The Effect of Design Students' Command Interactions in Artificial Intelligence Applications on User Experience: An Exploratory Study with Psychophysiological Data Harvesting

Araştırma Makalesi/Research Article

Barış ATİKER[1], Behiç Alp AYTEKİN[2]*, Neslihan ERDEM[3], Ezgi ŞEN ATİKER[4]

[1]Aydın Adnan Menderes Üniversitesi, İletişim Fakültesi, Görsel İletişim Tasarımı Bölümü, Aydın, Türkiye
[2]Aydın Adnan Menderes Üniversitesi, İletişim Fakültesi, Görsel İletişim Tasarımı Bölümü, Aydın, Türkiye
[3]Aydın Adnan Menderes Üniversitesi, İletişim Fakültesi, Görsel İletişim Tasarımı Bölümü, Aydın, Türkiye
[4]Çanakkale Onsekiz Mart Üniversitesi, Güzel Sanatlar Fakültesi, Grafik Tasarımı Bölümü, Çanakkale, Türkiye

baris.atiker@adu.edu.tr, alpaytekin@adu.edu.tr, neslihan.erdem@adu.edu.tr, ezgi.senatiker@comu.edu.tr

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Abstract— In recent years, people have been talking a lot about how generative AI affects design. These technologies change how we usually do design and bring new chances and problems. This study looked at how generative AI affects design, focusing on creativity and user control. It studied tools like Ideogram.ai and Krea.ai with 15 visual communication design students at a university in Turkey. The study used a technique called Psychophysiological Data Harvesting (PDH) to analyze student experiences and creative results. It compared text-to-image and sketch-to-image design processes using eye tracking, electrodermal activity, and post-test questions. The study found that generative AI can greatly improve design processes, but the interfaces need to be better to help users control and explore creatively without feeling stressed.

Keywords— generative AI, visual communication design, creativity with AI, human-computer interaction, user experience, eye-tracking, electrodermal activity response

Tasarım Öğrencilerinin Yapay Zekâ Uygulamalarındaki Komut Etkileşimlerinin Kullanıcı Deneyimine Etkisi: Psikofizyolojik Veri Hasadı ile Keşifsel Bir Çalışma

Özet— Son yıllarda üretken yapay zekânın tasarım üzerindeki etkisi sıkça tartışılmaktadır. Bu teknolojiler, geleneksel tasarım süreçlerini dönüştürmekte ve beraberinde hem yeni olanaklar hem de çeşitli sorunlar getirmektedir. Bu çalışma, üretken yapay zekânın tasarım üzerindeki etkisini yaratıcılık ve kullanıcı kontrolü odağında incelemiştir. Türkiye'deki bir üniversitede öğrenim gören 15 Görsel İletişim Tasarımı öğrencisiyle yürütülen araştırmada, Ideogram.ai ve Krea.ai gibi araçlar kullanılmıştır. Psikofizyolojik Veri Hasadı (PVH) tekniği ile öğrencilerin deneyimleri ve ortaya çıkan yaratıcı çıktılar analiz edilmiştir. Metinden görsele ve eskizden görsele tasarım süreçleri, göz izleme, elektrodermal aktivite ölçümü ve son test soruları ile karşılaştırılmıştır. Bulgular, üretken yapay zekânın tasarım sürecini önemli ölçüde geliştirebileceğini, ancak kullanıcı arayüzlerinin yaratıcı keşfi destekleyecek şekilde geliştirilmesi gerektiğini göstermektedir.

Anahtar Kelimeler— üretken yapay zekâ, görsel iletişim tasarımı, yapay zekâ ile yaratıcılık, insan-bilgisayar ekileşimi, kullanıcı deneyimi, göz izleme, elektrodermal aktivite yanıtı

1. INTRODUCTION

Design processes play a critical role in developing students' creativity, problem solving and innovative thinking skills. However, in today's world of rapidly evolving digital technologies, the design paradigm is also undergoing a transformation [1, 2]. Generative AI has significant potential to optimize the design process by aiding diverse idea generation, data analysis, and user research, while maintaining uniqueness and human-centered approaches [3]. This study proposes a novel approach to assess the effects of generative AI in design processes, aiming to examine the implications of these technologies on key design concepts such as creativity and control in light of findings from Psychophysiological Data Harvesting (PDH) technique.

Traditional design pedagogy has relied on analogies, metaphors and critical thinking strategies [4] to maximize the creative potential of visual communication design students. However, digital technologies, and in particular the proliferation of generative artificial intelligence (AI) systems, have exposed the limitations of this traditional approach [5]. Generative AI encompasses algorithmic models that can deliver creative outputs based on both textual and imaginative inputs. These systems have the capacity to provide designers with simultaneous feedback, offer solution alternatives, and even generate entirely new ideas. However, these innovations raise questions about how they affect the designer's control over the creative process and creative decision-making [6].

This study explores how generative AI-assisted design processes influence design students' views on creativity and control, particularly by comparing text-to-image and sketch-to-image prompt-based AI applications. Specifically, it seeks to determine whether significant differences exist between design processes utilizing text versus sketch inputs, as well as between sequential and synchronous design workflows. These comparisons are essential for understanding the pedagogical implications and potential of such technologies. Furthermore, the study explores the effects of generative AI on students' time management, problem-solving abilities, and technical competencies, offering actionable insights and recommendations for future design practices. By elucidating the potential benefits and limitations of artificial intelligence in design processes, this article aims to establish a foundation for further research in this evolving field.

