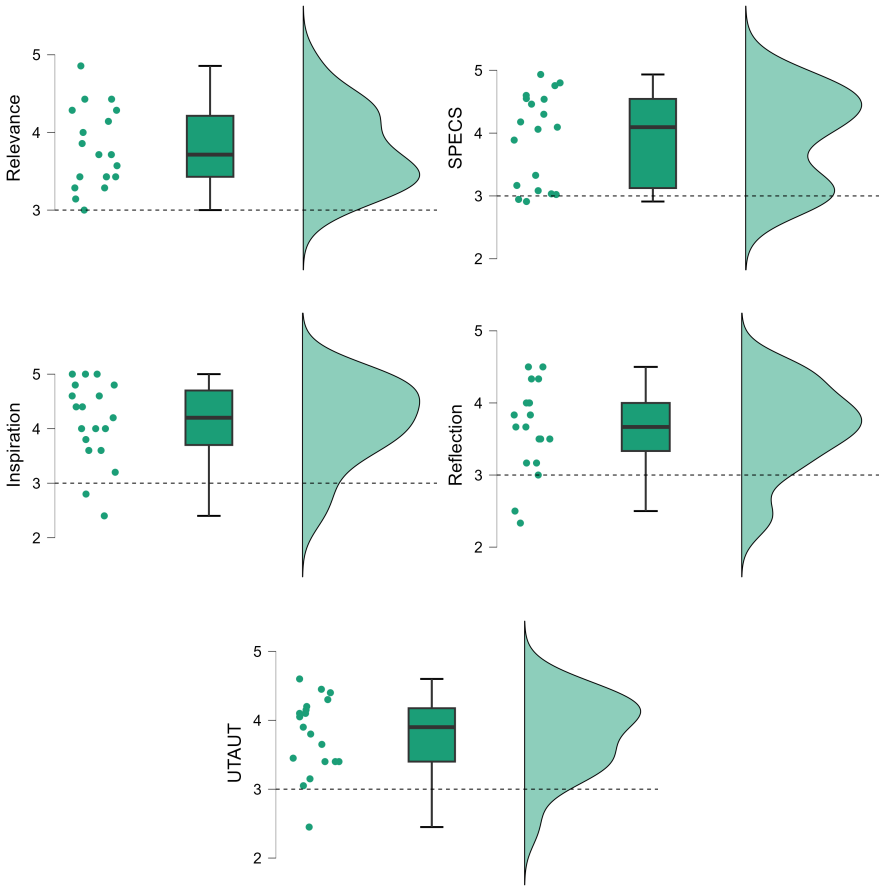

Fig. 2. Raincloud plots for the averaged variables of i) Relevance, ii) SPECS, iii) Inspiration, iv) Reflection, v) UTAUT. The dotted lines indicate the test value of the one sample T-test which corresponds to the "Neither agree not disagree" response in the Likert scale. We can see the overall positive inclination of participants in all variables.

SPECS also displayed statistically significant divergence from a neutral standpoint (Mean = 3.93, SD = 0.71; $t(18) = 5.58, p < 0.001$). Similarly, the results of the inspiration variable displayed statistically significant deviation from a neutral standpoint, with a notably elevated mean score (Mean = 4.12, SD = 0.75; $t(18) = 6.49, p < 0.001$). The same effect was observed for the variables of reflection (Mean = 3.65, SD = 0.62; $t(18) = 4.59, p < 0.001$) and UTAUT (Mean = 3.79, SD = 0.56; $t(18) = 6.15, p < 0.001$). All variables have been tested for normality using the Shapiro-Wilk test and it was found that there is no strong evidence to suggest that the data deviates significantly from a normal distribution. This can also be seen in the distributions of the raincloud plots in Figure 2. These statistical outcomes highlight the predominantly positive inclinations of the participants in all sections of the questionnaire which can also be seen more clearly in Figure 2.

Further analysis on the individual question of the sections could not be performed due to violation of normality according to the Shapiro-Wilk test in those items. However there a few questions we would like to report as they standed out from the different items in matters of mean value and standard deviations. Figure 3 shows the stacked bar of the responses in the originality subsection of SPECS. We can see how Q3 (Interacting with Midjoureny produced surprising images) stands out among the participants with: Mean = 4.26, SD = 0.56. Similarly Figure 4 shows the scores for reflection. In this case, Q3 (This experience provided me with possibilities for future work) also stands out with: Mean = 4.16, SD = 0.69. Similarly, in the inspiration sections participants demonstrated the most clear responses in the item "I felt inspired." (Mean = 4.11, SD = 0.74). In the item "I expect that learning to use AI-imagery tools would be easy for me" of UTAUT participants responses equaled to: Mean = 4.42, SD = 0.61. Finally, it is noteworthy that only two items elicited relatively neutral or negative responses. The first item was the statement "I expect that I would find it easy to get AI-imagery tools to do what I want it to do." and the associated statistical metrics were: Mean = 3.16, SD = 1.07. The second item was "I would do most ideation tasks by using AI-imagery tools." and the corresponding statistical measures were: Mean = 2.63, SD = 1.07.

Subsequently, we conducted a Spearman's correlation analysis to examine the relationships among the averaged scales within the questionnaire sections. The outcomes revealed several noteworthy positive correlations between questionnaire items, many of which achieved statistical significance. A visual representation of these correlations is depicted in Figure 5 (a). It is particularly noteworthy that the SPECS variable exhibited the highest and statistically significant positive correlations with the outcomes obtained from sections related to reflection, inspiration, and the UTAUT model. These correlations are further illustrated through scatter plots presented in Figure 5 (b) to (d). It is important to mention that all reported correlations underwent validation for normality using the Shapiro-Wilk test for multivariate normality, affirming the appropriateness of the statistical analyses conducted.

