Bodily Perception and Innovation in Design: Modern Practices of Embodied Cognition Theory

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Inspired by Maurice Merleau-Ponty's phenomenology of perception and the concept of "body-subject", this study advances a new paradigm of "embodied" design thinking. This approach not only investigates how design can foster an organic connection between people and the world but also delves into the "embodiment of emotions" within design practices, thereby strengthening emotional resonance and empathy between design works and individuals. This transformation in design thinking holds significant importance for advancing and deepening research into design methodologies. The research aims to enhance the understanding of the intrinsic logic within design, aiding designers in creating works that resonate more profoundly with human daily productivity and life, and facilitating an emotional dialogue between the design and its users. Originating from a profound human-centered design philosophy and guided by Don Ihde's theory of embodiment, the study begins with the functional relationships of bodily embodiment, employing phenomenological methods in design, enriched by in-depth case study analysis. Our research analysis has revealed three core logics of bodily embodiment in design: The logic of behavioral embodiment emphasizes innate and acquired human behavioral patterns; the logic of organ embodiment pertains to the interactions between internal organs and the external environment; and the logic of scenographic embodiment includes the design of empathetic scenes and subtler environmental layouts. In essence, this study underscores that modern design logic should consider the interplay between the human body, behavior, and the environment. Such Embodied Design logic offers new theoretical perspectives and guiding principles for future research and practical applications in design methodologies.

Keywords: Embodied Cognition Theory, design methodology, bodily embodiment, experience design

Introduction

In the contemporary design field, the Theory of Embodied Cognition has gradually become a focal point of research. Originating from psychology and cognitive science, this theory emphasizes that cognitive processes are profoundly influenced by bodily experiences and interactions with the environment. With the rise of Merleau-Ponty's phenomenology of perception and his concept of the "lived body", a new design thinking paradigm, "Embodied Design", is gaining attention (Anderson, 2021). This methodology not only explores how design can strengthen the organic connection between people and the world but also emphasizes the realization of "embodied

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emotionalization" through design practice, enhancing the emotional resonance and empathy between design works and individuals. The rise of Embodied Design marks a deep exploration of the intrinsic logic of design. It not only helps designers create works that better meet people's daily needs but also fosters deeper emotional communication and understanding between designers and users (Shapiro, 2019). In recent years, as design methodologies continue to evolve, Embodied Cognition Theory provides a new perspective for examining the design process, especially in the fields of product design and interaction design (Johnson, 2015; Anderson, 2021; Shapiro, 2019).

The core of this paper is to delve into this "human-centered" design philosophy, guided by Don Ihde's theory of embodiment, and to conduct an in-depth analysis using the method of design phenomenology through the functional relationships of bodily embodiment. This study focuses on the three core logics of bodily embodiment in design: behavioral embodiment, organ embodiment, and scenographic embodiment. Each logic significantly impacts the design process and outcome, enriching the close connection between design theory and practice. By integrating specific case studies, this paper aims to demonstrate how these theories can be applied in actual design work, thereby advancing research in design methodology and providing new ideas and guiding principles for design practice.

Against this backdrop, the goal of this study is to analyze and evaluate the application and impact of the Embodied Design paradigm across different design domains. Through a comprehensive review of related research, we aim to reveal the profound impact of embodied cognition theory on modern design practice, particularly how it has transformed our understanding of the design process and design products. We will also explore how this theory offers new tools and methods for designers to better meet the needs and expectations of users. This research is not only a comprehensive analysis of Embodied Design but also a deep investigation into the application of embodied cognition theory in the design field, aiming to provide new theoretical perspectives and guiding principles for future research and practice in design methodology.

## The Development and Definition of Embodied Cognition Theory

Embodied Cognition Theory, a significant branch of cognitive science, posits that the cognitive process transcends the confines of the brain, involving the entire body and its interaction with the external world. The development of this theory dates back to the 20th century when scholars began to explore the role of the body in cognitive processes, thereby challenging the traditional "mind-centric" view that cognition is solely a function of the brain.