2. THEORETICAL BACKGROUND

2.1. New Paradigms and AI in the Design Processes

The evolution of design processes has long been shaped by technological advancements. The transition from traditional, labor-intensive methods to digital tools marked a significant turning point in the field. More recently, the rise of artificial intelligence has transformed design practices by extending the boundaries of creativity and innovation. Beyond its practical applications, AI's influence on creative thinking and problem-solving approaches warrants closer examination. This combination of technical and cognitive perspectives offers a deeper understanding of how AI is reshaping the design landscape.

One of generative AI's most significant contributions is its ability to make creative production more accessible and inclusive [7, 8]. Tasks that once required advanced technical expertise can now be explored by a broader range of users. For example, parametric design and automation tools enable students to experiment with geometric forms and engage in the design process as a hands-on learning experience. Without the need for complex calculations or programming skills, students are able to apply the principles of algorithmic thinking and access areas of design that were previously beyond reach.
Generative AI systems are increasingly positioned as creative partners in design, particularly in the domains of ideation and production [9]. These tools stimulate alternative thinking by broadening designers' cognitive processes and enabling outcomes not easily achievable through conventional means. Yet, this potential raises important questions: How can algorithmically generated ideas maintain harmony with human originality? And to what extent might reliance on such systems limit, rather than enhance, creativity? To prevent design processes from becoming constrained by algorithmic boundaries, it is essential to treat generative AI not as a replacement, but as a supportive component within the designer's toolkit.

The integration of AI into design education extends beyond technical skill development; it also fosters critical thinking and creative problem-solving abilities [11]. Given that design problems are often characterized by uncertainty, AI can support the exploration of multiple approaches. Algorithms capable of producing diverse solutions enhance creativity while simultaneously sharpening students' analytical and evaluative capacities. This contributes to a more holistic design approach that incorporates considerations such as sustainability, user experience, and production efficiency. In this context, AI functions both as an accelerator and as a reflective tool in the educational design process.

AI-enabled creative tools are also transforming collaboration in design education [12]. Once regarded as a solitary pursuit, design is now increasingly collaborative, with AI supporting the generation of varied ideas and the rapid visualization of conceptual solutions. These technologies enable students to engage with multiple perspectives and collaborate in dynamic learning environments. Such interactions enrich the design process and, in addition, help students develop essential skills in human-computer interaction and digital communication—competencies that are critical for future designers.

Automation remains one of AI's most impactful contributions to design workflows [13]. By managing repetitive and time-consuming tasks, AI allows students to concentrate on the creative and strategic dimensions of their work. However, this shift also necessitates a deeper understanding of how these systems operate, rather than merely how to use them, and the ability to critically evaluate their outputs.

AI is also reshaping pedagogical models in design education. Unlike traditional, linear knowledge transfer from teacher to student [14, 15], AI encourages more interactive learning environments [16], where students actively engage with content. Empirical research shows that effective collaboration between students and generative AI can enhance meta-cognitive and self-regulated learning [17]. Likewise, doctoral students who engaged in iterative and dialogic use of AI tools performed better than those who employed them passively [18]. Nevertheless, positioning generative AI as a learning partner presents challenges. It requires a careful balance between leveraging technological support and preserving human agency and critical thinking. Accordingly, it is advised that AI be introduced as one of many process tools within a designer’s repertoire, rather than as a means for generating final outputs [19]. In sum, generative AI holds significant potential for enhancing both educational and creative practices in design. To fully realize this potential, its integration must be guided by ethical awareness, critical reflection, and a strong commitment to human-centered collaboration.

3. METHODOLOGY

This exploratory study aims to expand psychophysiological research on Generative AI design tools, recently introduced into visual communication design education [20, 21, 22]. The research nature is PDH led mixed method approach based. Psychophysiological measurements can be obtained independently of the participant's cognitive effort and without intervention since psychophysiological measurements are obtained from peripheral nervous system components classified according to the nervous system in various studies and somatic and autonomic nervous systems [23, 24, 25].

Table 1. Psychophysiological Data Harvesting technique–multi method [26]

Step 1	Adaptation to Human-Computer Interaction (Preparation for PDH) PDH can be performed at this step based on physical field procedures and remote psychophysiological data collection. Regardless of the selected structure, this step is required to complete the preparation processes for participants and allow them to adjust to the technological stage. This step involves waiting for the participant’s biological rhythm to be ready for psychophysiological measurements, controlling the environmental conditions for stimuli like light, sound, et cetera, and, if measurements are done remotely, completing procedures like technical eye and face calibration: • Determining Basal Metabolic Rate • Eye calibration for eye tracking • Face calibration for facial recognition • Preparing and testing computer, camera, and sound recording equipment • Procedural actions to ensure appropriate conditions for remote PDH • Signing the relevant permission and consent forms • Informing and guiding participants about the procedure
Step 2	Autonomic Nervous System Data Collection At this step, the data is collected from the participants using the preferred PDH tools and within the appropriate timing. This step can be configured for physical harvesting or remote harvesting. The techniques for this step are listed below: • Eye-Tracking • Electrodermal Activity Data Analysis (EDA) • Face Recognition and Facial Expression Analysis (FACS) • Heart Rate Analysis (ECG) • Heart Volume Analysis (PPG) • Functional Magnetic Resonance Imaging (fMRI) • Electroencephalography (EEG) • Other Psychophysiological Indicators (Temperature, Blood Pressure, Blood Oxygen, etc.)
Step 3	Cognitive Data Collection After completing the PDH procedure, this step involves collecting cognitive responses from participants to allow in-depth findings and data analysis using the preferred qualitative and quantitative techniques. This step can be configured as a scale-based quantitative process, a qualitative-based interview process, or a structure that adopts both approaches. Example techniques include: • In-Depth Interview • Focus Group Work • Questionnaires • User Research Methods (Card Sorting, Think Aloud, et cetera.) • Mouse Tracking • Tasks and Orientation • Other Quantitative Methods