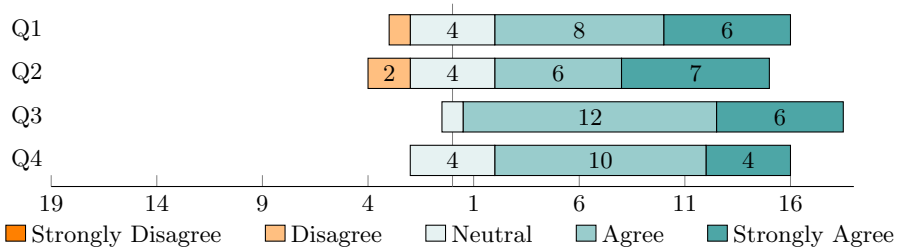

Fig. 3. Stacked bar chart for the individual questions for originality in the SPECS section. Q1: Interacting with Midjourney prompted novel ideas. Q2: Interacting with Midjourney produced novel images. Q3: Interacting with Midjourney produced surprising images. Q4: Interacting with Midjourney produced novel transformations of my prompt images.

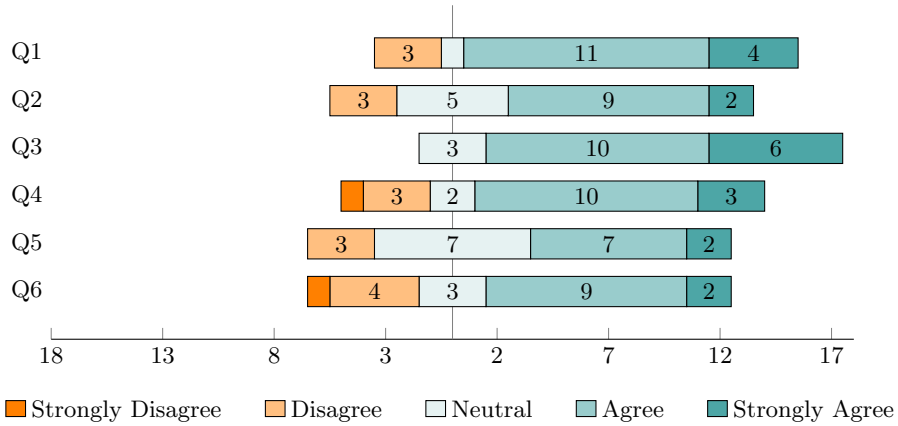

Fig. 4. Stacked bar chart for the individual questions in the section of Reflection. Q1: This experience made me reflect on my work. Q2: This experience provided me with new insights related to my existing work. Q3: This experience provided me with new possibilities for future work. Q4: This experience helped me to analyse my work better. Q5: This experience helped me to evaluate my work better. Q6: This experience helped me make new connections between my work and other people's work.

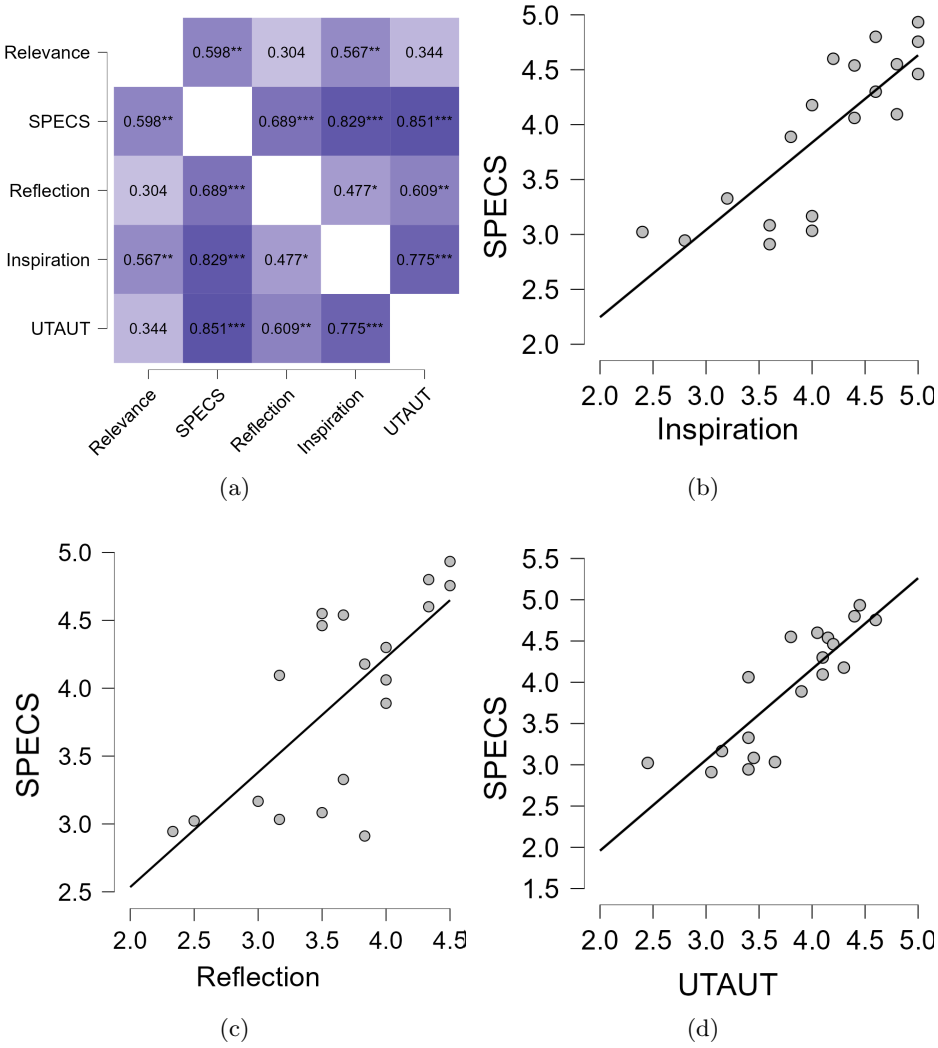

Fig. 5. (a) Spearman's correlation analysis heatmap between the different sections of the questionnaire. Asterisks signify the significance with "*" indicating values <.05, "**" indicating values <.01, "***" indicating values <.001), (b),(c),(d) Scatter plots between SPECS and Inspiration, Reflection and UTAUT sections respectively.

