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Human–Computer Interaction Modeling Based on Gestalt Principles in Digital Graphic Design: From the Perspective of Donald Arthur Norman

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Abstract

In the digital era, effective Human–Computer Interaction (HCI) requires a deep understanding of users' perceptual, cognitive, and behavioral mechanisms. This study aims to model HCI based on Gestalt principles and Donald Arthur Norman's perspective, elucidating the connection between perceptual psychology and digital graphic design. Within the theoretical framework, Norman's interaction model, including three core components—perception, cognition, and action—is considered the foundational processes of User Experience (UX). Concurrently, Gestalt principles such as proximity, similarity, continuity, figure–ground, closure, and balance are introduced as a framework for visual organization and for facilitating the cognitive processing of visual information. Theoretical findings indicate that Gestalt principles play a mediating and facilitating role at each stage of Norman's model: enhancing visual coherence and clarity during the perception stage, supporting semantic understanding and predictability of system behavior during the cognition stage, and promoting ease of interaction and effective feedback during the action stage. Accordingly, the present conceptual model delineates a dynamic cycle from perception to action, in which the UX is shaped holistically and intuitively. This study concludes that integrating Norman's cognitive perspective with Gestalt principles offers a novel approach for human-centered, comprehensible, and interactive digital graphic design and provides a theoretical basis for the development of user interface and UX design.

Keywords: Human–computer interaction, Gestalt principles, Donald arthur norman, Digital graphic design, User experience.

1 | Introduction

With the expansion of digital technologies and the increasing prevalence of interactive tools in human life, the quality of User Experience (UX) and the nature of Human–Computer Interaction (HCI) have become

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fundamental challenges in the fields of design and cognitive sciences. In digital graphic design, each visual element not only conveys aesthetic value but also plays a crucial role in facilitating comprehension, guiding cognition, and eliciting user action. Consequently, successful design in digital environments requires a deep understanding of users' perceptual and cognitive processes to establish a communicative bridge between system functionality and human mental models. In this context, Gestalt principles, as one of the most fundamental theories of visual perception psychology, provide a scientific framework for understanding how the mind organizes information. The Gestalt theory, first proposed in the early twentieth century by German psychologists such as Max Wertheimer, Kurt Koffka, and Wolfgang Köhler, holds that humans perceive visual stimuli as meaningful wholes rather than as collections of separate components [1]. This theory introduces concepts such as proximity, similarity, continuity, figure–ground, and closure as perceptual laws that can be applied in digital graphic design to establish visual order, readability, and coherence [2]. On the other hand, Donald Arthur Norman [3], born in 1935 in the United States, is a cognitive psychologist, engineer, and design theorist, recognized as a pioneer in HCI. He gained significant renown for his efforts to integrate human psychology with the design of technology and digital products. Norman was among the first to apply cognitive psychology to industrial design and information technology. Through his analysis of human interaction with complex systems, he demonstrated that effective design must be based on an understanding of users' minds, memory, perception, and behavior, rather than solely from an engineering perspective. In his 1988 theoretical model, Norman proposed three key components—perception, cognition, and action—to explain the cycle of user interaction with a system. According to Norman, effective interaction occurs when the user can accurately perceive the system, understand and predict its functionality, and ultimately perform purposeful actions in response. This model conceptualizes the relationship among design, perception, and user behavior as a dynamic cognitive process.

Despite significant advances in UX design, a theoretical gap persists in systematically integrating Gestalt principles of visual perception with the cognitive processes underlying HCI. Most studies have either focused on the technical aspects of interface design or on the analysis of visual aesthetics, whereas combining these two approaches can lead to a deeper understanding of users' perceptual and interactive behavior.

Accordingly, the present study aims to model HCI based on Gestalt principles within Donald Norman's cognitive perspective. This research seeks to demonstrate how Gestalt principles can be effectively applied across Norman's three stages—perception, cognition, and action—to create a seamless, intuitive, and efficient UX.