In the early stages of development, psychologists and cognitive scientists began to focus on the role of the body in cognitive processes. Particularly influenced by Merleau-Ponty's phenomenology of perception, researchers paid more attention to the role of the body, especially its manifestation in cognitive processes (Gallagher & Zahavi, 2020). The theory of "imageless thought" proposed by the Gestalt psychology school (Feest, 2021), William James's theory of peripheral emotions (Barrett, 2017), and John Dewey's views on experience and reason (Alexander, 2013), all emphasize the importance of bodily experience in cognition. At the same time, Piaget's genetic epistemology and Vygotsky's sociocultural theory of psychology emphasize the importance of the interaction between the cognitive subject and the environment (Stetsenko, 2017).

In the latter half of the 20th century, Embodied Cognition Theory gained further development within the field of cognitive science. Scientists began to question the traditional "computer model", focusing instead on the role of the body in thinking and cognition. The works of George Lakoff and Mark Johnson, along with Don

Ihde's phenomenology of technology, further reinforced the relationship between humans, the body, and technology.

Embodied Cognition Theory argues that cognition is closely linked to the body's physiological structure, actions, and forms, highlighting how bodily states influence cognitive processes. The core concepts of this theory include the embodiment of cognition, its situational nature, and its dynamism. The embodiment of cognition indicates that the physical structure of the body and the sensory systems shape the development and emergence of cognition. The situational nature of cognition suggests that cognition results from the body's experiences in specific environments, emphasizing the dynamic interaction between the body and its surroundings. The dynamism of cognition views cognition as a continuous evolutionary process under the interaction between the body and the environment.
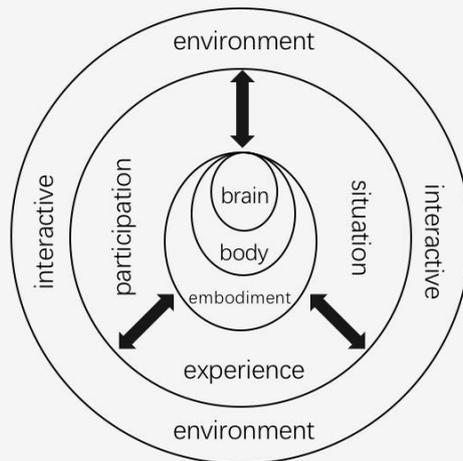
Figure 1. The basic characteristics of embodied theory (Li, 2019, p. 22).

As this theory has continued to evolve, its influence has progressively expanded into the field of design. Designers and researchers have begun to explore how to apply Embodied Cognition Theory to design practice, especially in terms of creating more profound user experiences through design. This shift marks a significant developmental phase in the field of design, moving from a focus solely on physical form and function to a more comprehensive emphasis on the user's bodily experience and emotional interaction. This transformation in the design field has not only enriched research in cognitive science but also introduced new perspectives into the development of design methodology. In the following sections, we will discuss how Embodied Cognition Theory influences modern design practice, particularly how the emerging paradigm of Embodied Design is applied and practiced in various fields such as product design and interaction design.

Embodied Design: Concepts and Practice

Embodied Design is a design method rooted in Embodied Cognition Theory. It transcends the traditional focus of design—merely creating physical objects or visual effects—and instead emphasizes creating experiences that directly interact with the user's body and emotions. The rise of this concept signifies a major shift in the design field, moving from focusing on functionality and aesthetics to a deeper level of user experience.

The essence of Embodied Design lies in deeply understanding and utilizing human bodily experiences and perceptual capabilities. It views design as a process that includes active participation and experience by the user, rather than a one-way act of creation. Under this approach, designers strive to capture and apply knowledge of how people interact with the world through their bodies and senses. This involves not only a deep understanding of human behavior, emotional responses, and modes of perception but also how to translate these understandings into practical design practices.

