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Generative AI in creative design processes: a dive into possible cognitive biases

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In this paper, we report on the initial results of an explorative study that aims to investigate the occurrence of cognitive biases when designers use generative AI in the ideation phase of a creative design process. When observing current AI models utilised as creative design tools, potential negative impacts on creativity can be identified, namely deepening already existing cognitive biases but also introducing new ones that might not have been present before. Within our study, we analysed the emergence of several cognitive biases and the possible appearance of a negative synergy when designers use generative AI tools in a creative ideation process. Additionally, we identified a new potential bias that emerges from interacting with AI tools, namely prompt bias.

Keywords: creative design process; cognitive bias; prompt bias; ChatGPT

1 Introduction

The world has reached yet another evolutionary stage in regard to technology as a result of the rapid spread of generative Artificial Intelligence (AI) within almost every household. Generative AI is becoming increasingly integrated into our personal and professional lives. It has already demonstrated its efficient implementation in a wide range of fields (Dwivedi et al., 2023) such as medicine (Murphy & Thomas, 2023), education (Jamshidi et al., 2020), and art (Mazzone & Elgammal, 2019), among many others.

As generative AI continues to make its way into various domains, it is also gaining momentum in the design industry (Hughes et al., 2021). In this context, it has the potential to bring about substantial changes in creative design processes. Even though we can identify some of the opportunities that generative AI brings within the creative sphere, various hidden obstacles can also arise from the usage of generative AI within design processes. One of the potential hindrances can be the influence of cognitive biases.

In this paper, we report on the initial results of an explorative study that aims to investigate the occurrence of cognitive biases when designers use generative AI in the ideation phase of a creative design process.

2 Literature review

2.1 The creative process

Designing is an inherently creative process (Barlex 2006; Goldschmidt 2014; Howard et al. 2007). Following the dual-process theories of creative cognition, we can identify two modes of thinking between which there is a continuous shifting when working towards a creative solution: divergent (DT) and convergent thinking (CT) (Goldschmidt 2014, 2016; Finke et al. 1992; Howard et al. 2008; Sowden et al. 2015). DT is generative in nature, referring to the exploration or branching out in different directions, and CT is evaluative in nature, where the thinking is funnelled towards a single, typically definitive, solution or answer (Guilford, 1956).

The usage of generative AI tools may have different implications on designers' divergent (DT) and convergent (CT) thinking. Designers recognize its potential to bring out substantial changes in the creative design processes as well as decision-making. They are increasingly inclined to incorporate it into their workflow. Experienced benefits of generative AI to the creative design process are for example automatization and design optimization (Oh et al., 2019), seamless idea generation (Zhu & Luo, 2022), fast and cheap prototyping and iterations (Parra Pennefather, 2023), and time efficiency (Dwivedi et al., 2023).

Therefore, the current exploration focuses on the possible influence that generative AI tools can have on designers' creative processes.

2.2 Generative AI

When referring to generative AI, we are talking about the type of artificial intelligence system that can create a wide variety of content such as text, images, 3D models, audio, etc. The primary emphasis of this study is specifically on large language models and text-to-image models, specifically ChatGPT (GPT-3.5) and Dreamstudio.ai (Stable Diffusion 1.5) in the context of creative thinking. Both tools are readily available to various designers of all levels, making them an ideal choice for exploring the potential of these technologies in the creative design process.

2.3 Cognitive biases

Cognitive biases can influence various stages of the design process, including idea generation, evaluation of design alternatives, and decision-making. (Hallihan et al., 2012), (Lockton, 2012). Amos Tversky and Daniel Kahneman (1974) introduced the term "cognitive bias," which refers to a systematic tendency for people to deviate from norms or rationalities in their judgement and decision-making processes (Caverni et al., 1990). Cognitive biases are inherent in any creative process, as each individual possesses their distinct perception, judgment, and decision-making approach. The occurrence of these biases within creative design processes is not necessarily problematic. However certain biases may be deepened when incorporating generative AI.

Considering the current potential influence of cognitive biases on the design processes and outcomes, we propose a closer look into the way using generative AI tools can deepen these biases and whether it can introduce new biases that may not have been present before.

3 Methodology

In this explorative study, we aim to investigate the occurrence of known cognitive biases and potential new ones when incorporating generative AI into the ideation phase of a creative design process. We aim to observe the designers' thoughts and behaviours when using generative AI to get a detailed understanding of the possible biases that may occur. Therefore, qualitative data was gathered on ideation processes combined with semi-structured post-interviews.