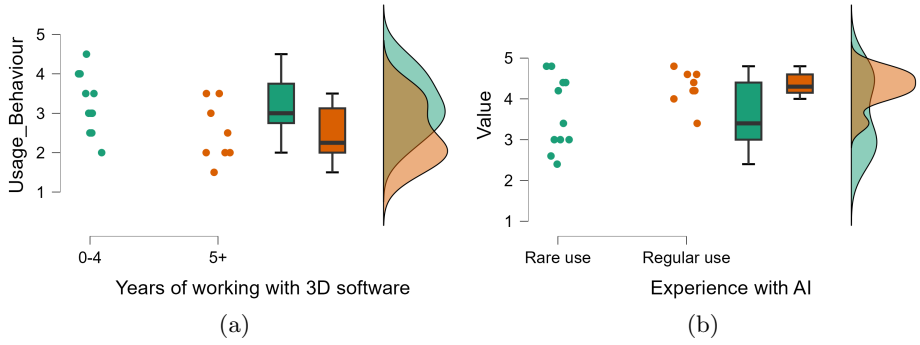

Fig. 6. (a) Raincloud plot comparing the usage behavior results among creatives with varying levels of experience in 3D software. (b) Raincloud plot illustrating the perceived value of AI-generated imagery outputs in relation to the expertise levels of creatives using AI tools.

Finally, we conducted an in-depth analysis to investigate potential variations among groups based on their levels of experience in working with 3D software and their familiarity with AI technology. A statistically significant difference was identified concerning the "Usage Behavior" subsection of the UTAUT model when comparing creatives with 0-4 years of experience and those with 5 or more years of experience ($t(17) = 2.07, p = 0.027$). As depicted in Figure 6 (a), individuals with less experience in 3D software exhibited a greater inclination to employ AI-powered imagery tools for ideation (Mean = 3.23, SD = 0.75) when contrasted with their more experienced counterparts (Mean = 2.5, SD = 0.76). Furthermore, another statistically significant difference emerged between participants who had used AI-imagery tools sparingly (up to one or two times) and those who had employed AI-imagery tools more frequently, particularly in relation to the "Value" subsection of SPECS ($t(17) = -1.85, p = 0.041$). Figure 6 (b) illustrates that individuals with greater familiarity and frequent use of AI-imagery tools tended to appraise the value of their output more highly (Mean = 4.27, SD = 0.44) compared to individuals with more rare use of AI tools (Mean = 3.64, SD = 0.89). For the individual items we did not find any between groups correlations that were statistically significant while demonstrating normally distributed results for both groups.

3.2 Interview Findings

3.2.1 The emotions during the interaction

Generally, participants' characterization of their engagement with the AI tool conveyed predominantly positive sentiments. Prominent themes that emerged from their descriptions encompassed emotions such as **enjoyment**, **surprise**, and **inspiration**. Notably, a subset of participants also expressed a sense of "calmness" during the interaction, a sentiment attributed to the inherent open-ended nature of the experimental task, which lacked a predefined specific goal.

> "I felt very excited, inspired and I was feeling creative in that moment."

> "I found this experience compelling and inspirational. I input a game I did three years ago and AI gave me back something very close to the mental image I had of it."

A noteworthy observation was that certain participants reported a diminishing intensity of their surprise as their interaction with the AI tool progressed. Participants attributed this diminishing effect to two primary factors. Firstly, some participants perceived that the AI tool's output became increasingly repetitive and predictable in its stylistic variations, leading to a reduction in the element of surprise. Secondly, another group of participants acknowledged that their own approach to the interaction played a role. They indicated that their interactions with the AI system were characterized by a lesser degree of experimentation and a greater adherence to the natural flow of its process.

> "At first I was surprised and intrigued by the results but later it got more blunt and the images were looking the same. Then nothing was really surprising to me from what was coming out. But this might be because I worked with it in a close-loop way."

> "As I continued the process I felt that I was more and more led by the bot in the generation process."

The enumeration of negative emotions primarily revolved around two key sentiments: **fear** associated with the act of sharing personal creative work with AI and **disappointment** arising from instances where AI failed to align with the desired or anticipated outcomes. Significantly, these negative emotional experiences were accentuated when the creative content in question belonged to the artists themselves. The sentiment was related to a perceived disconnection between the AI system's comprehension and the creator's intended perspective regarding the image. In essence, it implied a discordance in AI's ability to fully grasp the artistic or creative vision, thereby resulting in the negative emotional reactions described.

> "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 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."

3.2.2 Evaluation of AI-imagery and the proposed techniques for ideation

Regarding the utilization of AI-imagery tools for ideation, a consistent sentiment emerged among participants, reflecting a general disposition characterized

by openness and positivity. Participants uniformly conveyed their willingness to incorporate these tools into their creative workflows or explore them further. Some participants indicated that they would only consider using AI-imagery tools after the stage of generating the concepts and ideas of their project, and not before the visual experimentation process starts.

> "I don't think it would help for coming up with concepts, but for a later pre-production stage that we want to push the visual boundaries. At first, I would like to focus myself and follow my thoughts. And if you have to type all the time and wait etc, you lose your track of thoughts. It's not compatible with the pace of thinking."

> "I would see it more in a moodboard stage, than the idea stage itself. The reason you want to share a certain art piece is that the idea moves you and is important to you."

Numerous participants shared their individual visions of how AI could be incorporated into the ideation process. A prevalent theme was the use of AI for **sketching** indicating a strong interest in utilizing AI technologies to facilitate sketching during ideation. Furthermore, some participants emphasized the potential value of AI in "prototyping" and crafting presentation materials for client pitches within the context of creative projects.

> "I would use it more for sketching (rather than mere ideation). It would be useful for making content for pitching to clients. To quickly give shape to your ideas and communicate them."

> "It's relevant and really effective for prototyping and sketching out ideas you have in your mind. So it saves a lot of time individually or in a team."

When it comes to the use of the artist's own works in the ideation process, most participants expressed a positive inclination towards utilizing both their own artistic creations and third-party artworks in conjunction with AI-driven tools for ideation purposes.