In practice, the Embodied Design method has been applied across multiple fields, from product design and interface design to service design. Designers employing this concept have created works that can evoke emotional responses and provide more intuitive, natural interactive experiences. For example, the design of smart home devices considers natural interaction between users and technology, utilizing voice control and smart sensing technologies to reduce the need for physical operations while simultaneously enhancing user comfort and convenience.

The table below outlines the application of Embodied Design concepts across different design domains and their impact on user experience. It showcases how considering the user's bodily and emotional experiences can improve the practicality, comfort, and emotional connection of design works.

Table 1

The Application of Design Concepts in Different Design Fields and Their Impact on User Experience

Design field	Specific examples	Reflecting design application	User experience impact
Product design	Tool handle	Ergonomically designed handle based on the way your hand holds it	Reduce user fatigue and improve operation intuitiveness and comfort
Interface design	Mobile application interface	Improve the intuitiveness and usability of the interface through visual layout and animation design	Enhance user attention guidance and provide an intuitive and easy-to-understand experience
Service design	Restaurant service experience	Design takes into account customers' physical space and interaction needs	Improve the overall dining experience, increase comfort and satisfaction
Interaction design	VR Virtual Reality games	Use body movements and head movements as game controls	Create immersive gaming experiences that increase engagement and realism

However, the practice of Embodied Design also introduces new challenges, particularly in how to accurately understand and quantify users' bodily experiences and emotional responses. This requires designers to conduct in-depth user research, incorporating interdisciplinary knowledge and methods of user participation, to ensure the effectiveness and adaptability of design decisions.

Embodied Design represents a significant shift in the design field. It not only emphasizes a deep connection with user experience but also offers new perspectives and methods for creating more attractive and human-centric design products. As we delve deeper into the application of Embodied Cognition Theory in specific design domains, we will see how Embodied Design impacts various aspects of modern design and how it can be applied to actual design projects.

Core Logics of Bodily Embodiment in Design

Under the paradigm of Embodied Design, the design process not only focuses on the functionality and aesthetics of products but also delves deeper into the users' bodily and emotional experiences. This design method encompasses three core logics: behavioral embodiment, organ embodiment, and scenographic embodiment.

These logics not only change the process and outcome of design but also deepen the connection between design and user experience.

Behavioral Embodiment

The core of behavioral embodiment lies in understanding and designing products that align with users' natural behaviors and action patterns. This means that designers must consider not only the physical actions of users when operating products but also the habits and cultural factors behind these actions. Taking smartphones as an example, early phone designs relied on physical buttons for operation, while modern smartphones use touchscreens. This design shift reflects users' preference for more intuitive, gesture-based interaction methods. The touchscreen interface allows users to control the device through natural gestures such as swiping, tapping, and pinching, which are more in line with human natural behavior habits.

Table 2

User Behavior Improves User Experience Through Design Elements

User conduct	Design elements	Improved user experience
Gesture operation	Touch interface (smartphone)	Intuitive operation
Physical exercise	Motion sensor (game controller)	Enhance interactivity

Organ Embodiment

Organ-centered design focuses on how products interact with users' bodily organs to enhance comfort and efficacy during use. This requires designers to deeply understand human anatomy and sensory needs. For example, the design of headphones must not only deliver excellent sound quality but also consider comfort during prolonged wear. Designers often meticulously plan aspects such as the weight, pressure distribution, materials, and shape of the headphones to prevent discomfort or pressure on the ears, ensuring users can wear them comfortably for extended periods. For instance, Sony's WH-1000XM5 and Apple's AirPods Max both utilize lightweight materials and soft ear cushions. They excel not only in sound quality but also in optimizing wearing comfort, ensuring users feel relaxed and pleased even after long usage periods.

Figure 2. Apple's AirPods Max. From Apple AirPods Max official website.