2|Research Background

Gestalt theory, established in the early twentieth century by psychologists such as Max Wertheimer, Kurt Koffka, and Wolfgang Köhler, holds that the human mind tends to perceive visual stimuli not as a collection of individual components but as a coherent whole [4].

Within this theoretical framework, laws or principles such as proximity, similarity, continuity, closure, figure–ground, and common fate have been introduced to explain how visual elements are integrated at the perceptual level. From a graphic design perspective, these principles gain significance because designers rely on such perceptual knowledge to organize visual information, guide users' gaze, and establish meaningful relationships among elements. A study entitled the integration of gestalt theory into graphic design [5] has shown that graphic designers employ Gestalt principles to achieve a coherent visual document, and that these principles can serve as guidelines for directing selective human attention.

While a comprehensive, unified model is currently lacking, existing empirical evidence fragments affirm the direct link between visual organization and interaction outcomes. For instance, studies examining the effect of visual grouping (a function of Gestalt principles like Proximity and Similarity) have been shown to directly impact metrics of Norman’s action stage. Specifically, research by Michalski et al. in 2006 [6] demonstrated that geometric design characteristics and icon grouping significantly improve task efficiency in HCI environments. These findings empirically support the notion that Gestalt-informed layout directly translates

to optimized user behavior. The present study addresses the resulting theoretical gap by synthesizing this disparate evidence into a single, cohesive, and systematic framework.

In summary, Gestalt theory provides a suitable theoretical foundation for the present study, as HCI is ultimately a visual, cognitive, and perceptual process, and digital graphic design operates primarily at the visual level. Moreover, HCI examines how humans interact and communicate with computer systems; this interaction is no longer purely technical but is also influenced by perception, cognition, UX, and aesthetics. Within this domain, one key consideration is the graphical design of User Interfaces (UI/UX), which shapes the interface's visual elements and thereby affects users' perceptual and cognitive processes. For instance, a body of research has demonstrated that interface graphical features, such as item size, positioning, and grouping, significantly impact user performance and task efficiency. In one study with 490 participants, statistical modeling indicated that the geometric characteristics of interface components (including size and icon grouping structure) influenced the effectiveness of user tasks [6].

Therefore, in digital graphic design within interactive environments, the conscious application of visual perception principles—such as Gestalt principles—can play a crucial role in enhancing UX, reducing cognitive load, facilitating visual guidance, and increasing user satisfaction.

3 | Gestalt Theory and Its Application in Digital Graphic Design

Visual perception is one of the most fundamental cognitive processes, enabling humans to understand and organize the world around them. Humans perceive the world not through isolated elements, but as meaningful wholes. This holistic understanding forms the theoretical basis of Gestalt theory, which emerged in the early twentieth century [1]. Initially developed in perceptual psychology, Gestalt theory later influenced diverse domains, including art, architecture, graphic design, and interactive design. The principles of this theory help designers understand how the human eye categorizes, groups, and interprets visual information.

In this chapter, the origins and evolution of Gestalt theory are first examined; then, its fundamental principles are introduced and analyzed in detail. Finally, the application of these principles in digital graphic design and interactive environments is reviewed.

Gestalt theory emerged in Germany during the 1910s as a reaction to behaviorism and associationism. Its founders Max Wertheimer, Kurt Koffka, and Wolfgang Köhler—demonstrated through experiments on perceptual phenomena such as apparent motion that humans perceive motion as a whole rather than as a collection of discrete images. The term Gestalt in German means shape, structure, or organized whole. According to this perspective, the human mind tends to organize sensory stimuli to achieve the most excellent coherence and perceptual simplicity [7].

From the Gestalt viewpoint, the whole is more than the sum of its parts; that is, the perception of an image depends on the relationships among its elements rather than on the elements themselves. This principle underlies the understanding of composition in graphic design and digital visual interactions. Gestalt theory introduces a set of laws of visual perception that explain how sensory data are organized in the human mind. The following sections systematically examine the most important of these principles.

