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Design Principles Guide Meaningful Play by Improving Ease and Intentionality of Game Design

Sauman Chu

Department of Design Innovation, University of Minnesota, USA

E-mail: schu@umn.edu

Stephen J. Guy

Department of Computer Science & Engineering, University of Minnesota, USA

E-mail: sjguy@umn.edu

Zachary Chavis

Department of Computer Science & Engineering, University of Minnesota, USA

E-mail: chavi014@umn.edu

Aaron Glick

Department of Computer Science & Engineering, University of Minnesota, USA

E-mail: glick094@umn.edu

Debra Lawton

Department of Design Innovation, University of Minnesota, USA

E-mail: dllawton@umn.edu

Risheng Liang

Department of Design Innovation, University of Minnesota, USA

E-mail: liang941@umn.edu

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Abstract

This project examines the role of design principles and how they impact the experience of players using a digital minigame created and inspired by the CLUE board game. We examine the role of design principles in guiding users toward finding hidden clues and whether or not users are drawn to spots with design principles predetermined and embedded. We investigate this by examining if pre-selected spots with design principles are perceived as more intentional than a baseline of spots identified by random points, mediated through the GroundingDINO object detector. Results showed that players were twice as likely to find design principles spots than randomly selected spots. Players found the design principles spots more intuitive and perceived intentional than the random baseline. In addition, results showed that there were varying effects from different design principles and can improve game design and allow designers to control the difficulty of the game experience.

Keywords: meaningful play, design principles, digital games, computer vision object detection, intentional gameplay, game design

1. Introduction

1.1 Introduce the Problem

Design principles serve as a fundamental knowledge framework for graphic design education. These evidence-based principles guide designers in creating visually compelling and effective compositions with the goal to facilitate visual comprehension and enhance understanding of information. These principles, such as, contrast, placement, repetition, and visual hierarchy help ensure that elements are designed and organized in a way that is visually appealing and easy to understand. For instance, placement ensures visual stability by distributing elements evenly throughout the design and contrast of color or size purposely draws the viewer's attention to intended focal points. By applying these principles, designers can create highly intentional, purposeful, and functional designs that effectively communicate a message. In game design, particularly in the digital world, design principles could play a key role in compositional design and ultimately enhance play experience. The application of these principles could also lead to better, more meaningful play if the play experience requires player's inputs or interaction. The strategy in placing visual elements using design principles can help guide players to look at important information presented in the game environment and further encourage players to select or implement certain expected behaviors.

In this project, we study how design principles can impact the experience of players through the use of a digital minigame inspired by the board game CLUE. This paper focuses on the process of augmenting the digital gameplay experience using design principles as a proposed method to guide the behavior of players. In CLUE, players assume the roles of different characters trying to solve a murder mystery, requiring them to visit rooms in a mansion setting where they can collect clues via cards. As players gather information, they narrow down the possible solutions, allowing them to solve the mystery through a final accusation. Our digital minigame distills the core CLUE experience, still requiring players to visit mansion rooms and find clues; however, the new goal of our minigame requires the players to physically search for clues, with the intention that the player must further embody their sleuth role. By designing the game synergistically with CLUE, we open the possibility of future hybrid game experiences, where the digital game serves as a supplementary experience to the analog game.

We applied visual design principles to examine the best strategy to predict where players will click on a screen with objects (e.g. fruit bowl on a kitchen countertop) that may contain hidden clues and therefore enhance play experience and meaningful play. The concept of meaningful play is to evaluate and assess the connection between actions and their outcomes. Meaningful play occurs when the link between a player's actions and the resulting outcomes is both clear and tied to the larger context of the game. Creating meaningful play is a key objective in effective game design (Tekinbas & Zimmerman, 2003).

1.2 Explore Importance of the Problem

While there has been significant progress in using AI in games, there is limited research on using design principles as a strategy to facilitate game design. This study seeks to address that gap and determine if using design principles could play a role in game design scenarios and if the design principles lead players to select particular spots. This question will be explored by comparing player behaviors finding hiding spots pre-selected using design principles compared to the randomly chosen hiding places (identified using the GroundingDINO object detector. This study will provide insights into how design principles can improve user experience in game design, thus contributing to meaningful play. The findings will offer practical guidance for optimizing players' engagement, interactivity, choice, and benefiting game developers and designers.

1.3 Relevant Scholarship

Graphic design is inherently interdisciplinary as it integrates creativity and functionality to address design problems with users as the key audience to drive design decisions. Design principles serve as the foundational rules and guidelines for designers on how visual elements are arranged and combined to communicate ideas, evoke emotions, and guide the viewer's attention and behavior. Besides providing strategies to create visually appealing designs, these principles, such as balance, contrast, values, and hierarchy, are essential in ensuring that the final design communicates the intended messages and that the users can immediately comprehend the information as presented.

