Dec 11th, 12:00 AM

AI Plus Other Technologies? The Impact of ChatGPT and Creativity Support Systems on Individual Creativity

Yanda Tao
McGill University, yanda.tao@mail.mcgill.ca

Changseung Yoo
McGill University, changseung.yoo@mcgill.ca

Animesh Animesh
McGill University, animesh.animesh@mcgill.ca

AI Plus Other Technologies? The Impact of ChatGPT and Creativity Support Systems on Individual Creativity

Short Paper

Yanda Tao
McGill University
1001 Rue Sherbrooke O, Montréal, QC, Canada, H3A 1G5
yanda.tao@mail.mcgill.ca

Changseung (Chang) Yoo
McGill University
1001 Rue Sherbrooke O, Montréal, QC, Canada, H3A 1G5
changseung.yoo@mcgill.ca

Animesh Animesh
McGill University
1001 Rue Sherbrooke O, Montréal, QC, Canada, H3A 1G5
animesh.animesh@mcgill.ca

Abstract

The emergence of generative artificial intelligence (AI) has triggered a massive technological surge. Software and systems increasingly incorporate generative AI as a fundamental component of their applications. Unfortunately, there is a lack of awareness of the interaction between generative AI and other tools and their consequences and causes. In this research, we explored the impact of the concurrent use of generative AI and creativity support systems (CSS) on users' creativity. In addition, by categorizing the stimuli provided by the CSS into high and low relatedness, we further investigated the effects of using generative AI with various CSS. By focusing on the interaction effect between generative AI and CSS, this research not only sheds light on the broader implications of generative AI but also serves as a guiding framework for the evolution of future CSS and furthering the enhancement of individual creativity.

Keywords: AI, Artificial Intelligence, Generative AI, Creativity Support Systems, Stimuli

Introduction

The emergence of generative artificial intelligence (AI) has triggered a massive technological surge, particularly in the realm of large language models (LLM) such as ChatGPT, which has attracted significant attention in recent times. As a disruptive technology that has resulted in vast societal changes, LLM-based generative AI's (hereafter referred to simply as generative AI) potential benefits and problems have justifiably become the focus of attention (Morris 2023). On the one hand, many system designers and software developers recognize the enormous potential of incorporating generative AI as a fundamental component of their applications. This interaction between generative AI and extant information technologies may result in efficiency, process, and even creativity gains. On the other hand, it raises concerns regarding security, privacy, and even technological addiction. Unfortunately, the current research focus on generative AI tends to be restricted to the tool itself. There is a lack of awareness of the interaction between generative AI and other tools and their consequences and causes. The absence of research hinders researchers' and practitioners' comprehension and perception of generative AI techniques and can impact the management of generative AI and subsequent system designs. To solve this problem, the focus of this conceptual paper is the impact of using generative AI on individual creativity. Specifically, we are interested in determining **how generative AI, as an emerging technology, interacts with extant creativity-supporting technologies to impact individual creativity**.

Creativity is the ability of an individual to generate "novel, appropriate, useful, correct, and valuable" (Amabile 1983) ideas when confronted with a problem. It is vital to the development of products, the operation of businesses, and the growth of society. Therefore, the promotion of individual creativity and the effect of technology on individual creativity have been popular topics in the information systems field for a long time (Elam and Mead 1990; Massetti 1996; Marakas and Elam 1997). To enhance individual creativity, computer-based or other information technology-based systems, known as creativity support systems (CSS), have been developed and utilized (Abraham and Boone 1994). Nowadays, the emergence of generative AI promises opportunities for the further growth of CSS, but it has received little attention in the information systems field. To address this issue, we adopted the concepts of the Search for Ideas in Associative Memory (SIAM) model (Nijstad et al. 2002) to explain the impact of the concurrent use of generative AI and CSS on users' creativity. In addition, by categorizing the stimuli provided by the CSS into high and low relatedness, we further investigated the effects of using generative AI with various CSS, which will also provide helpful insights for CSS developers.

This paper provides theoretical and practical contributions to the interaction of generative AI with existing information systems, thereby contributing to the ongoing discussion surrounding the management of generative AI. Moreover, while extant research on CSS has provided significant findings, the current use of generative AI offers more opportunities for further enhancing individual creativity. Our findings can be used to support the development of creativity-supporting technologies in a new phase. Furthermore, this research provides managers with an additional perspective of the potential benefits from generative AI.