As shown in Table 1 above, within the scope of the Psychophysiological Data Harvesting (PDH) technique, which offers the opportunity to evaluate different psychophysiological techniques together, Eye Tracking [27, 28, 29, 30] and Electrodermal Activity (EDA) [31, 32] and post-test [33] techniques were preferred and in PDH scope evaluated together in order to analysis students' gaze and emotional state changes. In addition, the post-test questions meticulously around three key elements: control, creativity, and improvement.

3.1. Participants and Equipments

In line with Nielsen's [34] research that user experience research can be conducted with five or more participants and Faulkner's [35] research that reliability increases as the number of participants increases, the study was conducted with 15 visual communication design students studying at a state university in Turkey. Prior to their involvement, informed consent was obtained from all participants. Additionally, the research was conducted in compliance with ethical standards, as evidenced by the approval granted by the ethics committee (Approval No: 14/10).

Tobii Pro Fusion 60 Hertz screen-based eye tracker was used to collect the students' eye trace. Eye prints were recorded with Tobii Pro Lab software version 1.181. The eye tracker was calibrated using a nine-point calibration procedure that students had to follow on a flat, gray background. Students were seated between 55-65 cm away from the screen for calibration and participants' data were included in the study, taking into account a calibration rate of at least 90% and above for data validity. Synchronously, electrodes were attached to two fingers of one hand and earlobe and EDA data were collected via Shimmer GSR+ to measure students' emotional state changes (deep and peak values) with Skin Conductivity Level (SCL) or Event Related SCR (e-SCR). Area of interests (AOIs) were created in the stimuli for data analysis [36]. Data were analyzed in Tobii Pro Tobii Pro Lab software version 1.181.

3.2. Stimuli and Procedure

Each participant engaged in sessions lasting 20-30 minutes, structured into three distinct phases in below Table 2. The initial phase, the Pre-test, required students to design a logo sketch based on one of three provided concepts: "Golden Fish Restaurant", "Spark Energy Drink" or "Broken Scissor Barber". Participants were allotted five minutes to complete their hand-drawn sketches, after which they were instructed to generate descriptive prompts (keywords) corresponding to their designs.

In the subsequent phase, participants utilized AI tools to digitally recreate the logos they had sketched. Given the varying levels of English proficiency among the students, they were directed to translate their prompts using the DeepL translator [37], which is also AI supported smart translation software, prior to commencing this phase. This step ensured clarity and accuracy in the AI-generated outputs, facilitating a more effective design process.

The second phase consisted of two stages. In the first phase, the participants were asked to transfer the design in the sketch from “text-to-image” within five minutes using the Ideogram AI tool [38]. In the second phase, they were asked to create the sketch in five minutes with Krea AI [39] another prominent AI tool for converting “sketch-to-image”. In the meantime, they were expected to create the logo in real-time on the Krea AI interface by drawing in Adobe Illustrator [40] on the left side of the screen, which is a feature of Krea AI. In the second phase of the study, eye tracking and EDA data were collected simultaneously. In the third phase, participants answered a survey based on a 5-point likert scale for both AI tools.

Table 2. Three phases of the PDH technique

Psychophysiological Data Harvesting
Pre-Test Phase
• Project briefing • 5 minutes quick sketch prosedure • Keywords selection as prompts
Test Phase
• First step: Text-to-image in Ideogram.ai • Second step: Real-time digital sketch-to-image in Krea.ai with eye-tracking and electrodermal activity real-time measurement
Post-Test Phase
• Post Questionnaire with 15 statements

In the research, the applications Ideogram.ai and Krea.ai were utilized to examine the effects of generative AI on visual design processes. Both applications were chosen due to their extensive capabilities in generating designs from text and sketches, as well as the high quality of the outcomes they produce. Within the scope of the study, the contributions of these two applications to design processes, their impact on student experiences, and their influence on creative outputs were compared.

The research was structured around two distinct exercises: the first exercise involved generating images from text, while the second exercise focused on generating images from sketches. In the sketch-based exercise, students were asked to select one of three different logo design projects, first sketching their ideas on paper- as seen in Figure 1- and then using the applications to create logos that were either close to their original sketches or more creatively advanced. All stages of the process were meticulously documented and analyzed.