In game design, predicting and guiding the player's behavior in achieving meaningful play is crucial for creating immersive and engaging environments. Design principles such as visual hierarchy use contrast in color, values, size, texture, placement, and form to provide a framework for enhancing intuitive exploration. Separately, computer vision AI models, such as DeepGaze, have taken a quantitative approach for predicting users' eye gaze and actions, with the goal of enhancing user experience and interaction. Computer vision techniques have also been used to develop object classification models, like GroundingDINO, which automatically find and label objects in an image which can then be used to interpret what a user is looking at in an image. The following literature review explores the roles of both approaches in game design and highlights each method's strengths and limitations.

1.3.1 Role of Design Principles in Game Environments

Using, understanding, and training in design principles for designing 2D and 3D composition are commonly treated as core preparation across design education and related disciplines, including in graphic design (Hsieh et al., 2021). Fu et al. (2016) defined principles as "a fundamental rule or law, derived inductively from extensive experience and/or empirical evidence, which provides design process guidance to increase the chance of reaching a successful solution". Ma (2025) investigated how perceptual design principles based on hierarchical graphic information influence visual hierarchy perception in interface design. The study demonstrated that manipulating key visual variables, such as size, distance, and contrast, can significantly shape how users perceive structured information and visual elements. The findings suggested that manipulating layout, dimensions, and overlapping elements can dramatically clarify visual hierarchy and user interaction. Mai et al. (2025) further emphasized that using contrast in form, size, color, texture, and layout to build visual hierarchy is an essential strategy for guiding players' visual perception and improving communication. These principles guide the design of the hierarchy and order of exploration of visual and interactive elements, ultimately affecting players' behavior and decision-making.

In the game environment, the use of visual hierarchy can help designers to determine how game elements are arranged in order to direct player attention. A study conducted by Yalçınkaya-Doma and Catak (2024) suggested that key visual perceptions in game design, such as color and contrast, size and scale, lighting and shadow, and motion cues, are crucial in guiding players' visual perception and navigational choices within virtual spaces. Borkin et al. (2013) concluded a correlation between the use of high contrast, color associations with visual elements, and greater memorability from their study. The authors stated visualizations that were most memorable (and did not contain pictograms) were due to high contrast and the feature of more color. These qualities made the images easier to see and differentiate and contributed to their higher memorability. However, an overemphasis on certain elements could lead to visual overload. Designers must seek balance and ensure critical elements attract attention without overwhelming the users.

Design principles can also be used as feedback mechanics in a digital game environment. They can be applied to provide immediate responses to actions taken by the user. These responses can provide subtle cues to confirm or enhance the player's experience or sensory prompts. For example, visual feedback such as changes in color or form can hint or indicate that the player is in the right place and advancing in the game play. These mechanics help maintain a sense of player autonomy as they guide the player progress in the game and allow them to feel a sense of control over their exploration. Yalçınkaya-Doma and Catak (2024) highlighted the importance of spatial relationships to ensure that users can meaningfully explore the environment and are not overwhelmed by irrelevant distractions. The placement of the elements in the game environment, especially the spatial layout of interactive elements, is another key factor in guiding users to critical areas (Dillman et al., 2018). Games create "narrative spaces" that allow players to interact with characters, the environment, and each other. These spaces are mapped within the game's world, and the narrative emerges through the relationships between space and events. Therefore, the placement of objects should be considered critically and intentionally. In the context of the CLUE game being explored for this study, the hiding spot for clues associated with objects were placed purposely with pre-identified design principles in various scenes.

The main design principles being used for this study were spots with contrast in value, texture, color, form/shape, and size. In addition, tension, placement, and visual pathways were also examined. Contrast was the key principle being used to direct attention to areas containing hidden clues or essential game elements and subtly guide players to explore without making them feel overly directed. Contrast refers to the difference between two or more elements, such as value, color, size, shape, or texture, within a composition. For instance, high contrast can help draw attention to important elements and create visual interest and can immediately capture the viewer's attention. Ko (2017) suggested that contrast is not only a visual design consideration but also a key factor of legibility and visual performance. In a composition with well-contrasted design, designing information with distinguishable characteristics enhances the viewer's ability to process, understand, and remember the message being communicated. Effective use of contrast can significantly manipulate user’s behavior, such as in interactive design where user’s inputs are needed.