Literature Review

Creativity and Idea Generation

Creativity comprises three preconditions: domain-relevant skills, creativity-relevant skills, and intrinsic task motivations (Amabile 1983). Several models of creativity have been proposed to explain the idea-generative process of individuals, such as the five-step model, which argues that the creativity process contains problem presentation, preparation, response generation, response validation, and outcome stages (Amabile 1983) such as the Geneplore model proposed by Finke (1990) and the SIAM model (Nijstad et al. 2002).

Among them, the model that has been most widely utilized in the field of information systems is SIAM (Nijstad et al. 2002). The SIAM model explains the potential impact of information technology on individual creativity (Rietzschel et al. 2007; Knoll and Horton 2011; Althuizen and Reichecl 2016; Bhagwatwar 2018; Wang and Nickerson 2019), as it clarifies how memories are stored, how creative ideas are generated, and why idea generation ceases. The SIAM model is built on the search of associate memory (SAM) theory (Raaijmakers and Shiffrin 1981) and suggests that ideas are generated through the following two main processes: the knowledge activation stage and the idea production stage (Nijstad et al. 2002) and depend on the following two types of memory: long- and short-term memory or working memory (Raaijmakers and Shiffrin 1981). Long-term memory is stored in the form of concepts (or images), where each concept is connected to multiple features (e.g., for the concept *school*, the corresponding features could be *has teachers*, *has students*, *has classrooms*, and so on). Different concepts are connected by features. For example, by the feature *has students*, the concept *school* and the concept *university* can be linked easily. Therefore, different concepts and features form a huge memory network in long-term memory.

According to SIAM, when users try to generate ideas, they first activate knowledge concepts in their long-term memory (i.e., the knowledge activation stage). Then, the features associated with these activated concepts are stored in short-term memory for combination (i.e., the idea production stage) to form new ideas. Each step is represented as a feedback loop. Therefore, multiple concepts may be triggered, and multiple ideas may be generated in the whole idea generation stage. Notably, the SIAM model points out that the termination of the idea generation is caused by the accumulation of monitored failures. When the human mind generates the same idea or fails to generate ideas during the idea generation process, the accumulation of individual failures will be superimposed. When a certain number of monitored failures is reached, the idea generation process will cease. Individuals generate the same ideas or are unable to generate ideas attributable to the limited number of search cues or the incapacity of search cues to activate concepts in their minds (Nijstad et al. 2002).

Creativity Support System

In response to the growing demand for individual creativity in business and society, several computer-based tools have been developed to enhance individual creativity and support the individual creative process (Massetti 1996; Marakas and Elam 1997; Althuizen and Reichecl 2016). These computer-based tools are collectively known as CSS (Abraham and Boone 1994). In previous research, creativity was measured by quantity, quality, usefulness, and depth and breadth of ideas, as shown in Table 1.

Measurement	Definition	Studies
Idea quantity	Number of ideas	Massetti 1996; Wierenga and Bruggen 1998; Garfield et al. 2001; De Dreu et al. 2008, Dennis et al. 2014; Bhagwatwar 2018; Wang and Nickerson 2019; Minas and Dennis 2019
Idea quality	Uniqueness of ideas	Elam and Mead 1990; Massetti 1996; Marakas and Elam 1997; Wierenga and Bruggen 1998; De Dreu et al. 2008; Dennis et al. 2014; Althuizen and Reichel 2016; Bhagwatwar 2018; Wang and Nickerson 2019; Minas and Dennis 2019
Idea usefulness	Feasibility and implementability of ideas	Massetti 1996; Althuizen and Reichel 2016; Bhagwatwar 2018; Wang and Nickerson 2019
Idea breadth	The comprehensiveness of ideas	Bhagwatwar 2018; Minas and Dennis 2019
Idea depth	Complexity and sophistication of ideas	Bhagwatwar 2018; Minas and Dennis 2019

Table 1: Measurement of creativity in CSS research

In accordance with their rationale for promoting individual creativity, we classify CSS into two categories: process-based CSS and stimulus-based CSS. The basic mechanism for process-based CSS is to assist the user in the creative process. Depending on the nuances of the concept, the process-based CSS can be further divided into two classes: Mind Mapper and Process Guider (Althuizen and Reichecl 2016). Mind Mapper's primary objective is to foster creativity by requiring individuals to draw association diagrams while considering a problem (Massetti 1996). Process Guider improves the cognitive abilities of its users by posing questions at each stage of the ideation process (Althuizen and Reichecl 2016). In the existing literature, the impact of both classes on creativity of individuals has been proved (Elam and Mead 1990).