> "I would do 50/50 of using my own work and external work for ideation. It's really interesting to see the interpretation of my work from Midjourney and to see how I can improve it in the future."

Several participants articulated their appreciation for the feedback provided by the Image2Text feature of the generator during the process of inputting their work.

> "There were so many terms! I didn't know about goblincore to be honest. It helps because you can put names to your aesthetics. And I also learned about new softwares and artists."

During the inquiry into participants' preferences and reservations, a recurrent theme that emerged was related to the topic **control**. Specifically, participants frequently raised the issue of the perceived degree of agency hindered by the tool—essentially, the extent to which they could exercise control over its functions and outcomes.

> "I feel that it doesn't give enough control. I would more likely use it if I had more control and could direct more what is happening. Eg choose specific parts in the image to change."

Another point raised by some participants revolved around the concept of habituation to AI tools for ideation, potentially at the expense of more conventional or traditional methods and personal authenticity.

> "My primary concern revolves around becoming overly reliant on the text-to-image process and making it the primary method for ideation and brainstorming. This could potentially sideline other, more embodied forms of inspiration, such as forest bathing or discussion or whatever. Given the time constraints and the individualistic nature of AI-driven ideation, I fear that I might excessively depend on it in the future, neglecting other potentially valuable sources of inspiration that could be more suitable for specific projects."

> "I guess we get inspirations from anywhere. But with technology we can have this situation of over-relying to it. Is this tool going to steer my work in the direction of the system?"

A recurring and noteworthy theme that was frequently mentioned among participants was AI's propensity for making **mistakes**. Participants who raised this aspect expressed a keen interest in these errors and regarded them as a valuable and positive element within the context of their ideation endeavors.

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

> "The mistakes from AI were the most innovative parts. AI has its own chaotic logic, which can bring out some unexpected work. It's the mistake of AI to not follow entirely correctly the human logic. But the mistake can be a very beautiful thing."

In conclusion, certain participants conveyed a desire for the AI tool to generate outputs that were less refined and devoid of a "final" quality, thus leaving more space for experimentation and manipulation of raw creative elements.

> "Results were too polished and detailed, without leaving room to experiment. Those were the least inspiring images. Maybe they were immediately looking too commercial, I think that's boring."

4 Discussion

The findings derived from our survey indicate an overall favorable disposition among the participants regarding their interactions with the AI-tool. Participants' positive reactions on inspiration and reflection benefits as well as their inclination for future adoption of AI-tools for ideation were found statistically significant. These quantitative results were complemented by the overall favorable responses documented in our interviews, with most participants reporting positive emotions and attitude towards using AI-tools for ideation in the future. These findings provide encouraging evidence for the main hypothesis of our research, signifying that AI imagery tools can effectively contribute to the ideation stage in the creative process of digital and 3D creatives. In the subsequent sections, we intend to synthesize our quantitative and qualitative insights to conduct a comprehensive analysis of this assertion, delving deeper into the underlying topics and critical attributes that should typify AI-tools designed for ideation purposes.

4.1 Creativity Evaluation

Participants indicated that the AI-tool consistently generated outputs characterized by creativity in terms of originality, value, and divergence. It is important to note that this scale primarily gauges participants' assessments of the output rather than their direct influence during the interaction with the AI-tool. However, we believe that the perceived creativity of the results plays a pivotal role as a prerequisite for the utility of the tool in the ideation process. In simpler terms, if participants view AI-tools as effective in promoting divergent thinking, this perception is likely to increase their willingness to use these tools to enhance their own divergent thinking processes. This proposition finds support in our empirical findings, particularly through the significant correlation coefficient of 0.85 established between SPECS and UTAUT. Additionally, noteworthy correlations emerged between SPECS and the sections of reflection and inspiration in our questionnaire, yielding correlation coefficients of 0.69 and 0.83, respectively. These findings align with prior research and underscore the artists' demonstrated capacity for making rapid and effective judgments regarding the creative merit of an image [34]. As anticipated, when presented with images perceived as highly creative, artists are capable of harnessing them for their ideation benefit. These findings serve to further underscore the pivotal role that high creativity outputs assume in nurturing the ideation process and incentivizing users to consider the adoption of AI-tools for analogous tasks in future endeavors.

4.2 Inspiration & Reflection

Our research findings reveal a positive disposition of participants in both the inspiration and reflection sections of our questionnaire. Significantly, both of these scales exhibit noteworthy correlations with the UTAUT section, exhibiting correlation coefficients of 0.61 and 0.78, respectively. These correlations underscore

their potential as indicators of future adoption tendencies regarding AI-tools for ideation. Furthermore, as observed in previous studies [38,41,25,43], both inspiration and reflection seem to play a pivotal role in the ideation process. Consequently, the success of AI-imagery tools and the techniques proposed in this research in eliciting inspiration and reflection are seen as instrumental in facilitating ideation processes. Finally, it is worth noting that inspiration garnered a higher mean rating of 4.12 compared to reflection, which received a mean rating of 3.65. This difference can be explained by insights from our interviews, where several participants conveyed a relatively lower focus on the textual feedback processes of AI. This observation is in alignment with the fact that textual feedback was provided by only one of the four AI techniques employed in our experimental design.