Tension is used to create an intentional disruption of harmony, create unease or anticipation within a composition. The goal of using tension is to enhance visual impact by adding dynamic interaction between elements and create visual interest, thus, to enhance viewer experience and engagement. Silva et al. (2020) suggested tension can be categorized into two types: dramatic tension and gameplay tension. Dramatic tension creates a feeling of uncertainty or anticipation based on the player's emotional engagement with the characters and the events of the story, while gameplay tension is driven by the player's desire to overcome challenges and succeed in the game, regardless of the narrative (character or story).

Within a composition, placement is considered to describe how elements like text, images, and graphics are positioned. Placement affects how information is perceived and guides the viewer’s eye and intersects with hierarchy and visual appeal. Zhang et al. (2024) used eye-tracking approach and concluded that layout order and the position of a core element, such as maps, diagrams, system interfaces, monitoring screens, and information lists, significantly shape users’ visual search behavior. The results of the study supported that placement as a key strategy for creating emphasis and establishing an information hierarchy that directs attention to critical information.

The visual pathway provides a visual flow that a viewer’s eye takes as they engage with a design. The goal of the visual pathway is to direct the viewer’s attention to specific elements in a predetermined order. Therefore, ensuring that the most important aspects of the design are perceived first. Chuang et al. (2024) revealed that visual flow can be intentionally shaped through visual guidance (leading lines), and that compositions with a clear focal point can attract viewers’ attention; moreover, leading lines can regulate visual attention and guide gaze direction, supporting a designed visual pathway for the viewer.

Using design principles to design a game play environment can potentially increase player engagement. It is important to avoid overloading players’ visual perception which can cause disengagement from the game. Balancing guidance with player autonomy has been shown to play a critical role in sustaining player immersion and supporting a sense of control over exploration and discovery (Delmas et al., 2022; Teng et al., 2024; Tyack & Wyeth, 2021).

1.3.2 Role of AI Models in Game Design (Midjourney & Grounding DINO)

We explore (1) the use of generative AI, specifically Midjourney, for the rapid development of realistic visuals used during gameplay and (2) the use of predictive AI, specifically GroundingDINO, to categorize and label objects within our visual elements, as part of the player interaction technique and data analysis.

Many game companies are leveraging generative AI to augment the creation of environments, characters, voices and music, and even aspect of storylines; however, as we are primarily interested in how users interact with visual design principles we focus our attention on using generative AI to create rich, realistic, and engaging visuals. We use Midjourney, a text-to-image GenAI software, to facilitate the ideation process of creating eight different spaces based on the original CLUE game. Midjourney generates images based on a prompt entered by the user. The prompt could be as simple as one word or a phrase. Midjourney provides basic tips on generating prompts including consideration of subject, medium, environment, lighting, color, mood, and composition. Tan and Luhrs (2024) used Midjourney in their study as a design tool to enhance architects' creativity and accelerate design processes. In their study, Midjourney was used to speed up both the identification and refinement of a user persona and the ideation of various space designs. The study also highlighted how GenAI can be used to facilitate divergent and convergent thinking, which are critical in creative design. In addition, one of the key reasons these authors applied Midjourney was the capability for rapid visualization process. Based on the provided keywords, the software can generate images in one minute and the speed allows designers to test, experiment, and develop multiple concepts efficiently. Their work further suggested that GenAI tools, such as Midjourney, are options to expedite design, for image-making and visualization.

Furthermore, Hanna (2023) summarized that Midjourney can deliver impressive and diverse design results across various fields. The program generates multiple design solutions in a short time which would be difficult for designers to achieve manually. AI in design can cover areas such as architecture, art, science fiction, anatomy, and sculpture, among others. These programs help both designers and non-designers in the context of time, creating comprehensive and integrated scenes for any given topic.

Separately, predictive AI models can be used to guide and understand user behavior interaction, by quantifying where and how users interact with the visual environment presented. Computer vision models (like YOLO and Detectron2) have advanced to the point where rapid classification and object-detection can be done with ease, by simply specifying a list of objects to identify in an image (Redmon & Farhadi, 2018). GroundingDINO, is a state-of-the-art object-detection algorithm, leveraging vision-transformers and cross-modality fusion (i.e. attention to both the image input and text input), to automatically classify objects within images (Liu et al., 2024). GroundingDINO improves upon other models by being able to detect arbitrary objects defined by text-input and outperform other models for referring expression comprehension tasks (localizing a specific object by providing a descriptive phrase). This is critical to applying predictive AI to gameplay because it is important to not only be able to detect all objects in the environment but also tune prompts to specific objects that the player should interact with. Although GroundingDINO can be used in real-time video tracking with SAM2 (Zhang et al., 2025), instead, we leverage its object-detection capabilities to compare player interactions to rapidly label and quantify the visual environment, such that we can characterize which objects users interact with and which objects are the most salient. This provides a repeatable framework to identify objects and distinguish specific objects (i.e. those that use design principles) for any type of game visual. Alternative approaches, like the predictive AI model DeepGaze, predict visual saliency and even user gaze paths by leveraging human interaction data (Kümmerer et al., 2022). While we intend to explore selecting objects via DeepGaze in our gameplay, it is not the focus of the current study.