Most of the CSS literature in current information systems research is founded on a stimulus-providing perspective (Bhagwatwar 2018), as indicated in Table 2. The stimulus-based CSS is intended to provide the user with additional external stimuli, such as words, images, or sounds (Nijstad et al. 2002). Stimulus-providing CSS primarily functions in the knowledge activation phase of the SIAM model, where, according to the SIAM theory (Nijstad et al. 2002), the user activates certain concepts in long-term memory when presented with a problem and then combines specific features of current concepts in working memory to generate ideas. Stimulus-based CSSs seek to provide users with external stimuli to activate more concepts in their long-term memory, leading to an increase in the number of ideas generated.

For a stimulus-based CSS, the stimulus provided to the user is the most important factor in determining the enhancement of the user's creativity. Existing stimulus-based CSSs categorize stimuli as either priming or perceived stimuli (Wang and Nickerson 2019). Priming stimuli are those where the user remains unaware of their purpose during the idea generation process such as games (Dennis et al. 2013) or special environmental designs (Minas and Dennis 2019). In contrast, perceived stimuli are those where the user understands their purpose is to inspire creativity, such as the words (Massetti 1996), sentences, or images (Finke 1990).

Type of CSS	Definition	Studies
Process-based	Enhancing individual creativity by guiding the user's idea	Elam and Mead 1990; Massetti 1996; Marakas and Elam 1997; Althuizen and Reichel 2016

	generation process (e.g., mind mapping).	
Stimulus-based	Eliciting individual creativity by providing external stimuli (e.g., words, sentences, etc.) in the idea generation process.	Massetti 1996; Malaga 2000, Garfield et al. 2001; Santanen et al. 2004; Dennis et al. 2014; Althuizen and Wierenga 2014; Althuizen and Reichel 2016; Bhagwatwar et al. 2018; Minas and Dennis 2019; Wang and Nickerson 2019

Table 2: Types of CSS

In the context of perceived stimuli, researchers have investigated the effect of stimulus-work relatedness on the problem-solving, creativity-enhancing effects of individuals (Althuizen and Wierenga 2014; Chan et al. 2015; Tseng et al. 2008). Existing research indicates that stimulus-work relevance is positively related to creativity enhancement (Wang and Nickerson 2019), i.e., the less relevant the stimulus is, the less effective it is at fostering creativity. According to the SIAM model, the decline of creativity is caused by the accumulation of monitored failures. The more distant the stimulus is from the current job, the more difficult it is for the individual to activate concepts in the long-term memory or establish connections between active concepts and focal problems in the cognitive network (Wang and Nickerson 2019). It will lead to individuals accumulating monitored failures in the process of generating ideas faster. This makes it difficult for users to generate new ideas based on the low-relatedness stimuli provided by the CSS. However, low-relatedness stimuli are more likely to add new cognitive elements to individuals and enhance their creativity (Wang and Nickerson 2019). In this case, even though low-relatedness stimuli may provide potential benefits, individuals often struggle to make connections between these stimuli and their focal questions within their cognitive networks. Consequently, these potential advantages cannot be completely achieved. However, current research on how to mitigate the effect of stimulus relatedness on individual creativity has been overlooked.

Generative Artificial Intelligence

Generative AI is a subset of artificial intelligence that focuses on generating new content or data that did not previously exist. Unlike traditional conversational chatbots, which are based on traditional natural language processing techniques to understand users' questions and provide predefined content to users, generative AI relies on neural network and deep learning techniques to provide self-generated responses to users from scratch (Lim et al. 2023). While generative AI is increasingly deployed in current platforms such as Google, Microsoft, or Facebook, researchers have paid relatively limited attention to the capacity of generative AI to interact with current applications.