4.3 Relevance & Artistic Interpretation

The participants' assertion that the generated images exhibited relevance to their initial input images was found statistically significant. As previously described, we believe that this alignment serves as a foundational element in establishing a sense of acknowledgement, thereby enabling a constructive dialogue between the AI-tool and the participants. Indeed, the significant correlation of 0.57 between relevance and inspiration observed in our results supports this interdependence of relevance to one of the core aspects of the ideation process. This correlation is further supported by our qualitative results. When reporting negative emotions, a subset of participants attributed these sentiments to the system's perceived inability to interpret their work from their own artistic perspective, resulting in outcomes that deviated from their desired relevance. This affected negatively their perceived ideation potential of the AI-tool. This insight extends beyond mere relevance and introduces a new facet of artistic interpretation. To elaborate, it appears that AI-tools should not merely blindly replicate participants' supplied work; rather, in order to further support ideation they should exhibit a rudimentary comprehension of the artistic elements within the work, with a particular emphasis on these elements as the primary focal point. As previously mentioned, the matter of creative interpretation necessitates a shift toward a more process-oriented approach, as opposed to a solely final product-oriented one [30]. To enable AI-tools to effectively comprehend the perspective of an artist, they may need to be endowed with specific memory functionalities and engage in extended co-creation periods alongside the artist. Such approaches could facilitate a deeper understanding of the artist's intent, allowing the AI-tools to generate outputs that align more closely with the artist's creative vision. A different approach could be the incorporation of Reinforcement Learning from Human Feedback (RLHF) techniques, as proposed by Casper et al. [8]. The essence of this proposition lies in leveraging RLHF techniques to facilitate the refinement and adaptation of underlying machine learning models, allowing them to better align with the inherently abstract and elusive nature of artistic interpretation. By integrating human feedback as a source of guidance, machine

learning models can iteratively learn and improve their ability to discern and articulate the nuanced elements that underlie artistic creations.

4.4 Surprise VS. Control

The phenomenon of surprise emerged prominently in both the questionnaire responses and the interviews conducted with participants. In the specific questionnaire item, "Interacting with Midjourney produced surprising images" participants reported a mean rating of 4.26, underscoring the prevalence of surprise within the interactions. Additionally, surprise was one of the most frequently mentioned emotions expressed by participants during the experiment, often described as a positive emotion contributing to their ideational processes and overall enjoyment of the experience. It is noteworthy that several participants conveyed a diminishing sense of surprise as their interactions progressed. This diminishing effect was attributed to the AI becoming repetitive or participants feeling that they were not skillfully guiding the AI to produce novel content. Furthermore, surprise was linked to instances where the AI exhibited unpredictable behaviors, such as misinterpreting prompts or generating images with perceived "mistakes" or artifacts. Intriguingly, this unpredictability was deemed the most captivating aspect of the AI-tool by those participants. It is plausible to hypothesize that this unpredictive behavior was seen as an opportunity for experimentation, allowing participants to explore entirely new content and ideas that diverged from their initial concepts.

Simultaneously, another recurrent theme among participants revolved around the concept of control. Numerous participants reported during the interviews that they occasionally felt a lack of sufficient control over the AI-tool. This perceived lack of control emerged as a primary consideration for participants when contemplating the development of future AI tools for ideation. This sentiment was further reflected in the questionnaire responses, particularly in the item, "I expect that I would find it easy to get AI-imagery tools to do what I want it to do" where participants provided a neutral response with a mean rating of 3.16.

This divergence in expressed needs by participants highlights a noteworthy contradiction; demonstrating an unpredictable behaviour comes to the cost of enabling control and vice versa. A potential resolution to this contradiction lies in affording participants control over the degree of unpredictability inherent in AI-imagery tools. Therefore, a fruitful approach could involve the development of AI-imagery tools that allow for more granular art direction processes, e.g. by enabling participants to customize specific aspects of an image. At the same time, it would be beneficial to provide participants with the ability to modulate the level of unpredictability within the system. This would grant participants the autonomy to experience "surprise" only when they deem it useful and conducive to their ideational processes, thus reconciling the contrasting needs for control and unpredictability while maintaining a sense of agency.

4.5 Operationalizing the use and acceptance of creative systems through SPECS

The methodological approach of this study involved the incorporation of both SPECS and UTAUT frameworks 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 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.

4.6 Experience differences

Our quantitative findings have revealed a noteworthy disparity between users with varying levels of experience in 3D software. Specifically, individuals with limited experience (0-4 years) demonstrated a heightened likelihood to consider adopting AI-powered imagery tools for ideation purposes in the future, as compared to their more experienced counterparts (5+ years). This outcome may be considered as indicative of a predisposition among more experienced users to exhibit greater selectivity and reluctance to deviate from their established workflow. Conversely, individuals with less experience appear to be more receptive to experimentation and the integration of diverse tools into their creative processes, reflecting a propensity for exploration and adaptation in their workflows. This observation suggests the potential existence of distinct requirements corresponding to the varying levels of professional experience among creatives. More experienced professionals may have a greater demand for AI-imagery tools that seamlessly integrate into and are customized to their existing workflows and preferred software, reflecting a need for greater alignment with their established work processes.

Moreover, our quantitative findings presented a statistically significant distinction between individuals with varying levels of proficiency in the use of AI-imagery tools. Specifically, our results indicate that those with a more frequent utilization of AI-imagery tools tend to assign higher appraisals to the creative value of their generated outputs. This outcome presents several plausible interpretations. One interpretation is that individuals with greater expertise in AI-imagery tools possess a heightened ability to adeptly manipulate these tools,

thereby directing them towards the production of outputs perceived as more creative. If this interpretation holds true, it underscores the importance of designing AI-imagery tools with a gentle learning curve, enabling novice users to quickly grasp their functionalities and achieve satisfying outcomes. Alternatively, this observed effect could be attributed to the pre-existing positive disposition of more experienced users towards AI-tools. In other words, their frequent utilization of such tools might be explained by a greater appreciation for the outputs they produce.

4.7 Employing AI-imagery tools for ideation

It's important to note that this speculative research was conducted using a general-purpose AI-tool not specifically tailored for ideation, since we did not find such an existing example. During interviews with participants, a rich array of ideas, concerns, and preferences emerged, offering promising directions for the development of AI-imagery tools customized for ideational purposes. These ideas encompassed various applications, including idea sketching, moodboard creation, and prototyping, each of which would necessitate bespoke interface designs tailored to the unique demands and functionalities of ideation. Furthermore, participants envisioned the integration of AI-imagery tools with other software applications, such as digital drawing software, in collaborative efforts to augment the creative workflow. Participants also highlighted the importance of preserving the compatibility of AI-imagery tools with traditional ideational methods, emphasizing the need for these tools to harmonize with and complement conventional approaches. Notably, some participants expressed concerns about potential over-reliance on AI-imagery tools, indicating the importance of smoothly integrating these tools into the artists' practices to maintain a sense of creative agency and authentic artistic expression. These insights highlight the need for the development of ideation tools characterized by a hybrid and adaptable nature, capable of accommodating the diverse preferences, work habits, and domains of practice of their users.