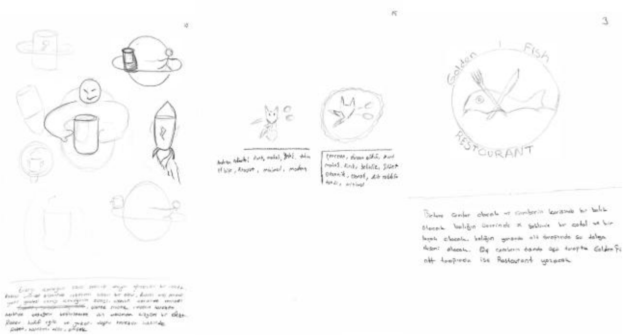

Figure 1. Design sketches of the participants

In the first step, the Ideogram.ai application was used for generating images from text. As the initial step, students prepared sketches containing their original design ideas and distilled the fundamental elements of these sketches into specific keywords. Subsequently, these keywords were entered as prompts into the Ideogram.ai application. In accordance with the operational principles of the application, the outcomes generated from the initial prompts were systematically assessed, and subsequent modifications were implemented to refine the prompts as required. In this exercise, the only control tool available to students for achieving creative output was the keywords they used. The process continued until students obtained results closest to their own sketches or achieved a design; they considered more creative than their original sketches.

In the second step, Krea AI was employed to generate images from preliminary sketches. Students used Adobe Illustrator to digitally render their conceptual sketches. All participants had previously completed project-based courses such as Desktop Publishing, during which they gained practical experience with design software like Adobe Illustrator and Photoshop. Based on this background, it was assumed that students had sufficient prior experience to use these tools effectively. They compared their manual designs with Krea AI's real-time visual suggestions, utilizing its sketch-to-image feature to transform basic shapes into intricate designs. Throughout the drawing process, students actively engaged with their designs by evaluating and selecting from the various iterations proposed by the application. The primary tools available to students for achieving creative outcomes included both the strategic use of keywords and the functionalities of Adobe Illustrator. The process was considered complete when students achieved results that either closely matched their original sketches or surpassed them in creativity.

In the post-test phase, participants evaluated the following statements in Table 3 on a 5-point likert [41, 42] scale from 1 to 5. (1=I completely disagree, 3= Neutral, 5=I completely agree)

Table 3. Post-test statements

1	It was easy to come up with new and original ideas
2	I was able to take more risks during the design process
3	Trying to manage the application stressed me out
4	I used my imagination more freely
5	I felt that my creative thinking skills improved
6	I was worried about losing control
7	I had more confidence in my design skills
8	I was able to express my ideas more easily
9	I put a lot of effort into managing the application
10	I felt less anxiety and hesitation while designing
11	I believed in myself more and my self-confidence increased
12	It was difficult to control the AI application
13	It was easy to find unusual and different solutions
14	The application did not do exactly what I wanted
15	I was proud of my work (design)

For analysis, the Ideogram interface, as shown in the following visual, is divided into two main AOIs in Figure 2. The primary rationale behind this division is that one AOI is designated for entering prompts, while the other is for observing the output.

Figure 2. Ideogram Prompt AOI vs Results AOI User Interface (Green and purple rectangles were referenced for different AOIs)

The Krea AI application is similarly divided into two AOI sections as its interface in Figure 3. The first area is where users create their drawings in Adobe Illustrator, while the second AOI area is where Krea AI generates real-time results. Unlike other artificial intelligence applications, Krea AI operates on a real-time, sketch-to-image logic. After the completion of the procedures, the analysis was carried out.

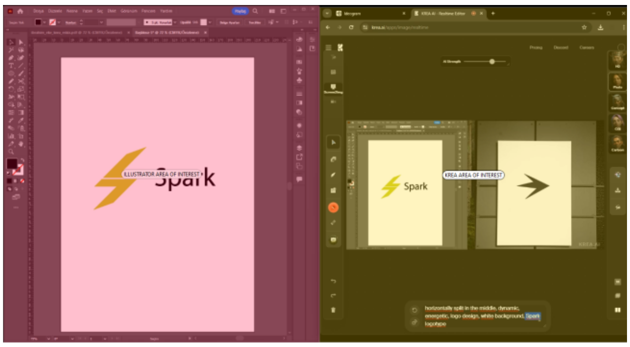

Figure 3. Krea Image Prompt AOI vs Simultaneous Results AOI User Interface

Integration of psychophysiological data increases the reliability of subjective responses. A common challenge in emotion-focused research is the potential for participants to misreport or under-express their emotional states. In such cases, physiological data serve as a valuable adjunct to self-reported survey results, facilitating a more robust and nuanced analysis. This complementary approach not only reduces the inherent limitations of subjective reporting but also contributes to a more comprehensive understanding of the emotional constructs under investigation. In this study, using a combination of different psychophysiological techniques, original, innovative findings for the use of AI for design were obtained.

4. RESULTS AND DISCUSSION

To evaluate the findings at this stage, the Area of Interest (AOI) data obtained from Ideogram and Krea AI, which differ in their interfaces and working principles, were examined. Firstly, one of the primary objectives of the research is the criterion of participants achieving outputs that are either close to their own sketches or more creative by using AI applications. Users with a high number of fixation count (FC) experienced a greater cognitive load when entering their sketched designs as text prompts into the interface. Fixation count refers to the total number of fixations on a given visual stimulus or region. That is, the number of times a person fixated on an object, word or region is recorded as fixation count and is usually calculated based on a minimum fixation duration threshold (e.g. 200 ms.) [43] Comparison is easy if there is a control group. Table 4 compares the FC of the AOIs of the prompt area and the result area in Ideogram AI.