1.4 Objectives and Research Questions

The objective of the study is to examine if users are more likely to click on hiding spots pre-selected using design principles as a prediction model, in comparison to randomly selected spots.

The key research questions are:

1) What role do design principles play in guiding users toward finding information (e.g. hidden clues)?

2) Are users more likely to click on points with relevant design principles, thereby eliciting player behavior which motivates game play?

3) Are spots highlighted by design principles perceived as more intentional than spots that are not (i.e., random spot)?

2. Method

To understand the impact of design principles on player experience, we asked users to play several rounds of a custom minigame via a browser-based interface, and answer questions in a brief survey between rounds. In each round, players were presented with a view of one of the eight rooms, each filled with various objects, and were asked to guess which object held a clue, using the murder mystery themes of the game CLUE as motivation. In this section, we describe the study in detail, and analyze the gameplay experience.

2.1 Prototype Design

A prototype game containing images of 8 scenarios that represent each CLUE-based room were included in the study. All images were generated using Midjourney, an AI platform, with prompts suggested by the research team to create suitable features in each room. The process of generating images went through several phrases of explorations of styles and characteristics before determining the final set of room designs. The rationale of using an AI platform to generate the prototypes was to utilize the tool in a way to enhance the design process, since designing a space is not a focus of the study. The decision to use AI to generate the images is also anchored with two key points: ensuring the process does not impact the objectives of the project and that AI usage does not become an interfering variable to the results of the study. Each room was intentionally created with limited objects, ensuring players are not overwhelmed with options to click on. Various objects in a scene are identified using GroundingDINO, and a set of object bounding boxes are created for objects in each image. Pre-selected objects that utilize design principles were then matched to these bounding boxes; all other bounding boxes can be used as randomly-selected objects.

Spots assigned with predetermined design principles were chosen in a consensus process between two graphic design faculty prior to the start of the study. The design principles being used to select these points were:

- Value

- Tension
- Texture
- Color
- Form
- Placement
- Visual pathway
- Size/Scale

Not all rooms contained all identified design principles as listed. Figure 1 (left) shows the lounge that contains five design principles applied on six different locations (tension was used twice in this space). Figure 1 (right) shows the series of points selected by a user in the study. Note, that while they did not click on the predetermined hidden spot (the lamp), many of the points selected by the user were close to points selected by the design principles analysis.

Figure 1. (Left) Hiding spots using design principles in the location of the lounge. (Right) Example user's clicks (shown as red Xs) show correspondence to design principles, even when they did not ultimately find the hidden clue (identified by the blue cross and yellow box)

2.2 Participants, Data Collection, and Analysis

Our study had 95 participants, but we include in our analysis the 82 participants (average age: 22 ± 6.98 years old; 73.2% female, 20.7% male, 6.1% other/not reported) who completed the study. Users were shown a rendering of one of 8 rooms (kitchen, lounge, billiards room, study, hall, ballroom, conservatory, library) and were told there was a hidden clue somewhere in the room. For most images (75%) the secret point that served as the clue the user was searching for was selected either at random or according to one of the following design principles. For the remaining data analyzed (25%) a random point was chosen, which served as a baseline for analysis. Some participants had hidden objects selected by an experimental algorithm, but those results are not included in our analysis.

The conditions for selecting the hidden point (random vs. design principle) were randomized for each new image, and the participants were not informed whether the object was random or selected by a design principle. The participants were given up to 6 guesses to find the hidden clue which would be a secret point in the image. Afterwards, the correct hiding spot was shown to them and participants were asked to rate how intentional the hidden spot felt and to elaborate on their rating via a short open response. For numerical analysis, intentionality was viewed as a range from 1-5, with 1 being very random and 5 being very intentional. An example of the UI is shown in Figure 2.