3.1 | Proximity Principle

The human mind tends to perceive elements that are spatially close to one another as a group or a coherent pattern. In graphic design, the principle of proximity is used to categorize related elements and separate content sections. In digital interfaces, placing related buttons next to each other helps users understand their shared function. For example, in website design, the main menu with closely positioned options is perceived as a single perceptual unit [8].

3.2 | Similarity Principle

Elements that share similar visual features such as color, shape, size, or texture are perceived by the user as belonging to the same group. This principle is essential for creating recurring patterns, visual order, and identity in design. In user interface design, buttons with similar color or form typically have similar functions; therefore, users can understand their relationships without explicit explanation [8].

3.3 | Continuity Principle

The human mind tends to follow paths or lines that exhibit continuity and a regular orientation. Accordingly, the eye perceives lines and curves that continue along a natural trajectory as continuous. In graphic design, the use of continuous visual axes guides the user's gaze across a page or screen. In digital interfaces, arranging elements according to the user's natural line of sight facilitates smoother information perception [8].

3.4 | Closure Principle

The human mind tends to perceive incomplete shapes as complete. Even when part of a shape is missing, the mind fills in the gaps using the available information. In digital graphic design, this principle is widely applied in the creation of icons, logos, and symbolic shapes. For example, the logos of the social network WhatsApp and the company IBM utilize incomplete and closed forms to facilitate faster and more memorable perception [9].

3.5 | Figure–Ground Principle

According to this principle, the human mind tends to distinguish parts of the visual field as the figure (foreground) and the remaining parts as the ground (background). This distinction is essential for focusing attention and perceiving meaning. In digital design, the use of color contrasts, shading, and white space helps designers highlight primary elements while keeping the background calm and supportive [10].

3.6 | Common Fate Principle

When multiple elements move in the same direction or pattern, the mind perceives them as a single, grouped unit. In interactive environments, this principle is applied in animations, button movements, and graphical transitions. For example, the simultaneous movement of several icons along a path conveys to the user a functional relationship among them [11].

3.7 | Principle of Prägnanz (Simplicity)

Also known as the law of good form, this principle states that the human mind tends to select the most straightforward, most stable, and most organized interpretation of visual stimuli. In design, the use of simple compositions, clear forms, and limited colors facilitates faster comprehension and a more favorable UX [11].

3.8 | Gestalt and Visual Perception in Digital Graphic Design

In digital graphic design, user perception is shaped not only through aesthetics but also through an organized cognitive process. Gestalt theory helps designers anticipate user perception and, by applying its principles, guide the path of attention. For example, the principles of proximity and similarity are applied in designing menus and content categorization. The figure–ground principle is used to create visual focus for key elements, such as buttons or essential messages. Continuity and closure principles effectively guide the viewer's eye across sections. The principle of simplicity (Prägnanz) enhances efficiency and reduces cognitive load in the UX. Thus, Gestalt principles provide designers with psychological and aesthetic tools to balance form, function, and user perception [1].

4 | The Role of Gestalt in User Interface (UI/UX) Design

In modern user interface design, the application of Gestalt principles is recognized as a fundamental aspect of cognitive design. Recent studies have emphasized that adherence to grouping and visual structure principles directly affects user efficiency, trust, and satisfaction. In UX design, the primary goal is to enable users to achieve their objectives quickly and without confusion; Gestalt principles provide visual order, guiding both gaze and meaning. From this perspective, Gestalt is no longer merely a perception theory but a practical tool for designing effective human–machine interactions. Understanding and applying these principles ensures that digital designs are not only aesthetically pleasing but also efficient, comprehensible, and human-centered. The following sections of this study examine HCI models and explore how Gestalt theory can be integrated with interactive design [12].