Table 4. Ideogram AI Fixation Count (millisecond)

Participant	Generating (AOI)	Results (AOI)
P1	139	386
P2	253	401
P3	160	91
P4	442	160
P5	352	321
P6	309	277
P7	95	310
P8	248	282
P9	432	495
P10	128	255
P11	175	272
P12	278	135
P13	329	135
P14	252	221
P15	234	190

This situation arises from the fact that the language they use to input prompts differs from their native language. The users' native language is Turkish; however, both applications operate exclusively in English and do not support the use of their native language. Due to the control of the language variable [44, 45], the focus on each word resulted in a higher fixation count (FC) on these AOIs for these users. Nevertheless, post-test findings indicate that, despite this challenge, the Ideogram AI (text-to-image) were motivationally satisfied with the outputs obtained and felt that the process was complete for them.

On the other hand, the Result AOIs were less affected by the native language variable. They were able to detach from the influence of this factor and focus more on the design process. By entering prompts with less cognitive load, they were able to examine the alternative outputs provided by the AI more thoroughly. Students who devoted greater focus and attention to analyzing the AI-generated outputs also reported during the post-test phase that the text-to-image process was straightforward and comprehensible.

It has been observed that while AI-driven design applications offer several advantages—such as enhanced concurrency, adjustable parameters, and a wide array of options—these features may inadvertently impose excessive cognitive load on users [46, 47, 48, 49, 50, 51] leading to counterproductive outcomes. This cognitive overload, coupled with a perceived loss of control and the inability to achieve desired design outcomes, can result in adverse effects, including reduced user motivation. Similarly in the post-test results reveal significant findings regarding students' use of generative AI and their sense of control. Analysis of the differences between the models clearly showed that students using sketch-to-image had more difficulty controlling it. For sketch-to-image reported higher levels of negative emotional arousal in response to questions related to control in Figure 4.

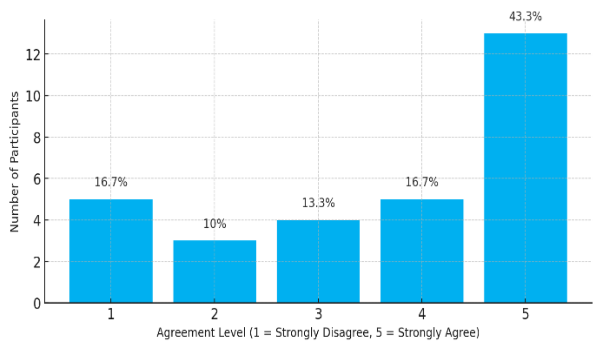

Figure 4. Responses to statement 14: “The application did not do exactly what I wanted”

Students encountered fewer difficulties with control when using the text-to-image tool. The parameter variables that AI can respond to, and control are increasing exponentially day by day. The tool acts as a channel in the natural flow of design interaction, especially in the concretization phase of an idea. It is essential that the tool is presented to the user at a level that does not cause loss of control.

Table 5. Krea Fixation Count (millisecond)

Participant	Adobe Illustrator (AOI)	Krea (AOI)
P1	**434**	187
P2	**450**	284
P3	**404**	214
P4	**749**	519
P5	**751**	331
P6	**319**	290
P7	**819**	385
P8	**383**	328
P9	**1123**	245
P10	112	155
P11	**386**	348
P12	**430**	248
P13	332	392
P14	**376**	246
P15	**249**	72

The findings from the Krea AI AOI Fixation Count presented in Table 5 overlap with the EDA data results. All participants provided significantly more focus-related data compared to the FC values observed in the other AI application. This indicates that the sketch-to-image process in AI usage requires substantially higher cognitive load compared to the text-to-image process. Factors such as the abundance of parameters to be managed and the principle of obtaining visual results simultaneously with visual suggestions trigger the users' Fear of Missing Out (FoMO) and amplify their sense of loss of control [52].

When we evaluate the process based on AOIs, 87% of the participants predominantly reported difficulty in creating sketch-to-image prompts within the Adobe Illustrator interface. Furthermore, significant marginal variations were observed in the total FC values. Although the sample group consisted of design students who are familiar with applications like Adobe Photoshop and Illustrator, the workflow of sketching and simultaneously obtaining outputs from AI posed challenges for the users in every examined aspect. At this point, it is worth taking a closer look at the sketch-to-image process. Numerous AI agents utilizing image-to-image prompts generate novel outputs by processing pre-existing representational images. In contrast, tools such as Krea AI allow users to create drawings within environments like Adobe Illustrator and facilitate prompt communication based on the principle of simultaneity within this framework. A comparative overview of the text-to-image and sketch-to-image processes based on control, output, and psychophysiological responses is presented in Table 6.

Table 6. Comparative Overview of Text-to-Image and Sketch-to-Image Design Processes

Feature	Text-to-Image	Sketch-to-Image
User control difficulty	Low–Moderate	High
Output closeness to intent	Moderate	Variable
Emotional arousal (SCR peaks)	Low	High
Interface usability	High	Moderate
Creativity satisfaction	Moderate–High	Mixed

As reflected in Table 6, these differences are further supported by psychophysiological indicators, which reveal how design processes affect user experience on a deeper, embodied level. This phase, as evidenced by the observed EDA data, led to shifts in user motivation, increased complexity, and a sense of dissatisfaction with the generated outputs- thereby impacting the overall user experience, Since individual skin conductance levels can vary significantly between participants, this study interpreted the EDA data based on within-subject changes and relative fluctuations rather than fixed thresholds, as suggested in previous psychophysiological research [32, 53]. As illustrated by the pronounced SCR fluctuation observed in Participant 7's Krea.ai output in Figure 5, which is consistent with trends observed in other participants.