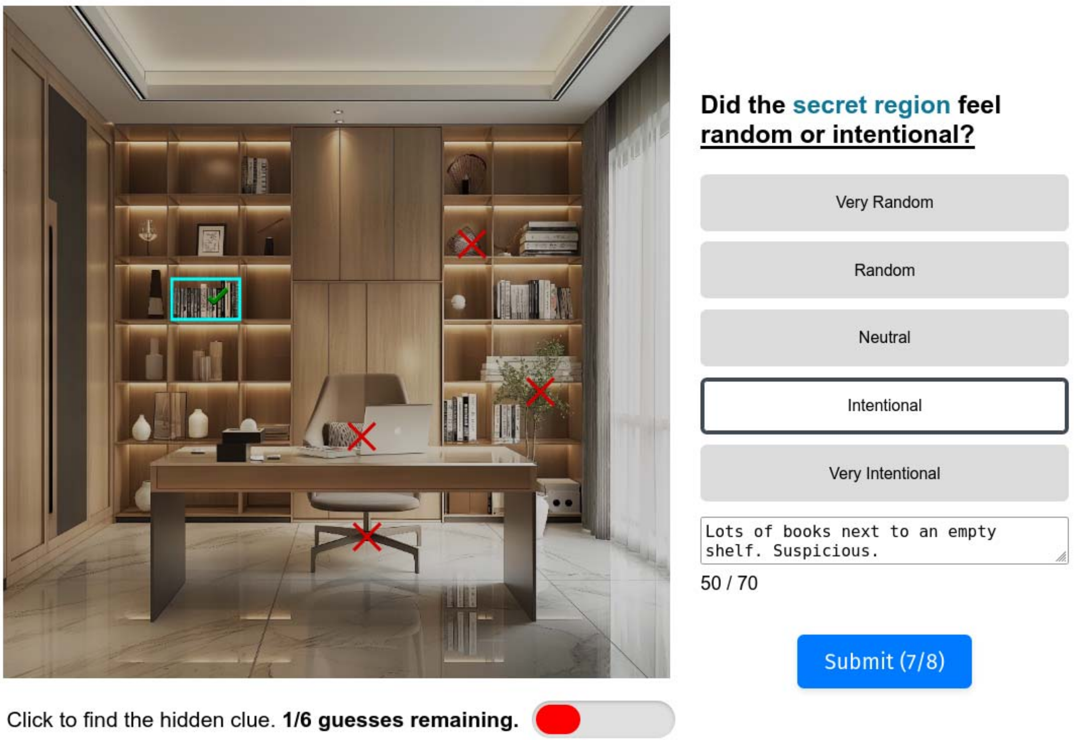

Figure 2. Player's view after interacting with one of the images (study). After searching the room (either finding the clue or using all 6 guesses), players are shown their clicks as red Xs, a green check if they found the clue, and a turquoise box showing the secret region of the hidden clue. They are presented with the question on the right panel, and a textbox to add additional details for that specific room and hidden clue. Players have a progress bar for that room (1/6 guesses remaining) and are shown the number of completed rooms on the submit button (7/8)

Overall, users clicked on a variety of objects in the scene, with each image having an average of 5.01 clicks (of the maximum 6 allowed). Figure 3 shows an example interaction in the game where the participant first clicks on the kitchen counter, then stove, before correctly choosing the fruit. In examples where the participant correctly found the secret location it took an average of 3.15 clicks. We introduce a search score to distinguish results which found the secret location (positive) and those that did not (negative), and to award higher scores for finding the secret location faster. Larger search scores indicate how fast the clue is found: finding the clue on the first try results in 6 points, each successive guess costs 1 point, and not finding the clue results in -1.

Figure 3. Example where the player finds the hidden clue. As shown in Figure 2, players are only shown the yellow object box for the solution; however, the exact object location is recorded and shown as a turquoise plus sign here. Player clicks are shown as red Xs, with pink arrows showing their progression. The player rated the location as "intentional" and explained "the red of the tomatoes stuck out."

For the specific example in Figure 3, after finding the secret location the player rated the hidden clue as "intentional" and made the comment "the red of the tomatoes stuck out" to explain their rating (in reference to the red fruit under the cross indicating the clue location). We perform a thematic analysis of these open text responses to further understand users' perception of the game in Section 4.3. The thematic analysis included reviewing most common words in responses, identifying common phrases and distinctive terms, and clustering these overarching themes. Namely, we compare the themes between the designer locations and random locations, and between locations rated as intentional versus random.

3. Results

We have several key findings suggesting the use of design principles provides a means for predictable control of game difficulty and leads to a game experience that participants found more intentional. From both quantitative and thematic analyses, we focus on two aspects of game play experience: ease of search gameplay, and intentionality of the hidden clue locations.

3.1 Search Location

The resulting data collected from each player contains the search locations they clicked on and the corresponding survey results for each room visited. Figure 4 shows the search location clicks across all players from the Hall. The left image shows where all clicks occurred in the Hall, while the middle image shows a heatmap representing the click density, with the most popular locations represented as warm colors. The results as shown in Figure 4 aggregate over all player searches (any of the six possible guesses for every player); however, subsequent analysis specifically considers individual player experience per room. Pre-selected designer points are selected 24% of the time, which remains consistent for all successive clicks; this is 33% higher than expected by random object selection ($p < 0.001$).