Scenographic Embodiment

Scenographic embodiment pertains to how design integrates into the user's living environment. It requires designers to consider the ways products are used within specific contexts and their impact on user behavior. Take furniture design as an example. Outstanding furniture design must contemplate aesthetics and comfort, as well as practicality within the home environment. For instance, IKEA's furniture design emphasizes spatial efficiency and multifunctionality, acknowledging modern families' needs for flexible space utilization. Many of its furniture products feature storage spaces, adjustable dimensions, and other characteristics designed to accommodate various living scenarios and the interactive needs of family members.

Figure 3. IKEA furniture design space. From IKEA official website.

The core logic of bodily embodiment necessitates designers to deeply understand users' behavior, physiology, and environmental needs, thereby creating designs that are more human-centric, comfortable, and emotionally

resonant. This design approach emphasizes the profound connection between design and user experience, offering new perspectives and methods for creating more attractive and functional design products.

The Application of Embodied Cognition Theory in the Design Field

The application of Embodied Cognition Theory in the design field marks a significant integration of theory and practice. Originally stemming from psychology and cognitive science, this theory underscores the core role of bodily experience and interaction with the environment in the cognitive process. With the emergence of Merleau-Ponty's phenomenology of perception and the concept of the "bodily subject", the design field has begun to emphasize the emotional resonance and interactive experience between design works and users, propelling the development of a "human-centered" design philosophy.

In product design, Embodied Cognition Theory guides designers to focus on the bodily and perceptual needs of users. For example, the design of the Apple Watch fully embodies the application of Embodied Cognition Theory. Designers not only pay attention to the functionality and aesthetics of the watch but also value its interaction with the user's body. For instance, the watch's lightweight design and streamlined contours consider long-term wearing comfort, while customizable straps meet the personalized needs of different users. In terms of interface design, the combination of a touchscreen and a digital crown allows users to navigate through intuitive gestures, taking into account users' natural gestures and motion habits, enhancing usability and efficiency. Such attention to the user's bodily experience, integrating daily activities with health data visualization through technology, exemplifies a user-centered design approach that emphasizes the close connection between design and users' lifestyles, thereby enhancing the product's practicality and appeal.

Figure 4. Apple Watch. From Apple official website.

Embodied Cognition Theory in design practice also emphasizes the importance of emotional resonance and empathy. For example, in IKEA's home products, the furniture design is deeply influenced by Embodied Cognition Theory, highlighting the enhancement of user comfort and emotional experience while meeting functional needs. IKEA's product design focuses on the balance between practicality and aesthetics, taking into account the interaction between furniture and the human body. For instance, the design of its chairs and sofas considers the human sitting posture and body curves, aiming to provide maximum comfort. Additionally, IKEA's design philosophy is reflected in its spatial efficiency and multifunctionality, with flexible furniture layouts and storage solutions allowing the furniture to better integrate into users' living spaces and daily habits.

Figure 5. IKEA product design. From IKEA official website.

Smart home systems, such as Google Home or Amazon Echo, achieve home automation through voice assistants, allowing users to control devices within their homes via voice commands. The design of these systems considers the natural interaction between users and their home environments, enabling control over lighting, temperature, and more with simple voice commands. The core design philosophy of smart home systems reflects the trend of seamlessly integrating technology into users' daily lives. Voice interaction reduces the need for physical operations, demonstrating a deep understanding of users' natural behavioral patterns. This design showcases how Embodied Cognition Theory can be applied to enhance convenience and comfort in everyday living.

In the realm of interaction design, the application of Embodied Cognition Theory has introduced unprecedented immersive gaming experiences. Taking the design of VR (Virtual Reality) headsets as an example, users, upon donning the headset, can enter a three-dimensional virtual world. Here, interaction no longer depends on traditional game controllers but is achieved through the user's head movements, gestures, and bodily actions. This design allows users to use their bodies as the medium of interaction, significantly enhancing the realism and engagement of the game. For instance, in a virtual reality adventure game, players control the movement and interaction of characters through bodily actions, making the gaming experience more vivid and natural.