3.1 Participants

The selected participants for this study consisted of a group of 10 second-year international bachelor students aged 19 to 25 comprising 6 females and 4 males, who were enrolled in the User Experience Design course at The Hague University of Applied Sciences in the Netherlands. Prior to the study, the participants were already acquainted with the concept of generative AI and had various levels of hands-on experience with integrating generative AI tools within their creative design processes. This information was acquired through a short survey consisting of open-ended questions.

3.2 Data collection: Ideation workshops & post-interviews

To investigate the proposed premise, 5 ideation sessions and post-interviews were conducted. In each session, 2 students participated, who were divided into duos based on availability in their schedule. During each workshop, the duo was asked to go through an ideation process using generative AI, specifically ChatGPT (GPT-3.5) and Dreamstudio (Stable Diffusion 1.5), to develop a concept for a given design challenge.

The given design challenge involved the redesign of the student's learning experience in the "Orange Space", which is an open study area within a university dedicated solely to UX, UI and IT design students. The participating students were all frequent users of this study area.

Each session took place in a classroom at the university. The set-up consisted of a table with two chairs, one computer with access to the previously mentioned generative AI tools to support their ideation and encourage collaboration, the digital tool Miro and physical paper, post-its, and pens to record their ideation process and concept.

Each ideation session lasted 60 minutes, with an additional 10 minutes at the start to introduce the design challenge and experiment with the given tools. The facilitator was not present in the classroom during each session, to not disrupt the participants' creative process. While the scope of the workshops was investigating potential biases in correlation with generative AI, the participants were not made aware of this focus.

After each workshop session, a semi-structured post-interview was held with each duo, lasting around 30 to 50 minutes to gather data on their experiences and perceptions of the ideation process and to retrospectively identify any potential biases that may have arisen when using generative AI.

The collected data consisted of audio and video recordings of the workshops and post-interviews, together with screen recordings of the digital process, the chat transcript of ChatGPT, and photographs of the physical materials produced during the session.

3.3 Data analysis

3 of the 5 workshop sessions and post-interviews were selected for data analysis. The decision to exclude the remaining two workshops was made due to too divergent approaches taken by the participants in these workshops.

During the data analysis, the transcripts from the workshops, post-interviews, and ChatGPT conversations were coded along with the photographs of the physical materials. A combination of deductive and inductive coding was used. The codes were divided into 3 categories, namely Creative Processes (divergent & convergent processes), Cognitive Biases (*Table 1)*, and AI-generated ideas.

To establish rigour regarding the cognitive biases deemed important within this study, the curated list of cognitive biases was based on a scientometric analysis of cognitive biases (Fleischmann et al., 2014), from which nine potential biases were carefully selected based on two criteria: (1) cognitive biases that were likely to have direct implications in the creative process in the context of generative AI and could be readily identified within the ideation process, and (2) cognitive biases that were relevant to interacting with this type of technology in a creative context. See *Table 1* for an overview of the selected biases.

Table 1. Curated list of cognitive biases

Cognitive Bias	Definition
Framing Bias	Occurs when people make a decision based on the way the information is presented, as opposed to just on the facts themselves.
Confirmation Bias	Refers to the tendency of selecting information that confirms preexisting beliefs or ideas.
Availability Bias	Refers to the situation in which information that is readily available is used, rather than that which is necessarily the most representative.
Overconfidence	Occurs when people tend to be more confident in their own abilities than is objectively reasonable.
Anchoring	Occurs when people rely too heavily on the first piece of information received on a topic.
Sunk Cost Bias	Occurs when people stick with endeavours in which they've already invested time, money, or other resources even when changing course would be the more logical choice.
Status-quo Bias	Refers to the preference for maintaining one's current situation and opposing actions that may change the state of affairs.
Authority Bias	Refers to the unreasonable confidence in the belief that the information verified by a person with formal authority is correct, and therefore an individual is likely to be more influenced by them.
Prompt Bias	Refers to a type of bias in generative AI where the limited and unknowledgeable input information can impact the accuracy and believability of the generated output.
Priming Bias	Occurs when an individual's exposure to a certain stimulus influences his or her response to a subsequent stimulus, without any awareness of the connection.

4 Findings

Through our analysis, a wide range of results that touched upon various cognitive biases were uncovered. The majority of the findings are linked to the use of ChatGPT. To keep focus, we decided to omit the data that includes the use of Stable Diffusion in the results for this specific paper.

This section presents the outcomes of observed cognitive biases and their interconnectivity in various instances involving the integration of ChatGPT into creative design processes. Initially, we emphasize the similarity among the final outcomes of the sessions. Subsequently, we explore the incorporation or exclusion of AI tools in divergent and convergent processes, while also examining the decision-making process in relation to the utilization of ChatGPT. Lastly, we delve into 3 prevalent biases, namely confirmation bias, framing bias and prompt bias.