It's worth noting that the interaction between generative AI and humans, as well as the AI's content generation process, aligns with creativity theory. Viewing from the perspective of the interaction process between generative AI and humans, we can observe that both parties can inspire each other in the content creation process. On the one hand, generative AI can provide highly novel and anthropomorphic responses to humans (Lim et al. 2023). These contents can serve as external stimuli in a user's idea generation process. On the other hand, prompts from human inputs play an important role in determining the quality of the content produced by the generative AI (Dang et al. 2022). In this context, the prompts inputted by humans can be regarded as external stimuli for the content generation of the generative AI. Consequently, in the interaction between generative AI and humans, content crafted by both the human and the generative AI can simultaneously act as external stimuli for each other, thereby influencing the content generated by the other party.

Secondly, when considering the content generation process of generative AI itself, there are several similarities between the AI's content generation and the creativity theory. For instance, when users ask the ChatGPT "what is generative AI?", the ChatGPT will analyze the user's input and identifies the key topic "generative AI". Then ChatGPT will utilize a deep learning technique known as "autoregression" to produce responses (Wu et al., 2023). This approach involves algorithmically generating a collection of potential words and phrases associated with the key topic (i.e., generative AI in this example) from its pretrained foundation models, which are trained through reinforcement learning techniques such as generative adversarial networks, and then selecting the most fitting response. Thereafter, ChatGPT will generate the answer word by word, ensuring grammatical accuracy and contextual relevance of the response. In the aforementioned example, the pretrained foundation models are similar to the memory network described in SIAM theory (Amabile 1983), the keyword "generative AI" is similar to the activated concept, and the process of response generation is similar to the human's idea generation.

However, despite the close association between generative AI and creativity theory, the primary purpose for which generative AI has been developed differ significantly from CSS tools, which solely developed to facilitate idea generation of humans. Given the current capabilities of generative AI and its clear distinction from existing CSS tools, this paper focuses on the interaction between generative AI and stimulus-based CSS, as well as the interaction effects of AI and CSS for stimuli of varying distances.

Hypotheses Development

Existing research indicates that users' creative abilities are enhanced when they are stimulated during the idea-generating process. According to the SIAM theory, external stimuli from CSS will activate relevant concepts in a person's long-term memory, and the activation of relevant concepts may prompt the individual to generate additional ideas (Nijstad et al. 2002). When relevant concepts in the user's memory are activated, or ideas are generated due to external stimuli, we contend that the user's interaction with AI and understanding of content generated by AI will also change. For instance, when the user receives external stimuli and specific concepts are activated, the user can modify the content of their queries to the AI. In addition, when users receive external stimuli, they have a greater chance of making novel connections to AI-generated content and generating additional or more novel ideas. Based on the above arguments, we hypothesize that:

Hypothesis 1: The concurrent use of generative AI and stimulus-based CSS increases the quantity and quality of ideas generated by an individual compared to the case where an individual uses generative AI only.

Introducing generative AI will bring at least two improvements to individual creativity compared to using creativity support systems alone. First, in the existing literature on creativity support systems, it is suggested that external stimuli boost individual creativity primarily because of the memory triggered by the stimuli (Massetti 1996; Althuizen and Reichecl 2016). According to the SIAM theory, the termination of ideas is caused by the accumulation of cognitive failures as the number of ideas increases (Nijstad et al. 2002). Generative AI can reduce cognitive burden by expanding the knowledge base when an individual encounters a knowledge bottleneck during the idea-generation process. In addition, when individuals input some of their ideas into the generative AI, the generative AI can also act as a short-term (working) memory to store or combine the activated features, thereby expanding the capacity of the limited working memory of humans, so the generative AI can reduce the cognitive load for the idea generation process. Second, while CSSs are distinct from generative AI systems in their primary objective, the content generated by generative AI can also be viewed as an external stimulus, so this external stimulus will further stimulate the concepts in long-term memory, allowing individuals to generate additional ideas. Based on the above arguments, we hypothesize that:

Hypothesis 2: The concurrent use of generative AI and CSS increases the quantity and quality of ideas generated by an individual compared to the case where an individual uses stimulus-based CSS only.