Figure 4. Aggregated user data for the Hall. (Left) Exact click locations are (Center) aggregated to get a sense for the most frequent objects clicked, which shows an overlap with (Right) designer-chosen keypoints

3.2 Ease

Success Rate: Participants were more likely to find designer points than randomly selected, with designer points twice as likely to be found within the click limit as random points (40.2% vs 19.8%), which is statistically significant via a chi-square test (p = .0006). Furthermore, within the first two attempts, 18% of players found designer points compared to only 6% for random spots.

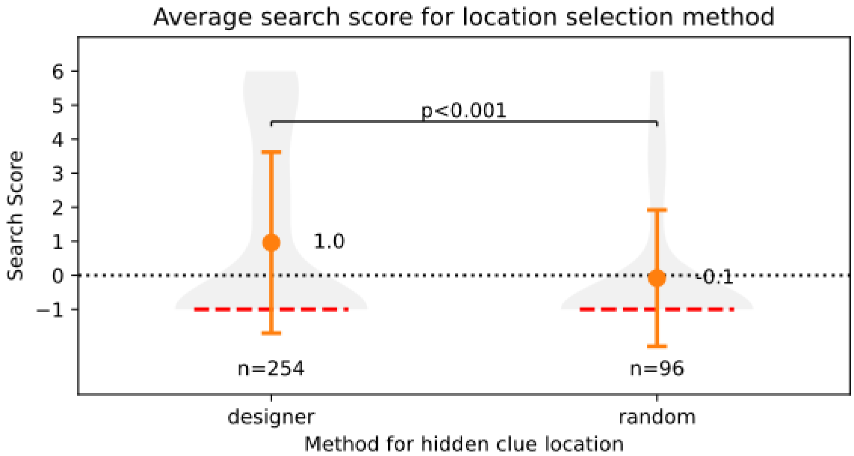

Figure 5. Comparison of average search score for designer points and random points. Mean search score values shown in orange with 95% confidence intervals shown. Median values shown as a dashed red line. Distributions of search scores are shown as grey shadows. Black dotted line indicates the separation between clues that were or were not found, i.e., a zero search score

Ease of Finding Location: To measure how quickly (in terms of clicks) a participant finds the selected location, we use the search score. Search scores reflect how quickly players find the clue: 6 points for finding it on the first guess, with each subsequent guess reducing the score by 1 point (down to 1 point for finding it on the sixth and final guess). Players receive -1 point if they fail to find the clue at all. Overall, results from a pairwise Tukey test ($p = .0005$) indicate the search score was statistically significantly higher for designer locations than random locations; however, this result does not hold when only comparing locations that were found. This is most likely a result of small sample size for random points being found (only 19 out of 96 randomly selected points were found).

Interpretation: Participants found designer points easier or more intuitive to find than the random baseline. Overall, participants found designer points more often and with fewer clicks.

3.3 Intentionality

Comparing designer-selected locations and random locations, users felt designer points were more intentional overall ($p < .0001$). However, we suspected that there may be rating biases where users had higher ratings of intentionality when they found the hidden location; and subsequent analysis confirmed that indeed users felt points they found were more intentional than points they did not find ($p < .0001$). We compared this confounding interaction (between designer/random locations and found/not-found points) with a Tukey test for multiple comparisons of means. First, points a user found were always rated as more intentional than those they did not find, regardless of being designer ($p < .0001$) or random points ($p < .0001$). Second, in general, designer points were rated as more intentional, but this interaction was only significant for not-found points (p < .0001); in cases when the secret location was found, participants still reported the designer points to be more intentional than random points (3.5 vs 3.2), though this difference was not large enough to be statistically significant (Tukey test, p = .779) given the small sample size (only 19 of the 96 random points were found).

A thematic analysis of intentionality further supports these findings. In Figure 6, we show the most common words and phrases from open text responses that were rated as intentional versus random. Responses with high intentionality ratings typically contained more specific terms of visibility, scene context, and object descriptions; they often described the strategic placement of the hidden object with words like *obvious*, *center*, *region*, and *place*. Responses with low intentionality had more random and arbitrary responses with less detail about the object itself; overwhelmingly, most responses reflected the player's confusion with phrases like, *nothing there*, *don't understand*, *seems random*, and *not sure*.