5 Limitations

It is essential to acknowledge several limitations that should be considered when interpreting and applying the findings of this research. First and foremost, this study was conducted as a pilot study, involving a relatively modest sample size of participants (N=19). While the results provide initial insights, the limited sample size may constrain the generalizability of the findings. Future investigations should seek to engage a larger and more diverse pool of creative professionals to enhance the robustness and reliability of the conclusions drawn.

Another limitation is related to the adaptation of the SPECS and UTAUT frameworks. Our study utilized modified versions of these frameworks, which had not been empirically validated prior to this experimental study. Consequently, the validity and applicability of these adapted scales may be subject to scrutiny.

Furthermore, the scales of reflection and inspiration were crafted specifically for the purposes of this investigation, drawing upon insights from prior literature, however, they had not undergone empirical validation prior to their deployment in this experimental study. As a result, in the statistical analysis of these scales, we employed an approach that entailed computing an averaged metric of all questions, assigning equal weights to each item. This methodology, while pragmatic for our study's objectives, departs from the rigorous assessment and validation typically associated with well-established scales. To establish stronger foundations for research in this area, it is advisable to rigorously adapt existing scales and empirically assess the suitability of any newly created scales in advance of future investigations.

Additionally, it is important to highlight that this study went into a speculative terrain by examining AI-imagery tools for ideation. Given the absence of specific AI-imagery tools designed explicitly for ideation purposes at the time of the study, participants were provided with a more general-purpose tool and were instructed to use it in a specified way. This may introduced a potential source of noise into our results, as the interface used by participants has not been optimally tailored to the study's objectives. Subsequent research endeavors could benefit from the development of more suiting interfaces using AI-imagery technologies or the meticulous adaptation of existing interfaces to align with the specific needs and goals of ideation processes.

While this study offers promising insights into the application of AI-imagery tools in the creative domain, its limitations necessitate cautious interpretation. Addressing these limitations through larger sample sizes, validated scales, and more purpose-built interfaces in future research will further refine our understanding of the potential and efficacy of AI-imagery tools in the ideation processes of digital and 3D creatives.

6 Future Work

We hope that this study provides a foundation for future research endeavors within the domain of AI-imagery systems for ideation. We believe that future research should focus on the development of AI-imagery tools specifically tailored for ideation purposes. These tools should incorporate design elements that align with the unique demands of ideation and the design values of co-creative systems. From this study we have also gathered some key topics that should be taken into account when designing future AI-imagery systems for ideation:

- **Co-creativity**: AI-imagery systems should actively promote interactive collaboration, fostering a dynamic exchange of ideas and creative inputs between users and AI entities. Future research endeavors could delve into the precise design principles that can be employed to configure AI-imagery tools as co-creative partners capable of engaging in an inspiring and ongoing dialogue with creative individuals.

- **Customization**: AI-imagery tools should strive to provide an extensive level of control and customization, empowering users to finely tune the tool's outputs to align with their individual creative requirements and preferences. To explore and implement the most effective means of delivering this customization, valuable insights can be derived from examining co-creative applications in diverse domains and conducting targeted empirical investigations.
- **Balancing Automation and Control**: It is considered essential to look into achieving a balance between automation and user control for future ideation systems. Users should have the ability to customize specific aspects of generated imagery while also being able to modulate the level of unpredictability within the system. This will empower users to maintain creative agency while benefiting from AI's assistance as a divergent thinking collaborator. To achieve that, future systems could benefit from memory functionalities that enable them to remember user preferences and style, facilitating more personalized and aligned outputs over time, or through reinforcement learning from human learning techniques.
- **Compatibility with Traditional Methods**: Highlighting the significance of AI-imagery tools seamlessly complementing traditional ideation methods is essential. The goal should be to get inspired by traditional ideation methods while maintaining a smooth transition and synergy with them. An essential area of investigation lies in the extent to which AI-imagery tools can effectively augment processes such as sketching, moodboard creation, or prototyping within the broader creative workflow.
- **User Experience Enhancement**: Additional research endeavors should be directed towards the domain of interface design and user experience (UX) for AI-imagery tools intended for ideation. We believe that these user interfaces should exhibit characteristics of intuitiveness and user-friendliness, coupled with optimization for ideation tasks. Such considerations are paramount to ensure that individuals across a spectrum of expertise levels, spanning from novices to experienced professionals, can effectively and readily leverage the tool's functionalities.
- **Long-term Co-Creation**: Exploring the viability of extended co-creation periods between artists and AI systems is a promising avenue for future investigation. These long-term interactions hold the potential to facilitate a more profound comprehension of an artist's creative intent and distinctive style by AI tools, ultimately resulting in the generation of outputs that exhibit a higher degree of alignment with the artist's vision.
- **Integration with Existing Software**: It is valuable to explore strategies for the seamless integration of AI-imagery tools with existing creative software applications, such as digital drawing or 3D modeling software. This integration seeks to enable a smooth fusion of AI-generated imagery into artists' workflows and foster collaborative synergies across different stages of their creative process.
- **Ethical Considerations**: It is crucial to explore the ethical implications of AI-imagery tools in the creative process. Research should address issues related to intellectual property, data privacy, and the potential impact of

over-reliance on AI tools to the feelings of artistic self-authenticity. At the same time, systems should include ethical safeguards, such as clear guidelines for data usage, intellectual property rights, and mechanisms for addressing bias and fairness.

Future research could also explore the development and standardization of evaluation metrics for assessing the effectiveness of AI-imagery tools in the ideation process. As shown in this study, these metrics could encompass factors such as relevance, creativity evaluation, inspiration and reflection. Finally, we consider important to encourage the cross-disciplinary collaboration between AI researchers, artists, designers, and psychologists to gain a deeper understanding of the interplay between AI-imagery technologies and creative ideation.