5 | HCI and Its Integration with Gestalt Principles in Digital Graphic Design

Today, digital graphic design has moved beyond mere aesthetics and has become a multidimensional domain within human–technology interaction. In this context, HCI, as an interdisciplinary field, seeks to identify patterns and mechanisms that make the interaction between users and digital systems effective, efficient, and enjoyable. Meanwhile, Gestalt theory, as a foundational concept in perceptual psychology, can help understand how users perceive graphical elements and how these elements are mentally organized. Integrating these two domains—HCI and Gestalt theory—enables the design of systems that are visually appealing and align with human perceptual and cognitive processes. In this chapter, Donald Arthur Norman's interaction model, a key perspective in HCI, is first reviewed, followed by an analysis of its relationship with Gestalt principles. HCI is an interdisciplinary field that draws on computer science, cognitive psychology, industrial design, and visual communication to examine how people interact with computer systems [13]. The primary goal of HCI is to improve usability, accessibility, and UX when interacting with technology. Essentially, HCI addresses the question: How can systems be designed to align with human perceptual, cognitive, and emotional capabilities? According to Norman, effective design should facilitate the smooth and predictable flow of information between the system and the user.

Effective HCI relies on three key components:

I. Perception: the user's reception and interpretation of visual and graphical cues.

II. Cognition: understanding system functionality and predicting its behavior.

III. Action: the user's physical and mental responses or interactions with the interface [3].

5.1 | Perception

Perception is the initial stage of human interaction with a system, during which the user receives information from the interface primarily through the senses, especially vision. The quality of perception depends on how visual cues, color, contrast, visual hierarchy, and the organization of graphical elements are presented. In digital environments, designers guide user attention and foster a coherent perception of the overall interface structure by applying principles such as proximity, similarity, and visual continuity. Indeed, when visual organization is based on Gestalt principles, users can grasp the design's structure and logic at a glance, reducing perceptual confusion [3].

5.2 | Cognition

Cognition is the stage of mental processing of perceived information. At this stage, the user interprets the meaning and purpose of interface elements, constructs a mental model of system functionality, and predicts system behavior based on prior experience. Effective graphic design should facilitate cognitive processes; that is, symbols, icons, and interactive structures should align with users' general mental models. Gestalt principles,

such as figure–ground and closure, help users mentally complete incomplete elements and perceive dispersed components as a coherent whole. This approach simplifies and makes system functionality more predictable [3].

This cognitive stage can be analyzed with greater depth through the lens of Cognitive Load Theory (CLT), a prominent concept in educational and cognitive psychology. CLT posits that the human working memory, where active mental processing occurs, has a finite, limited capacity. This theory distinguishes between intrinsic load (the inherent difficulty of the information itself) and extraneous load (the mental effort required to process the way information is presented).

When a digital interface violates fundamental Gestalt principles—such as ambiguous proximity , inconsistent similarity , or a lack of continuity —it imposes a high extraneous cognitive load. The user's finite mental resources are consequently diverted from their primary goal (understanding the task) to the non-productive, frustrating task of simply decoding the chaotic visual layout.

Therefore, Gestalt principles function as powerful cognitive aids. By organizing information into coherent, simplified wholes (the good Gestalt or Prägnanz), they drastically reduce this extraneous load. This allows the user to more efficiently form an accurate Mental Model of the system's functionality, which in turn enhances the predictability and perceived simplicity of the interaction [14].

5.3 | Action

Action is the stage in which, after perception and cognition, the user decides to interact and performs a physical or mental act, such as clicking, tapping, dragging, or entering data. Interface design should facilitate this action and provide appropriate feedback to complete the interaction cycle. Clarity in control design, consistency between feedback and action, and visual alignment with user expectations are crucial principles at this stage. In this context, Gestalt principles such as continuity and symmetry can assist designers in ensuring that movement paths, action sequences, and relationships among interactive elements are perceived naturally and intuitively [3]. Both Donald Norman's model and Gestalt principles emphasize a holistic and meaningful understanding of the UX. While Norman's model focuses on cognitive and behavioral processes of interaction, Gestalt principles provide a framework for visually organizing this experience. Perception achieves clarity and coherence through Gestalt organization, cognition is reinforced by interpreting relationships holistically, and action aligns with an intuitive understanding of the visual structure. Therefore, Gestalt principles act as an intermediary between perception and action in Norman's interaction model, helping designers create a cohesive, predictable, and perceptually and cognitively compatible UX.