We further considered the interaction effects between stimuli of different relatedness provided by CSS and generative AI. It has been demonstrated that the relatedness of external stimuli significantly improves human creativity (Guo and McLeod 2014; Wang and Nickerson 2019). When the relevance of external stimuli to the current problem is low, it is challenging for the human brain to relate it to the focal problem (Wang and Nickerson 2019). Therefore, cognitive failures accumulate swiftly in the individual's mind to a certain level, causing the individual to give up the effort of generating ideas. Consequently, the relatedness of external stimuli is negatively correlated with improving human creativity.

Generative AI, on the other hand, is characterized by a large knowledge base and highly expressive computational power, so when humans have difficulty in correlating low-relatedness stimuli with the problem at hand, generative AI can generate a potential chain of relationships between the two. The construction of such potential relational chains by generative AI, whether correct, incorrect, or reasonable, explains the association between the two. This explanation from generative AI can reduce the user's likelihood of monitored failure in the process of activating concepts and linking the stimuli with the focal problem. For stimuli with a high degree of relevance, the use of generative AI has a limited effect because individuals can generate pertinent ideas readily. Therefore, the reduction effect of monitored failure is limited when generative AI is used in highly relevant stimuli. However, for low-relatedness stimuli, it is exceedingly difficult for individuals to generate correlations between low-relevance stimuli without the assistance of generative AI, so the enhancement effect of using generative AI would be more pronounced. Thus, we argue that the creativity-enhancing effects of generative AI will be different when used with stimuli in different relatedness. Therefore, we hypothesize:

Hypothesis 3: The use of generative AI with low-relatedness stimuli produces a more significant increase in the quantity and quality of an individual's ideas than the use of generative AI with high-relatedness stimuli.

Based on the preceding hypotheses, we believe that the order in which generative AI is employed will influence its ultimate effect on creativity enhancement. We argue that the interaction effect of generative AI with external stimuli in terms of individual creativity stems from the fact that generative AI can help individuals suggest a connection between the stimulus and the focal problem, thereby reducing the likelihood of monitored failure that may occur when individuals form this connection on their own. Therefore, when an individual is exposed to external stimuli, the use of generative AI leads to enhanced creativity. However, when individuals use generative AI first and then receive external stimuli, they tend to align with the content provided by generative AI rather than relying on generative AI to establish associations between external stimuli and focal problems. We therefore hypothesize:

Hypothesis 4: Individuals who are first exposed to external stimuli and then use generative AI have a more significant improvement in the quantity and quality of their ideas than individuals who first use generative AI and are then exposed to external stimuli.

Experimental Design

Study Design: This study will deploy three experiments, with the first adopting a 3*1 experimental design to test the impact of using generative AI with CSS under a fixed stimuli condition. This study will provide three conditions from the tools perspectives: a generative AI tool, a traditional CSS tool, and an AI enabled CSS tool.

For traditional CSS, we will use word-as-stimulus tools, that is, this tool will provide users with multiple clickable words related to the question, each of which will contain words related to the word, serving as a source of inspiration for users. For AI enabled CSS, we will use ChatGPT's API to integrate generative AI into the existing CSS. For each word, ChatGPT's API will automatically execute the following command "Can you relate the [word] with [focal problems]?" The returned results will be automatically displayed below each word on the CSS. Furthermore, we will provide a dialogue box adjacent to the AI-generated content, ensuring that users can seek clarification if they have questions about the AI-generated content.

In the second experiment, a 2*3 experiment design will be employed to measure the influence of stimuli relatedness on the enhancement of creativity when integrating generative AI with CSS. This study will provide the following two conditions from perspective of the tool: a traditional CSS tool, and an AI enabled CSS tool. It will provide three conditions from relatedness of stimuli provided by the CSS: solely high-relatedness stimuli, solely low-relatedness stimuli and combination of stimuli comprising equal proportions of high and low.

In the third experiment, a 2*3 experimental design will be employed to measure the impact of using generative AI tools in different idea-generation stages under different stimuli conditions. This study will provide the following two conditions from the ordering of treatments perspective: using AI enabled CSS first and using traditional CSS first. It will also provide the following three conditions from the stimuli perspective: high-relatedness stimuli, low-relatedness stimuli and combination of high and low stimuli.