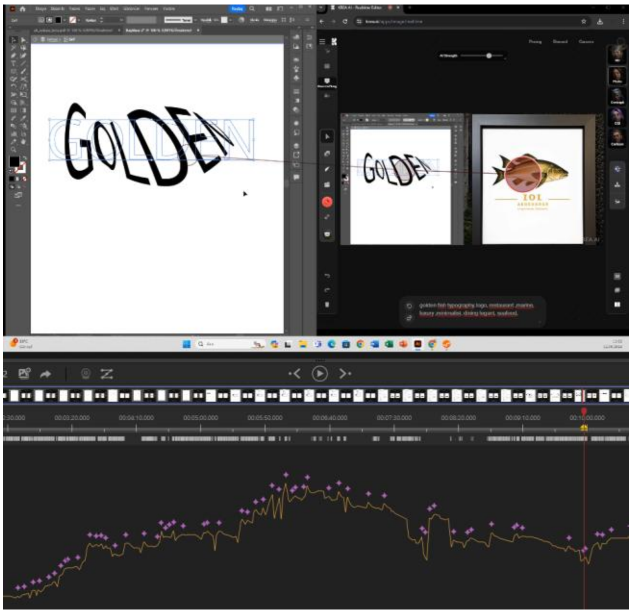

Figure 5. P7's Krea.ai SCR fluctuation

An increase in the total SCR count was observed among participants using the Krea AI application. When all methodological phases are taken into account, several reasons for this increase are identified collectively:

Firstly, participants experience significantly greater emotional stimulation in Krea AI due to the interface's real-time responsiveness compared to the text-to-image. These real-time emotional stimuli increase the cognitive load on participants, leading to an overall rise in their design responses during the process. This situation indicates that the need for greater control in real-time visualization and design elevates stress levels among participants.

In the post-test responses, among the notable differences, it was observed that sketch to image users reported exerting more effort to manage the application and experiencing higher stress levels. This suggests that control challenges are more pronounced in sketch-based systems, the statement *"The application did not exactly do what I wanted"* received the highest scores. This reflects the perception that students in both tools were unable to achieve full control over the outputs. Additionally, the responses given to the statement *"I was worried about losing control"* in Figure 6, were similarly high in both models, indicating a general sense of control-related negative emotional arousal.

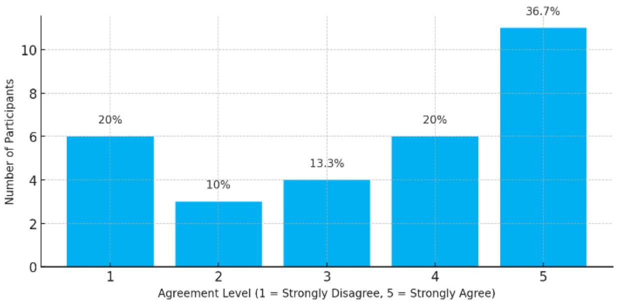

Figure 6. Responses to statement 6:" "I was worried about losing control"

When emotional and psychological effects are evaluated, it is observed that the concern about loss of control is at a notable level, the emotional level remains at a moderate, and feelings of negative emotional arousal persist during the design process in Table 7. This situation indicates that while artificial intelligence tools contribute to the development of professional skills, they have a more limited impact in the realm of personal development. Furthermore, it highlights the need for improving AI tools in terms of predictability and reliability. The moderate emotional level and ongoing feelings of negative emotional arousal suggest that students do not experience complete comfort and confidence when working with artificial intelligence tools.

Table 7. Ideogram and Krea SCR count (Skin Conductance response from EDA data)

Participant	Ideogram	Krea
P1	47	52
P2	43	37
P3	43	37
P4	**47**	**86**
P5	27	29
P6	**5**	**25**
P7	**19**	**82**
P8	67	69
P9	71	94
P10	17	20
P11	25	25
P12	**35**	**62**
P13	**5**	**10**
P14	21	13
P15	21	27

Secondly, it has been observed that increasing cognitive load disrupts positive motivational connections. This situation emerged from the participants' responses during the post-test phase and observations made during the test phase. The uncontrolled design variables in the sketch-to-image synchronization phase posed a cognitive load on users, which was interpreted as inconsistency, lack of control, and indecision, leading to a weakening in the positive motivational relationship in Figure 7. Therefore, while the presence of text-to-image SCR values can be interpreted as a positive motivational variable towards the generated visual in response to the relevant command, the increase in sketch-to-image SCR output can be interpreted as an opposite motivational state.