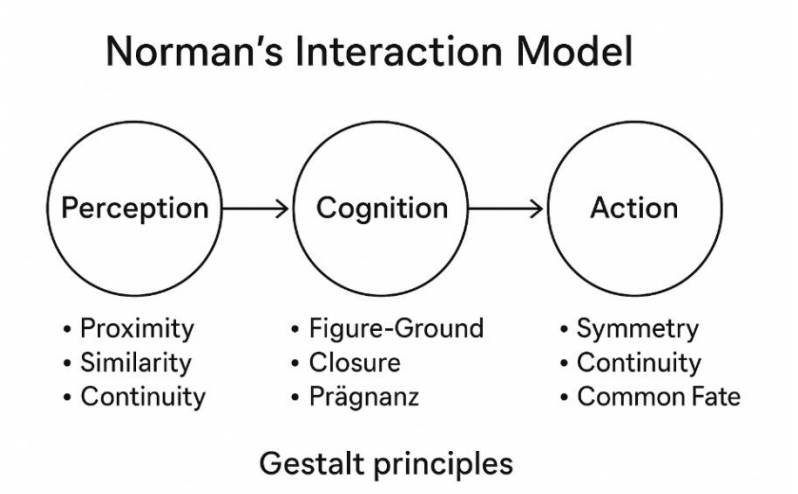

Fig. 1. The relationship between Norman's interaction model and Gestalt principles.

To consolidate the theoretical arguments presented across the stages of Norman's interaction cycle, *Table 2* provides a systematic and granular analysis of the integrated model. This table serves as a comprehensive mapping tool, explicitly detailing how each core Gestalt principle influences a specific stage of interaction, the resulting psychological effect (including the newly integrated concepts of Cognitive Load and Visceral Emotion), and the corresponding practical implication for digital graphic design. This synthesis moves the discussion from a high-level conceptual framework to a structured analytical tool.

Table 2. Integrated analysis of Gestalt principles across Norman's interaction model.

Gestalt Principle	Norman Stage	Cognitive/Psychological Effect	Design Implication
Proximity	Perception & cognition	Visual Grouping, Reduces Extraneous Cognitive Load	Clearly defines related elements (e.g., form fields and their labels), establishes visual hierarchy.
Similarity	Perception & cognition	Association, Predicts function, Aids Mental Model formation	Ensures consistency in interactive elements (e.g., all clickable buttons share the same color/shape).
Continuity	Perception & action	Guides the eye/interaction path, reduces visual search time	Creates clear navigational flows and intuitive paths (e.g., scrollable lists, breadcrumbs).
Figure-ground	Perception	Focuses attention, Establishes element importance/priority	Ensures critical elements (e.g., Call-to-Action) have high contrast against the background.
Closure	Cognition	Fills in missing data, promotes Prägnanz (Simplicity)	Allows for simplified and efficient iconography and logo design (reducing visual noise).
Prägnanz/simplicity	Cognition & visceral	Reduces ambiguity, Promotes immediate positive emotional response	The fundamental goal of minimalist aesthetics and clarity; ensures the simplest interpretation is selected.
Common fate	Action	Predicts group behavior and system response to user input	Provides clear visual feedback that a single action affects multiple items simultaneously (e.g., animated filtering or sorting).

5.4|The Emotional Dimension: Connecting Gestalt to Norman's Affective Model

The analysis of Norman's work is incomplete without considering his equally influential contributions to emotional design. While the Perception-Cognition-Action cycle effectively models the mechanics of interaction, Norman's three-level affective model Visceral, Behavioral, and Reflective explains the user's experience of that interaction. The Gestalt principles are not merely cognitive tools; they are the primary language of the Visceral level of design.