7 Conclusion

This study illuminates the potential of AI-imagery tools in the ideation processes of digital and 3D creatives. The participants' overall favorable disposition, evident in both quantitative survey results and qualitative interviews, highlights the significant contribution these tools can make to creative workflows. Our research delves into critical dimensions of the artist-tool interaction, emphasizing the importance of aligning AI-generated images with participants' input to establish acknowledgment and promoting a process-oriented approach. Furthermore, participants consistently recognized the creativity of AI-generated outputs, underlining the role of creativity in inspiring ideation. The study also highlights the paradoxical desire for both surprise and control in AI-imagery tools, suggesting the need for customizable unpredictability levels. Experience differences among users reveal distinct requirements based on proficiency in 3D software and AI tools. Lastly, our exploration of potential applications underscores the importance of adaptable AI-imagery tools that integrate seamlessly with traditional methods while preserving artistic agency. In summary, our study provides encouraging evidence for further research of AI-imagery tools for ideation in digital arts. We hope that it can be a good starting point for the development of AI-powered tools that enrich the creative process and accommodate artists' diverse needs and expertise.

References

1. Abbad, M.M.: Using the utaut model to understand students' usage of e-learning systems in developing countries. Education and Information Technologies **26**(6), 7205–7224 (2021)
2. Adobe: Generative ai - adobe firefly (2023), `https://www.adobe.com/sensei/generative-ai/firefly.html`
3. AI, O.: Open ai (2023), `https://openai.com/dall-e-2`
4. Amer, S.K.: Ai imagery and the overton window. arXiv preprint arXiv:2306.00080 (2023)

5. Anantrasirichai, N., Bull, D.: Artificial intelligence in the creative industries: a review. Artificial intelligence review pp. 1–68 (2022)
6. Böttger, T., Rudolph, T., Evanschitzky, H., Pfrang, T.: Customer inspiration: Conceptualization, scale development, and validation. Journal of Marketing **81**(6), 116–131 (2017)
7. Brown, T., Mann, B., Ryder, N., Subbiah, M., Kaplan, J.D., Dhariwal, P., Neelakantan, A., Shyam, P., Sastry, G., Askell, A., et al.: Language models are few-shot learners. Advances in neural information processing systems **33**, 1877–1901 (2020)
8. Casper, S., Davies, X., Shi, C., Gilbert, T.K., Scheurer, J., Rando, J., Freedman, R., Korbak, T., Lindner, D., Freire, P., et al.: Open problems and fundamental limitations of reinforcement learning from human feedback. arXiv preprint arXiv:2307.15217 (2023)
9. Creswell, A., White, T., Dumoulin, V., Arulkumaran, K., Sengupta, B., Bharath, A.A.: Generative adversarial networks: An overview. IEEE signal processing magazine **35**(1), 53–65 (2018)
10. Davis, N., Siddiqui, S., Karimi, P., Maher, M.L., Grace, K.: Creative sketching partner: A co-creative sketching tool to inspire design creativity. In: ICCC. pp. 358–359 (2019)
11. Déguernel, K., Sturm, B.L.: Bias in favour or against computational creativity: A survey and reflection on the importance of socio-cultural context in its evaluation. In: International Conference on Computational Creativity (2023)
12. Dwivedi, Y.K., Rana, N.P., Jeyaraj, A., Clement, M., Williams, M.D.: Re-examining the unified theory of acceptance and use of technology (utaut): Towards a revised theoretical model. Information Systems Frontiers **21**, 719–734 (2019)
13. Ellamil, M., Dobson, C., Beeman, M., Christoff, K.: Evaluative and generative modes of thought during the creative process. Neuroimage **59**(2), 1783–1794 (2012)
14. Forthmann, B., Jendryczko, D., Scharfen, J., Kleinkorres, R., Benedek, M., Holling, H.: Creative ideation, broad retrieval ability, and processing speed: A confirmatory study of nested cognitive abilities. Intelligence **75**, 59–72 (2019)
15. Gangadharbatla, H.: The role of ai attribution knowledge in the evaluation of artwork. Empirical Studies of the Arts **40**(2), 125–142 (2022)
16. German, K., Limm, M., Wölfel, M., Helmerdig, S.: Towards artificial intelligence serving as an inspiring co-creation partner. EAI Endorsed Transactions on Creative Technologies **6**(19) (2019)
17. Guilford, J.: The nature of human intelligence. new york, ny: Mcgraw-hill book co (1967)
18. Haase, J., Djurica, D., Mendling, J.: The art of inspiring creativity: Exploring the unique impact of ai-generated images (2023)
19. Inc., P.: Phygital+ (2023), `https://phygital.plus/?ref=futuretools.io`
20. Jackson, P.W., Messick, S.: The person, the product, and the response: conceptual problems in the assessment of creativity. Journal of personality (1965)
21. Jordanous, A.: A standardised procedure for evaluating creative systems: Computational creativity evaluation based on what it is to be creative. Cognitive Computation **4**, 246–279 (2012)
22. Karayev, S., Trentacoste, M., Han, H., Agarwala, A., Darrell, T., Hertzmann, A., Winnemoeller, H.: Recognizing image style. arXiv preprint arXiv:1311.3715 (2013)
23. Karras, T., Laine, S., Aila, T.: A style-based generator architecture for generative adversarial networks. In: Proceedings of the IEEE/CVF conference on computer vision and pattern recognition. pp. 4401–4410 (2019)
24. Kim, J., Maher, M.L.: The effect of ai-based inspiration on human design ideation. International Journal of Design Creativity and Innovation **11**(2), 81–98 (2023)