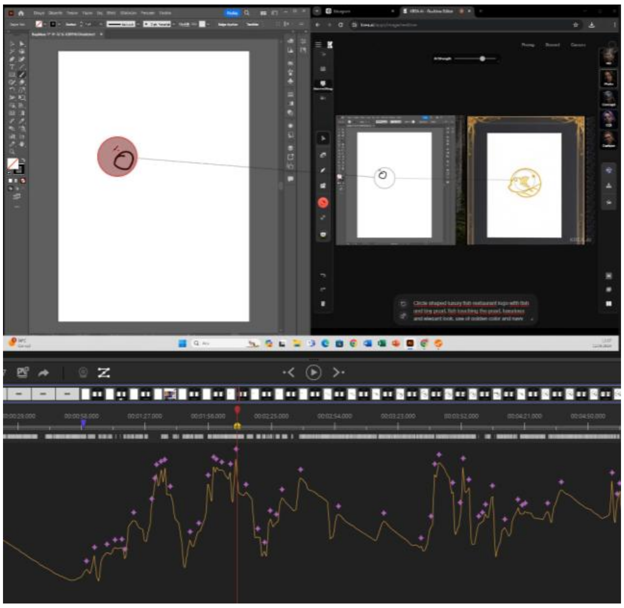

Figure 7. P8's Krea application on the screen of SCR (SCR peak and deep from EDA)

When the EDA variables between the two study phases are carefully examined, it becomes evident that the increased emotional arousal and complexity observed during the sketch-to-image process can be interpreted particularly in terms of the total SCL value and the variability of SCR peaks. Although participants were generally familiar with digital design tools, they experienced difficulty managing the sketch-based interface and synchronizing it with the AI system in real time. These challenges resulted in noticeable shifts in arousal levels, decreased satisfaction with the outputs, and ultimately disrupted the overall design experience. Despite these emotional and cognitive challenges, students' perceptions of how generative AI influenced their creativity remained relatively positive.

When analyzing students' approaches to the relationship between generative AI and creativity, a generally positive trend slightly above the moderate level is observed. The averages of responses to all questions related to creativity. In particular, the responses to the statements *"I used my imagination more freely"* in Figure 8 and *"I felt that my creative thinking skills improved"* indicates that generative AI tools generally have a positive impact on students' creative processes.

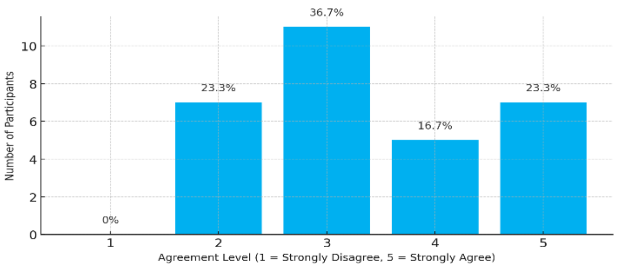

Figure 8. Responses to statement 4: "I used my imagination more freely"

Overall, it was found that students experienced moderate-to-high levels of negative emotional arousal and difficulty regarding control. Control issues were particularly more evident in sketch-based systems, and challenges in achieving the desired output were observed in both systems. These findings indicate that generative AI systems require improvements in terms of control and user experience. Specifically, it is recommended to focus on interface enhancements to increase user control and reduce cognitive load and stress, particularly in sketch-based systems. For instance, Participant 8 reported that the output generated with Ideogram AI was closer to their original sketch compared to the result produced with Krea AI.

Figure 9. P8's sketch and generative AI outputs

Table 8 provides a comparative summary of the SCL averages and motivational indicators across both design interfaces. The analysis results show that the same correlation persists when examining the SCL averages: the total motivational variables of users were higher on the Krea AI interface. This is attributed to the cognitive load arising from the variables and uncertainties inherent in the real-time control process of the application. This load, in turn, affects the user's positive motivational variables toward the design outcome.

Table 8. GSR Average (EDA-Skin Conductance Level)

Participant	Ideogram	Krea
P1	7,42	6,86
P2	0,87	0,77
P3	**7,20**	**8,84**
P4	**5,09**	**11,72**
P5	**3,74**	**4,22**
P6	**0,79**	**1,96**
P7	**1,30**	**2,56**
P8	**3,04**	**5,06**
P9	**4,12**	**6,31**
P10	**1,85**	**2,03**
P11	**1,09**	**1,76**
P12	**1,79**	**3,00**
P13	**0,97**	**0,99**
P14	3,38	2,20
P15	**1,83**	**5,16**

Participants reported greater positive motivational satisfaction with the outputs they obtained after creating their own drawings using Ideogram AI. They expressed above-average positive responses, indicating that the Ideogram AI outputs either closely matched or exceeded their envisioned design expectations. However, upon examining the distribution of responses, some noteworthy points emerge. For instance, in the statement *"Generating new and original ideas came easily,"* the responses appear to be highly polarized; while 9 students gave the highest score, 5 students gave the lowest score. This indicates that the impact of generative AI tools on creativity can vary significantly depending on individual differences. Similarly, in the statement *"Finding unusual and different solutions was easier,"* the fact that the majority of students (11 participants) provided a moderate evaluation suggests that the influence of these tools on creative problem-solving processes may be limited.