The Visceral level is pre-conscious, automatic, and deals with immediate gut feelings about an object's appearance. Principles such as Symmetry , Balance , and especially Prägnanz (simplicity) are foundational to this visceral response. When the human brain perceives a simple, orderly, and harmonious composition—a good Gestalt—it triggers an immediate, positive affective reaction. This positive visceral first impression is critical; it creates what is known as the Aesthetic-Usability Effect, a psychological phenomenon where users perceive beautiful and orderly interfaces as being inherently more usable. This initial positive emotion can make users more relaxed, creative in their problem-solving, and even more forgiving of minor usability flaws at the Behavioral level. Thus, integrating Gestalt principles achieves a powerful dual purpose: it builds the foundation for an intuitive, low-load cognitive experience (as per the interaction model) and simultaneously engenders the positive emotional response (the visceral experience) that is essential for a holistically successful and human-centered design [15], [16].

6 | Conclusion

The present study, focusing on the integration of Donald Arthur Norman's cognitive perspective and Gestalt principles of visual perception, aimed to provide a conceptual framework for analyzing and enhancing HCI in the context of digital graphic design. The review of theoretical foundations indicated that user interaction with digital systems is not merely a technical process but is fundamentally based on human perceptual, cognitive, and behavioral mechanisms. From this perspective, graphic design is no longer just the visual arrangement of elements; it functions as a cognitive–perceptual language between the user and the system.

In Norman's interaction model, three fundamental components—perception, cognition, and action—are introduced as sequential stages of user–system interaction. The findings of this study demonstrated that Gestalt principles can act as facilitating and mediating factors at each of these stages. At the perception stage, principles such as proximity, similarity, and continuity aid visual organization and clarity, enhancing the initial understanding of the interface structure. At the cognition stage, principles such as figure–ground, closure, and holistic perception facilitate meaningful interpretation of information and the prediction of system behavior. At the action stage, principles such as continuity and symmetry guide the visual path of interaction and improve user performance accuracy. Therefore, it can be concluded that Gestalt principles play an integrated role in optimizing Norman's interaction cycle, making the progression from perception to action dynamic, intuitive, and predictable. This integrative approach elevates digital graphic design from a purely aesthetic level to a cognitive–functional level, where every visual decision is grounded in an understanding of the human mind and perception.

The conceptual model proposed in this study demonstrated that combining Norman's perspective with Gestalt principles can provide a theoretical foundation for human-centered design, in which the UX results from a balance between cognitive logic and visual order. This model can serve as a basis for developing user interface design tools, evaluating UX, and teaching digital design grounded in perceptual psychology. Ultimately, the overall conclusion is that effective HCI is not merely the result of advanced technology, but of design grounded in human cognition. Design that leverages Gestalt principles for visual organization and draws inspiration from Norman's perspective to understand user behavior can create an experience in which technology serves human perception. In this way, the present study takes a step toward bridging perceptual psychology and digital graphic design, providing a theoretical and practical foundation for future research in HCI, UX, and intelligent graphical interface design.

It is essential to contextualize the findings of this research within its methodological limits. The proposed framework is a 'Conceptual Model' derived solely from theoretical synthesis and meta-analysis of established psychological and design literature. Although it presents a logically robust integration of Gestalt and Norman’s models, its full validation necessitates future empirical research. Specifically, the model requires testing through controlled user experiments, eye-tracking studies, and quantitative measurement to confirm the hypothesized reduction in cognitive load and the increase in task efficiency predicted by the integrated principles.

7 | Research Recommendations for Future Studies

Empirical evaluation of the proposed conceptual model

It is recommended that the Norman–Gestalt integrative model be validated through empirical tests and user studies in real-world environments. By designing graphical interfaces based on Gestalt principles and comparing them with versions that do not, the impact of each Gestalt law on interaction metrics—such as speed, accuracy, and user satisfaction—can be assessed.

Cross-cultural analysis of visual perception in digital design

Since perceptual understanding and organization may be influenced by cultural and social contexts, future research is recommended to examine the effect of cultural differences on the interpretation of Gestalt principles in interface design. Such studies can contribute to the development of localized, culturally adapted designs better aligned with the expectations of diverse user groups.

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Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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