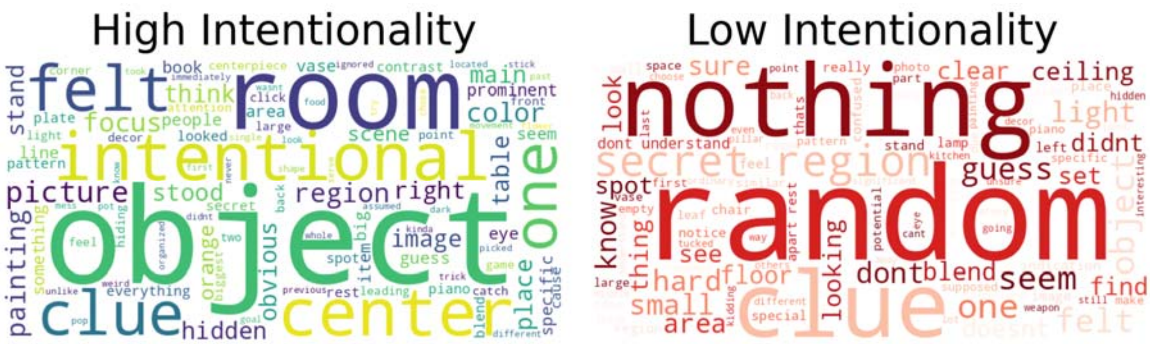

Figure 6. Thematic analysis of user explanations for high versus low intentionality ratings. Larger words appear more frequently across responses

Interpretation: When participants "won" by finding the object, there was not much of an effect on intentionality over the random baseline. This is perhaps because participants experience a self-serving bias where they assume the position must have been intentional which bolsters why they found it. However, the design principles showed the largest effect in cases where the participants lost: even when they did not find the designer point they found the hidden location more intentional, in hindsight.

Per Designer Principle Analysis: Different design themes had different effects on how quickly participants found the hidden location and how intentional participants viewed the hidden location. In terms of ease, the themes of object size, placement, color, and form had the largest effect and were the only themes with a statistically significant effect (respectively compared to random, p = .0003, p = .0042, p = .0023, p = .0131) on improving the search score to find the secret location over the random baseline (Figure 7). Compared to other design principles, only size, placement, and color had statistically significant higher search scores than value; size was also statistically significantly higher than tension and texture.

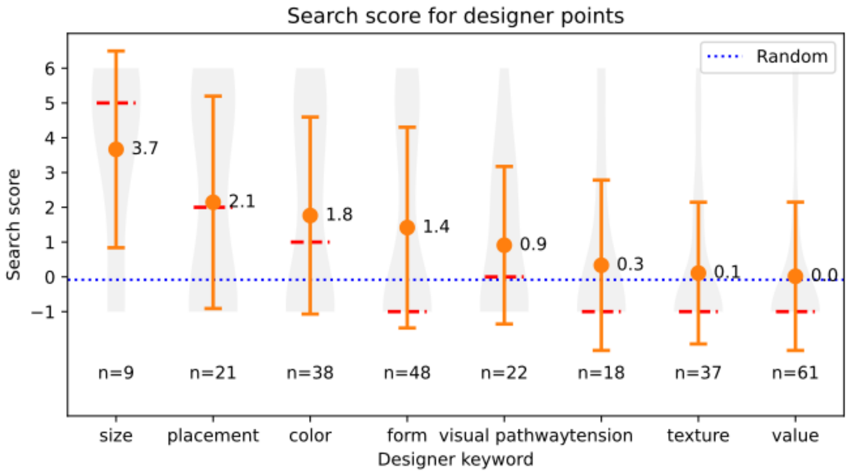

Figure 7. Comparison of average search score for designer principles. Mean search score values shown in orange with 95% confidence intervals shown. Median values shown as a dashed red line. Distributions of search scores are shown as grey shadows. Blue dotted line indicates the mean search score value for random points, to use as a baseline comparison

A similar breakdown across intentionality scores shows a different pattern (Figure 8). Every design theme was viewed as more intentional than random, and in all cases, the difference was statistically significant. The designer themes of form and texture, in particular, had a much greater impact on intentionality than they did on the ease of finding the point.