Participants and Treatments: In these studies, we will conduct laboratory experiments with student participants. Participants will be recruited from a business school in a North American university. Regarding treatment selection, we selected ChatGPT as our generative AI tool because we believe that, as a tool that has acquired more than 100 million users in a brief period of time since its release, using this tool for our experiments would guarantee the greatest generalizability of our research. In addition, we will develop a stimulus-based CSS that provides users with interconnected words or sentences for the tasks in experiments. We will utilize a self-developed CSS because it guarantees us full control over the relatedness of the words it provides to the user and allows us to integrate ChatGPT API into it.

Procedures and Tasks: At the beginning of experiments, we will provide users with task descriptions and instructions and guide users on how to use both tools. We will pre-screen and restrict the keywords presented to users by the CSS to ensure that each user in the same group receives the same keywords. In the first and second study, we will gather the final ideas generated by participants. In the third study, we will ask participants to generate ideas twice. First, we will ask users to generate ideas after we provide the first tool (either traditional CSS or AI enabled CSS). Then we will ask them to generate ideas again after we provide the second tool.

Following the previous studies on creativity (Bhagwatwar et al. 2018; Minas and Dennis 2019), we will ask participants to generate ideas for environmental issues and homelessness in the United States, respectively. During the experimental process, to minimize the risk of users directly inputting the focal questions into the generative AI, we will inform users to refrain from doing this at the beginning of the experiment. Additionally, we will implement restrictions in the backend of the AI enabled CSS to filter out questions that are same with the focal question. For all experiments, we will gather data on every user interaction with the AI enabled CSS, including specific queries and the corresponding AI responses. Moreover, upon experiment completion, we will survey users regarding the demographics and background about the generative AI.

Dependent Variables: Two professionals will evaluate each idea. The following metrics will be used to assess the quantity and quality of ideas. First, we will use two independent raters to classify each participant's ideas to find the number of unique ideas generated by participants. Second, regarding the novelty of ideas, we will use Dean's methodology to assess the creativity of ideas in terms of novelty and workability (Dean et al. 2006). Novelty will be further subdivided into originality and paradigm-breaking, and workability will be subdivided into implementability and acceptability. The four sub-dimensions will be evaluated on a scale from 1 to 4 by two experts. The average of the four dimensions will be utilized as the idea's quality, and the number of ideas with a mean of 3 or higher will be used as the measurement for quality of ideas for each participant (Bhagwatwar et al. 2018).

Relatedness of stimulus: In this study, we will employ a previously designed approach for calculating semantic associations based on Wikipedia (Wang and Nickerson 2019). This method determines whether a stimulus is relevant to the focal problem by analyzing the association between Wikipedia pages. For instance, if the question is about "innovation," on the innovation page, we can find the word "product" directly associated with it, which we refer to as the first-degree concept. The word associated with "product" is "raw material," which we will refer to as the second-degree concept, and so on. We consider these first-degree and second-degree concepts to be highly relatedness stimuli to the focal question, and users can easily link these highly relevant stimuli to the focal question being asked. The third-degree (such as "crude oil") and fourth-degree (such as "bitumen") concepts, on the other hand, are low relatedness stimuli, in which users have difficulty connecting them to the focal question in the mind. In highly-relatedness CSS, we will randomly select ten first-degree and fifty second-degree concept words. Ten third-degree and fifty fourth-degree concept words will be chosen as low-relatedness terms for the CSS. For mixed-relatedness CSS, we will randomly select half low-relatedness words and half high-relatedness words.

Implications and Future Research

At a time when generative AI is having a significant impact, researchers are unsure of its implications. To address this issue, we examined the implications of generative AI's interactive use with extant creativity support systems. On this basis, we further explored the effect of creativity enhancement by using generative AI and CSS with different stimuli. We contend that combining generative AI with existing CSS can enhance individual creativity more than using either generative AI or existing creativity support systems alone. In addition, we believe that this enhancement effect is amplified in the presence of low-relatedness stimuli provided by the CSS.

To the authors' knowledge, this paper is the first to examine the impacts of the interaction between generative AI and existing CSS on individual creativity. It will help researchers expand the literature on CSS and better comprehend the interaction between generative AI and existing information technologies. This is also the first paper to use the SIAM model to describe how generative AI interacts with extant CSS and how this interaction occurs. We provide a theoretical explanation of the effects that result from the interaction of the two tools and further extend the SIAM model to the domain of generative AI. In addition, there is an absence of research in the existing literature on how to mitigate cognitive failures caused by stimulus distance. To fill this gap, we further considered how to overcome or mitigate the reduced effect of individual creativity enhancement due to stimulus distance.