Within the creative sessions, participants exhibited cognitive biases in their divergent processes as well as in convergent ones. In various instances, it was observed that the diverging processes were dependent on or deeply connected to the direction given by ChatGPT. Despite the divergent approaches to ideation among the three groups and their respective decisions to include or exclude generative AI tools in the early stages of idea generation, their end results were inclined towards virtually the same direction: creating a colour-coded divided space in which focusing, relaxing and collaborating can coexist. The details of the results were again similar or in multiple cases the same: the utilisation of comfortable seating (suggested 14 times throughout workshops 1, 2 & 3), curtains (suggested 3 times throughout workshops 1 & 3), flexible seating (suggested 13 times throughout workshops 1 & 2), and soundproofing (suggested 13 times throughout workshops 1, 2 & 3). These examples were deliberately chosen for exemplification due to their recurring appearance in the ChatGPT conversations of the duos.

Converging processes such as analysis and evaluation were mostly performed by the participants since the ChatGPT model is designed to present the user with information, which inevitably requires processing. However, they were not limited to converging on their own, and in some instances, they adapted the usage of ChatGPT within their converging processes as well.

Based on their recurrence and observed influence, detailed results on the three of the most prevalent biases will be discussed in the following sections: confirmation bias, framing bias, and prompt bias. Moreover, when analysing the data we observed strong interconnectivity between these three biases, which will be touched on in the discussion section.

4.1 Confirmation bias

When discussing confirmation bias, we refer to the action of subconsciously seeking or interpreting information in ways that are preferential to existing beliefs (Nickerson, 1998). In all workshops conducted during the sessions, participants displayed instances of confirmation bias.

Within the third session, we observed a notable example of confirmation bias. During the session, the participants were discussing the attributes of the shared space. One of the participants proposed the idea of implementing windows within their concept and the second participant tried to build on top of the idea by proposing another idea, abundance of light:

> Participant 1*: Maybe like some windows, like it should be, let's say, not the open space but like […]*

Participant 2: *Like with a lot of light?*

Participant 1*: Yeah, probably.*

The idea was written down by Participant 2. Shortly after, the participants asked ChatGPT for the ideal room for UX designers, in which the features "Good lighting" and “Access to natural light” appeared throughout the numerous proposed ideas. The participant's reaction was:

Participant 2: *Yeah, good lighting, exactly what we said […]*

Participant 2: *For me, for example, when I’m working, I really like to have like a warming light, not the hospital light, like the white one.*

Later in the post-interview, when the participants explained their view on collaboration with generative AI, the same participant explained:

Participant 2*: I really like to work in the warm light, and ChatGPT just confirmed my direction basically.*

Within this example, we are highlighting that Participant 2 presented her affinity for warm lighting and, throughout the interaction with ChatGPT, was actively searching for confirmation of their idea. Later in the post-interview, the same participant explained that they preferred working in warm lighting and felt that ChatGPT had confirmed their preference, further indicating the influence of confirmation bias on their thinking.

4.2 Framing bias

Framing bias refers to the fact that subjects respond differently to information depending on how it is presented to them (Frisch, 1993). While ChatGPT can provide users with new ideas and insights, the probabilistic nature of the tool could also issue the appearance of framing bias by telling users what it “thinks” they want to hear. (Dwivedi et al., 2023)

The appearance of framing bias was spotted in situations in which ChatGPT swerved the participants from confirmation bias by providing new information that was conflicting with their beliefs. Within the third workshop, the participants were searching for information about colour psychology when they were presented by ChatGPT with the idea of implementing the colour red, a colour that went against the group’s beliefs.

Participant 2: *I don't know about red because it's like, really strong.*

Despite initial hesitation they decided to consider the colour red, basing their decision on the explanation of ChatGPT:

Participant 1: *[…] What is red?*

Participant 2*: It’s also calming*

Participant 1*: Passion and excitement. Yes, exactly.*

This situation highlights the possible shift from confirmation bias to framing bias since their reasoning for including the colour red within their concept appeared to be influenced primarily by the plausible explanation of ChatGPT.