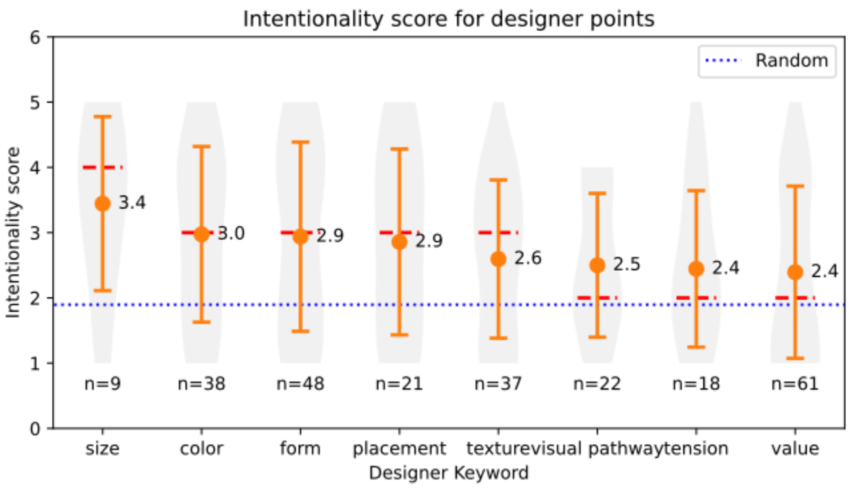

Figure 8. Comparison of average intentionality score for designer principles. Mean search score values shown in orange with 95% confidence intervals shown. Median values shown as a dashed red line. Distributions of search scores are shown as grey shadows. Blue dotted line indicates the mean intentionality score value for random points, to use as a baseline comparison

Interpretation: Understanding the varying effect from different design principals may allow designers to control the difficulty of the resulting experience in interesting ways. For example, picking hidden objects based on their size and color results in an easy experience, whereas picking objects based on form and texture provides a harder experience while still seeming intentional to the user, even if they lose. Intentional use of design principles may lead to more engaging gameplay.

4. Discussion

The first two research questions for this study are to examine the role design principles play in guiding users toward finding information and if users are more likely to click on points with relevant design principles; therefore, eliciting player behavior which motivates game play. Based on the findings, the data suggested that participants found hiding spots pre-selected by design principles easier and more intuitive to find compared to hiding spots identified by random selection. In addition, participants located spots pre-selected by design principles more often and with fewer clicks. In other words, our results conclude that design principles help to guide users in finding information and ultimately motivate player behavior, after evaluating the visual information.

The third research question aims to examine if hiding spots selected by design principles convey a stronger perception as intentional placement strategy as compared to random selected spots. Based on the findings, hiding spots pre-selected by design principles convey a stronger perception as intentional placement strategy as compared to random selected spots. When participants correctly identified the hiding spot, participants perceived that location as more intentional; this was the case regardless of whether the location was pre-selected by design principles or was randomly selected. However, analyzing the results of spots pre-selected by design principles showed the largest effect in cases where the participants did not find the correct spot; participants found the hidden location more intentional in this situation.

In addition, findings in the effectiveness of using various design principles demonstrated that applying different design principals may allow designers to control the difficulty of the resulting experience in more intentional and interesting ways. For example, selecting hidden objects based on their size and color will help players to locate the information faster and more easily. Applying form and texture as strategies to find objects creates a more difficult and challenging experience while still perceived as intentional to the user, even if they lose in such scenarios. In conclusion, the intentional use of design principles seems to lead to more engaging and meaningful gameplay. Furthermore, the use of different design principles leads to creating varying levels of difficulty which is a critical element in enhancing gameplay experience.

5. Conclusion

This study focused on investigating the role of using design principles in a digital game design environment with the goal to enhance engagement and meaningful play experience for the players. Results of this study are applicable to static and dynamic/interactive gameplay and provide practical insights for game designers. In addition, AI based prediction models such as DeepGaze have been used broadly in game design. Further study can explore and compare the effective use of AI prediction models vs. design principles as predictors in designing game visual elements.

The digital prototype game environment was designed synergistically with CLUE. This work serves as a starting point to expand the possibility of future hybrid game experiences where the digital game serves as a supplementary experience to the analog game could be explored. For instance, when a player enters a room through the board game, such as the Library, they transition to the corresponding digital game space (through a QR code) on a phone or tablet, where they search for clues to help solve the mystery. Therefore, the digital minigame experience ultimately helps the players deduce clues of the weapon, the perpetrator, or scene of the crime. In the traditional gameplay, the room serves as a place to make accusations. Players do not necessarily gain additional information by entering a room. Adding hidden clues in the digital space provides additional deductive information in helping players progress through the gameplay and ultimately accelerate the gamepace. Our findings suggest that design principles can enhance engagement and meaningful play in digital games.

Declarations

AI technologies have been used in the development of this work, but as discussed in the literature and methodology sections of the paper, have been used intentionally to study the role of these AI technologies in game design. Midjourney was used for rapid image development, but was optimized with specific prompts using design principles to make images that were visually consistent and detailed. GroundingDINO was used for object detection, to annotate images with object labels and bounding boxes for analysis. All outputs from AI technologies were carefully reviewed and refined by the researchers of the study.

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