At the managerial level, we believe this study will provide practitioners with evidence for managing generative AI. With the current popularity of generative AI and the considerable debate among managers regarding how to effectively guide individuals to use generative AI, managers might consider combining existing CSS with generative AI to further enhance the creativity of individuals when completing tasks. Second, this study offers a new way of thinking for designers of CSS. If our findings are confirmed, designers of stimulus-based CSS should consider incorporating generative AI into their existing systems. In other words, when providing users with words or sentences as stimuli, designers may want to use generative AI to generate possible associations with focal questions in advance, thereby reducing the user's cognitive load and enhancing the user's creativity. In addition, CSS tended to provide high-relatedness stimuli to prevent users from experiencing cognitive difficulties in connecting focal questions with low-relatedness stimuli. This paper encourages designers to provide users with some low-relatedness stimuli and leverage generative AI to establish a potential connection for users. The low-relatedness stimuli would provide the user with more novel cognitive elements, thereby improving the user's creativity.

Our findings also reveal opportunities for future research. First, we focused primarily on CSS which belongs to stimulus-based CSS. However, it is important to note that the potential interaction between process-based CSS and generative AI may be of tremendous value. Future researchers can explore whether the emergence of generative AI can provide enhancement potentials for the process-based CSS. Second, with respect to the type of stimuli, in this paper, we only considered perceived stimuli. Future researchers could consider the interaction of priming with generative AI, e.g., whether exposure to priming (such as music) influences an individual's use of generative AI and their understanding of the content generated by the AI. Furthermore, in this study, we utilized ChatGPT as our experimental tool. However, whether there exists heterogeneity between other LLM tools and ChatGPT, and the reasons for any such heterogeneity, warrant further exploration by researchers. Lastly, within the scope of this paper, we refrained from further categorizing distinct forms of creativity and examining the influence of various tools on each specific kind of creativity. We advocate for a more detailed analysis of creativity in future research.

Acknowledgements

The authors thank Liette Lapointe for her constructive and valuable suggestions on this research.

References

Abraham, T., and Boone, L. W. 1994. "Computer-based systems and Organizational Decision making: An architecture to support organizational innovation," *Creativity Research Journal* (7:2), pp. 111–123.

Althuizen, N., and Reichel, A. 2016. "The effects of it-enabled cognitive stimulation tools on creative problem solving: A dual pathway to creativity," *Journal of Management Information Systems* (33:1), pp. 11–44.

Althuizen, N., and Wierenga, B. 2014. "Supporting creative problem solving with a case-based reasoning system," *Journal of Management Information Systems* (31:1), pp. 309–340.

Amabile, T. 1983. *The social psychology of creativity*, New York: Springer.

Arreola, N. J., and Reiter-Palmon, R. 2016. "The effect of problem construction creativity on solution creativity across multiple everyday problems.," *Psychology of Aesthetics, Creativity, and the Arts* (10:3), pp. 287–295.

Bhagwatwar, A., Massey, A., and Dennis, A. 2018. "Contextual priming and the design of 3D Virtual Environments to improve group ideation," *Information Systems Research* (29:1), pp. 169–185.

Chan, J., Dow, S. P., and Schunn, C. D. 2015. "Do the best design ideas (really) come from conceptually distant sources of inspiration?," *Design Studies* (36), pp. 31–58.

Dang, H., Mecke, L., Lehmann, F., Goller, S., and Buschek, D. 2022. "How to prompt? opportunities and challenges of zero- and few-shot learning for human-ai interaction in creative applications of Generative Models," *arXiv.org*, September 3 (available at https://doi.org/10.48550/arXiv.2209.01390; retrieved April 29, 2023).

De Dreu, C. K., Baas, M., and Nijstad, B. A. 2008. "Hedonic tone and activation level in the mood-creativity link: Toward a dual pathway to creativity model.," *Journal of Personality and Social Psychology* (94:5), pp. 739–756.

Dean, D., Hender, J., Rodgers, T., and Santanen, E. 2006. "Identifying quality, novel, and creative ideas: Constructs and scales for idea evaluation," *Journal of the Association for Information Systems* (7:10), pp. 646–699.