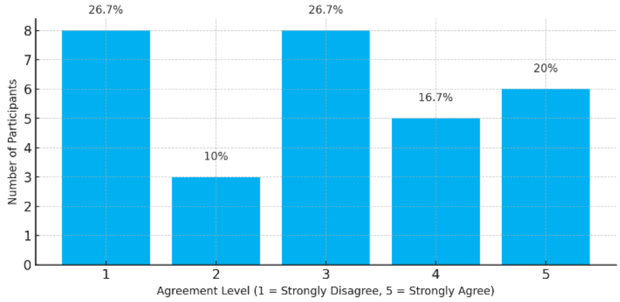

Figure 10. Responses to statement 15:" I was proud of my work (design)"

In terms of participant satisfaction, it is observed that all responses exhibit a balanced distribution, and the general consensus is not yet fully satisfactory in Figure 10. In light of these findings, it can be stated that AI tools possess significant potential in the visual design process; however, certain improvements are needed to fully realize this potential. Specifically, it is necessary for these tools to produce more consistent and predictable outcomes, enhance the user experience, and be designed in a way that further supports the development of students' self-confidence. These improvements will enable AI tools to be utilized more effectively and efficiently in the visual design process, thereby contributing more substantially to both the professional and personal development of students.

5. CONCLUSION

The study thoroughly investigates the impact of generative AI on design processes by examining its effects on creativity, control, and overall workflow. A mixed-method approach was adopted, combining Psychophysiological Data Harvesting (PDH) with participant surveys to collect both objective and subjective data. The study was focused on two AI image creation tools, Ideogram and Krea, each offering unique functionalities that influence the design process differently.

In the domain of creativity and problem-solving, generative AI tools were found to have a moderately positive impact on students' creative processes. According to responses to the statement "I felt that my creative thinking skills improved", 7 out of 15 participants (46.6%) agreed or strongly agreed, while one-third (33.3%) selected the neutral option. Although these findings suggest that AI tools supported the development of creative ideas for nearly half of the students, the influence was not consistent across the group. Some students found it easier to generate new ideas, whereas others still experienced limitations. Overall, while generative AI facilitated unconventional thinking to a certain extent, students continued to rely on their own creative instincts.

In addition to creativity, user control emerged as another critical dimension influencing the overall experience with generative AI tools. In terms of control, the study revealed that students experienced moderate to high levels of negative emotional arousal and difficulty in managing AI tools. The sketch-to-image method, used in Krea AI, was particularly challenging, leading to more control-related difficulties and higher negative emotional arousal compared to the text-to-image method used in Ideogram AI. Regardless of the method, students struggled to achieve full control over the outputs generated by the AI tools, highlighting a key limitation in user experience.

From a technical competence perspective, AI tools were found to simplify the design process and make it more inclusive by increasing accessibility. They allowed students to quickly experiment with geometric forms, apply algorithmic thinking, and explore creative ideas more efficiently. This ease of access was shown to increase students' confidence and enhance their design skills over time.

The feedback mechanisms provided by generative AI systems were another focal point of the research. These tools offered simultaneous feedback, generated alternative solutions, and helped students explore new ideas. Eye-tracking data revealed that students using Ideogram concentrated heavily on the prompt area, indicating a cognitive load associated with working in a non-native language. Meanwhile, students using Krea AI experienced higher cognitive load and stress due to its real-time interface, which made the process more demanding.

Psychophysiological data provided further insights into the emotional and cognitive responses of students. EDA data showed that students using Krea AI experienced higher levels of cognitive load and emotional arousal, attributed to the challenges of its real-time interface. In contrast, Ideogram AI was associated with more consistent skin conductance levels (SCL) and positive motivational responses following the generation of design outputs.

Eye-tracking data provided additional layers of analysis. Students using Ideogram AI spent more time focusing on the prompt area, suggesting that working in a non-native language added to their cognitive load. In Krea AI, students exhibited more fixations overall, reflecting the higher cognitive demands of the sketch-to-image method compared to text-to-image generation.

The research also delved into user experience challenges. While generative AI tools offer significant potential benefits, students faced notable issues related to user control and stress. These challenges underline the importance of balancing AI-generated creativity with human-driven processes. The study further highlighted that the need to use a non-native language contributed significantly to cognitive strain, adding another layer of complexity to the user experience.

The comparison between Ideogram AI and Krea AI revealed that each tool provided distinct experiences and outcomes. Ideogram AI, as a text-to-image generator, was more consistent and less stressful for students, while Krea AI, with its sketch-to-image capabilities, offered more flexibility but was associated with higher cognitive load and emotional strain.

In conclusion, the study underscores the significant potential of generative AI to enhance design processes but also emphasizes the need to address key challenges, including user control, stress, and the balance between AI-generated and human-driven creativity. The findings call for the development of AI tools that are more user-friendly, predictable, and supportive of students' creativity and personal growth. By integrating diverse research technique such as PDH, the study offers a nuanced understanding of how AI impacts the design process, paving the way for future innovations in AI-enhanced design tools.

Despite its contributions, this study has several limitations. It was conducted with 15 visual communication design students from a single institution, which may limit the generalisability of the findings across different cultural and educational contexts. However, the research was designed as an exploratory user study rather than a study aimed at statistical generalisation. In this context, the goal was to generate in-depth insights based on contextual interpretation and psychophysiological data. The relative homogeneity of the participants contributed positively to data consistency, allowing clearer analysis of system-specific challenges. As noted by Nielsen [34], even small sample sizes can reveal substantial usability issues in user research, especially when supported by multimodal data such as eye tracking and electrodermal activity (EDA). While the study did not include a control group- due to its focus on capturing user interaction patterns in naturalistic settings- future research could benefit from comparative designs and larger, more diverse samples to strengthen external validity and broaden the scope of findings.

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