In other instances, we observed that participants mentioned that ChatGPT provided them with specific information and conditions, which made it difficult for them to think outside of the provided content. Additionally, some participants observed their tendencies of trusting ChatGPT's responses without question, even if they later realised that they might not be accurate. This can be seen in the example below:

> *Exactly. I just trust it that it's correct. […] Even if you know you fall for it because it's so quick, so good and very confidently accurate. Yeah.* (interviewee 3, session 2, male)

4.3 Prompt bias

Through our data analysis, we discovered a potential bias that is particularly relevant in the context of generative AI. This bias, which we named prompt bias, appears when limited and unreliable information is inputted into the generative AI tools, affecting the reliability and plausibility of the outputted information. This bias is derived from the input bias which refers to the systematic misuse of input information in making judgments of outcomes (Ramachandran & Gopal, 2010). This bias is exemplified in one of the participants' experiences of using generative AI to quickly identify the factors that create the ideal learning environment, specifically for UX designers:

> *But before using any artificial intelligence it was, I needed to have access to the library or Google to search like specific colors say la la la and was not quite related to UX, you know. But here I can say like which is the best color for UX and be like, in my opinion is this and this and that. So I consider, you know, like, much faster actually, I like it. It's not going to waste my time.* (interviewee 5, session 3, female)

The participant in question was searching for information for a specific use case that lacks a clear definition through proper research. Their primed question further directed the generative tool to provide biased information that UX designers require a specific type of colour psychology. The outputted information of ChatGPT was based on incorrect inputs and skewed towards the user's preconceived notions, affecting the reliability of the information.

5 Discussion

The potential of generative AI tools to bring out substantial changes in the creative design processes as well as decision-making was recognized by designers and it was swiftly integrated as an ordinary procedure of the creative process (Griebel et al., 2020). Designers are increasingly inclined to incorporate it into their workflow, potentially resulting in an overreliance on these AI tools which raises multiple concerns.

Throughout the findings, we learned that cognitive biases tend to infiltrate the creative thinking processes, affecting both divergent and convergent thinking, whilst also impacting decision-making (Hallihan et al., 2012). This influence of cognitive biases on creativity is particularly evident in the context of generative AI and its eventual standardised usage. Our study revealed that, in this context, the occurrence of cognitive biases creates negative synergies between the individual biases of users and those embedded within the used AI tools. This phenomenon can impact decision-making throughout the creative thinking process. Consequently, creatives can be steered towards similar directions, causing similarities in results when ChatGPT is used as an ideation tool and potentially limiting the exploration of diverse and unconventional ideas and ultimately limiting innovation. It is

crucial to acknowledge, however, that the emergence of cognitive biases within the creative process is an inescapable outcome due to the way human cognition operates.

When assessing the interconnectivity between confirmation, framing and prompt bias, we observed that ChatGPT has the power of creating a harmful fusion between these biases due to its model of interacting and presenting information. The act of inputting information and expecting a response is inherently biased in this context as it can direct the exploration towards a specific direction, that in the end might not be reliable or valid. The user could potentially include incorrect information in their input (prompt bias), transmitting false information to ChatGPT. In response, ChatGPT might generate additional information that unintentionally reinforces the user's misguided assumptions or beliefs (confirmation bias). The information provided by ChatGPT would be framed to seem relevant (framing bias), and the user might then incorporate this fabricated data as factual in their creative work.

The similarity of the end results presented in the findings can be attributed to several factors. Firstly, the participants all learned decision-making and creative design methodologies in the same manner during their first year at the university since they followed the same course. Secondly, the groups were given the same design challenge, focusing on improving a space that was familiar to them; this prior familiarity allowed them to identify potential shortcomings and areas in need of improvement. Thirdly, the use of identical tools (ChatGPT and Stable Diffusion) and repeated exposure to the same ideas played a role in the similarity of their suggestions; this highlights the potential enhancement of priming bias in the interaction with generative AI tools, as well as an overreliance on received information from the ChatGPT conversations.

It is important to take into consideration that ChatGPT is a large language model that is primarily designed to generate human-like responses rather than to serve as a reliable source of information or as an ideation tool, so due to its nature, it is easy for the users to fall into the illusion of being presented with compelling information.

In the realm of Interaction Design, this study presents an exploratory examination concerning the improper integration of generative AI tools into designers' creative processes and the subsequent outcomes. It not only highlights the importance of recognizing current limitations but also proactively anticipates forthcoming barriers that could arise from the adoption of these new creative processes. In doing so, it encourages designers to be aware of the potential existence of cognitive biases and dwell on strategies to diminish their effects.

6 Future Work

The information uncovered within this study does not encompass the sum of all limitations that appear when generative AI tools are used in the creative design process. Therefore, further research is needed to better understand the limitations that appear in this situation as well as the overall context of this scenario. Currently, we anticipate that the limitations that we shed light on, namely the interconnectivity of personal cognitive biases with the ones within the generative AI tools consisting of confirmation, prompt and framing bias, can help raise awareness of the limitations associated with the integration of generative AI tools within the creative process. This awareness can also encourage designers to dwell on mitigation strategies.

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