Dennis, A. R., Minas, R. K., and Bhagwatwar, A. P. 2013. "Sparking creativity: Improving electronic brainstorming with individual cognitive priming," *Journal of Management Information Systems* (29:4), pp. 195–216.

Elam, J. J., and Mead, M. 1990. "Can software influence creativity?," *Information Systems Research* (1:1), pp. 1–22.

Finke, R. A. 1990. *Creative imagery: Discoveries and inventions in visualization*, New York: Routledge, Taylor & Francis Group.

Garfield, M. J., Taylor, N. J., Dennis, A. R., and Satzinger, J. W. 2001. "Research report: Modifying paradigms—individual differences, creativity techniques, and exposure to ideas in group Idea Generation," *Information Systems Research* (12:3), pp. 322–333.

Guo, J., and McLeod, P. L. 2014. "The impact of semantic relevance and heterogeneity of pictorial stimuli on individual brainstorming: An extension of the Siam Model," *Creativity Research Journal* (26:3), pp. 361–367.

Knoll, S. W., and Horton, G. 2011. "Changing the perspective: Using a cognitive model to improve thinklets for ideation," Journal of Management Information Systems (28:1), pp. 85–114.

Lim, W. M., Gunasekara, A., Pallant, J. L., Pallant, J. I., and Pechenkina, E. 2023. "Generative AI and the future of education: Ragnarök or reformation? A paradoxical perspective from management educators," *The International Journal of Management Education* (21:2), p. 100790.

Malaga, R. A. 2000. "The effect of stimulus modes and associative distance in individual creativity support systems," Decision Support Systems (29:2), pp. 125–141.

Marakas, G. M., and Elam, J. J. 1997. "Creativity enhancement in problem solving: Through software or process?," *Management Science* (43:8), pp. 1136–1146.

Massetti, B. 1996. "An empirical examination of the value of creativity support systems on Idea generation," *MIS Quarterly* (20:1), p. 83.

Minas, R. K., and Dennis, A. R. 2019. "Visual background music: Creativity support systems with priming," *Journal of Management Information Systems* (36:1), pp. 230–258.

Morris, M. R. 2023. "Scientists' perspectives on the potential for generative AI in their fields," *arXiv.org*, April 4 (available at https://arxiv.org/abs/2304.01420; retrieved April 29, 2023).

Nijstad, B. A., Stroebe, W., and Lodewijkx, H. F. M. 2002. "Cognitive stimulation and interference in groups: Exposure effects in an idea generation task," *Journal of Experimental Social Psychology* (38:6), pp. 535–544.

Raaijmakers, J. G., and Shiffrin, R. M. 1981. "Search of associative memory.," Psychological Review (88:2), pp. 93–134.

Reinig, B. A., Briggs, R. O., and Nunamaker, J. F. 2007. "On the measurement of Ideation Quality," *Journal of Management Information Systems* (23:4), pp. 143–161.

Rietzschel, E. F., Nijstad, B. A., and Stroebe, W. 2007. "Relative accessibility of domain knowledge and creativity: The effects of knowledge activation on the quantity and originality of generated ideas," *Journal of Experimental Social Psychology* (43:6), pp. 933–946.

Santanen, E. L., Briggs, R. O., and Vreede, G.-jan D. E. 2004. "Causal relationships in creative problem solving: Comparing facilitation interventions for ideation," *Journal of Management Information Systems* (20:4), pp. 167–198.

Tseng, I., Moss, J., Cagan, J., and Kotovsky, K. 2008. "The role of timing and analogical similarity in the stimulation of idea generation in design," *Design Studies* (29:3), pp. 203–221.

Wang, K., and Nickerson, J. V. 2019. "A Wikipedia-based method to support creative idea generation: The role of stimulus relatedness," *Journal of Management Information Systems* (36:4), pp. 1284–1312.

Wierenga, B., and van Bruggen, G. H. 1998. "The dependent variable in research into the effects of creativity support systems: Quality and quantity of ideas," MIS Quarterly (22:1), p. 81.

Wu, T., He, S., Liu, J., Sun, S., Liu, K., Han, Q.-L., and Tang, Y. 2023. "A brief overview of CHATGPT: The history, status quo and potential future development," IEEE/CAA Journal of Automatica Sinica (10:5), pp. 1122–1136.