25. Krishna Kumaran, S.R., Shi, W.W., Bailey, B.P.: Am i ready to get feedback? a taxonomy of factors creators consider before seeking feedback on in-progress creative work. In: Creativity and Cognition. pp. 1–10 (2021)
26. Lin, Y., Guo, J., Chen, Y., Yao, C., Ying, F.: It is your turn: Collaborative ideation with a co-creative robot through sketch. In: Proceedings of the 2020 CHI conference on human factors in computing systems. pp. 1–14 (2020)
27. Mathews, A., Xie, L., He, X.: Senticap: Generating image descriptions with sentiments. In: Proceedings of the AAAI conference on artificial intelligence. vol. 30 (2016)
28. Midjourney, I.: Midjourney (2023), `https://www.midjourney.com`
29. NVIDIA: Canvas (2023), `https://www.nvidia.com/en-us/studio/canvas/`
30. Oppenlaender, J.: The creativity of text-to-image generation. In: Proceedings of the 25th International Academic Mindtrek Conference. pp. 192–202 (2022)
31. Poly: Poly (2023), `https://withpoly.com/browse/textures`
32. Roose, K.: An ai-generated picture won an art prize. artists aren't happy. The New York Times **2**(September) (2022)
33. Runway, CompVis, S.A.: Stable diffusion (2023), `https://stablediffusionweb.com/`
34. Serafin, J., Kozbelt, A., Seidel, A., Dolese, M.: Dynamic evaluation of high-and low-creativity drawings by artist and nonartist raters: Replication and methodological extension. Psychology of Aesthetics, Creativity, and the Arts **5**(4), 350 (2011)
35. Song, Y., Ermon, S.: Improved techniques for training score-based generative models. Advances in neural information processing systems **33**, 12438–12448 (2020)
36. Sun, T., Wang, Y., Yang, J., Hu, X.: Convolution neural networks with two pathways for image style recognition. IEEE Transactions on Image Processing **26**(9), 4102–4113 (2017)
37. Thrash, T.M., Elliot, A.J.: Inspiration as a psychological construct. Journal of personality and social psychology **84**(4), 871 (2003)
38. Thrash, T.M., Moldovan, E.G., Oleynick, V.C., Maruskin, L.A.: The psychology of inspiration. Social and Personality Psychology Compass **8**(9), 495–510 (2014)
39. Vartiainen, H., Tedre, M.: Using artificial intelligence in craft education: crafting with text-to-image generative models. Digital Creativity **34**(1), 1–21 (2023)
40. Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D.: User acceptance of information technology: Toward a unified view. MIS quarterly pp. 425–478 (2003)
41. Wang, Y., Majeed, A.: How do users' feedback influence creators' contributions: an empirical study of an online music community. Behaviour & Information Technology **42**(9), 1357–1373 (2023)
42. Yan, J., Wang, W., Yu, C.: Affective word embedding in affective explanation generation for fine art paintings. Pattern Recognition Letters **161**, 24–29 (2022)
43. Zhuang, W., Zeng, Q., Zhang, Y., Liu, C., Fan, W.: What makes user-generated content more helpful on social media platforms? insights from creator interactivity perspective. Information processing & management **60**(2), 103201 (2023)

A Appendix: Questionnaire

Introduction

What is your age? (<18,18-30,31-45,46-60,60+)

How many years have you worked with a 3D software? (0-2,3-4,5-6,7-8,8+)

How often do you work with 3D related content? (Rarely,Once a month, Once a week,Multiple times per week, Multiple times per day)

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)

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)

Relevance

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)

Interacting with Midjourney produced relevant images to my prompt images.

Interacting with Midjourney produced relevant ideas to my prompt images.

Interacting with Midjourney produced images with textures relevant to my prompt images.

Interacting with Midjourney produced images with forms relevant to my prompt images.

Interacting with Midjourney produced images with colour palettes relevant to my prompt images.

Interacting with Midjourney produced images with compositions relevant to my prompt images.

Interacting with Midjourney produced similar-looking images to my prompt images.

Creativity Evaluation

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)

Interacting with Midjourney prompted novel ideas.

Interacting with Midjourney produced novel images.

Interacting with Midjourney produced surprising images.

Interacting with Midjourney produced novel transformations of my prompt images.

Interacting with Midjourney produced images that demonstrated sufficient depth to be interpreted at different levels or in different ways.

Interacting with Midjourney produced high-quality images.

Interacting with Midjourney produced aesthetically pleasing images.

Interacting with Midjourney produced useful images.

My experience of working with Midjourney added value for my work.

Interacting with Midjourney produced inventive images.

Interacting with Midjourney produced surprising transformations of my prompt images.

Interacting with Midjourney produced diverse transformations of my prompt images.

Inspiration and Reflection

To what extent do you agree with the following statements related to the image and text outputs generated by Midjourney during this experiment? (Strongly Disagree, Somewhat Disagree, Neither agree not disagree, Somewhat Agree, Strongly Agree)

This experience made me reflect on my work.

This experience provided me with new insights related to my existing work.

This experience provided me with new possibilities for future work.

This experience helped me to analyse my work better.

This experience helped me to evaluate my work better.

This experience helped me make new connections between my work and other people's work.

My imagination was stimulated.

My horizon was broadened.

I unexpectedly and spontaneously got new ideas.

I felt an urge to create new art / designs.

I felt inspired.

How often did this happen? (Not often at all, Somewhat often, Quite often, All the time)

How deeply or strongly did this happen? (Not strongly at all, Somewhat strongly, Quite strongly, Very strongly)

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

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.

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

I expect that learning to use AI-imagery tools would be easy for me.

I expect that I would find it easy to get AI-imagery tools to do what I want it to do.

Social Influences

If people that are important to me would use AI-imagery tools, it would in-

fluence me to use them as well.

If people who influence my behaviour were thinking positively of AI-imagery tools, it would persuade me to use them.

Facilitating Conditions

I feel I have the resources necessary to use AI-imagery tools.

I feel I have the knowledge necessary to use AI-imagery tools.

Behavioural Intentions

I predict that I would use AI-imagery tools in the future for ideation.

I would recommend AI-imagery tools to my colleagues/friends for ideation.

Usage Behaviour

I would consider myself a regular user of AI-imagery tools for ideation.

I would do most ideation tasks by using AI-imagery tools.