Interactive public art installations, such as light and shadow installations that move with passersby, are typically installed in public spaces. They change the light and shadow effects based on the movements of people, creating dynamic visual experiences. The design of these installations combines visual art with bodily movement, as the movements and pauses of passersby influence the changes in light and shadow. The innovation of such art installations lies in their bodily interaction with the audience. They serve not only as objects of admiration but also encourage viewers to participate in the art creation through bodily movement. This design concept breaks away from the traditional static appreciation of artworks and brings a new interactive experience to the public art domain.

Figure 6. Internet users in China.

They collectively emphasize the deep integration of design with users' bodily and emotional experiences, demonstrating that design is not merely about creating objects but also about crafting experiences and enhancing people's daily lives. Applying Embodied Cognition Theory to design practice also faces challenges. Quantifying the emotional resonance effect of design works is not straightforward, and ensuring the effectiveness of design decisions requires a deep understanding of users' experiences and needs. In the future, Embodied Cognition Theory is expected to offer more innovative inspiration and methods in the fields of human-computer interaction and user experience design, further advancing the development of the design field.

The Practical Challenges and Future Directions of Embodied Cognition

Practical Challenges

Applying Embodied Cognition Theory in the design field presents a significant challenge in translating theory into practice. The essence of Embodied Cognition Theory lies in understanding how human bodies and perception influence interaction with the environment. While this is theoretically fascinating, implementing it in actual design practice proves challenging. For instance, accurately capturing and applying users' bodily experiences in product design and quantifying the design's impact on users' emotions are deep areas of exploration for designers. This requires designers to possess not only creativity and technical skills but also a profound understanding of psychology and human behavior.

Another challenge is addressing user diversity. The differences in users' physical abilities, cultural backgrounds, and personal preferences mean that designers must consider these variations when applying Embodied Cognition Theory, making the creation of designs that meet all users' needs a significant challenge. This requires designers to focus not only on the average user experience but also on the specific needs of marginalized groups. This is not just a technical challenge for design but also a matter of social responsibility.

For instance, ensuring public spaces or services are accessible and friendly to all user groups is a crucial consideration.

Future Directions

In facing these challenges, an important future direction for the design field is the integration and innovation of technology. With the development of artificial intelligence and augmented reality technologies, designers have the opportunity to gain deeper insights into and simulate users' bodily experiences. For example, by using augmented reality technology, designers can simulate user-product interaction at the initial design stages, allowing for more precise adjustments to meet user needs. Cultural sensitivity and sustainability will become key considerations in future designs. Designers must contemplate how their designs adapt to users from different cultural backgrounds while ensuring sustainability and reducing environmental impact. This requires designers to focus not only on the functionality and aesthetics of products but also on their social and environmental impacts.

Embodied Cognition Theory brings new perspectives and challenges to the design field, as well as limitless possibilities for innovation. Through interdisciplinary collaboration and the application of new technologies, designers have the opportunity to create more attractive, human-centric, and socially and environmentally responsible design works.

Conclusion

This paper delves into the new paradigm of Embodied Cognition Theory in the design field, particularly how the concept of "Embodied Design" extends from psychology and cognitive science to design practice. By analyzing specific cases across various design domains, we have revealed the core logics of bodily embodiment—behavioral embodiment, organ embodiment, and scenographic embodiment—and their significant applications and impacts in design.

These core logics highlight the importance of a deep understanding of users' bodily experiences and perceptual habits in the design process. Behavioral embodiment guides designers to consider users' natural behaviors and motion patterns; organ embodiment demands that designs align with the characteristics of users' bodily organs; scenographic embodiment emphasizes the adaptability of designs within specific environments. This design approach centered on bodily experiences not only enhances the practicality and comfort of products but also deepens the emotional connection between design works and users. However, the application of Embodied Cognition Theory in design also faces challenges. The complexity of the theory, the diversity of user needs, and the quantification of design effects are difficulties that designers need to overcome in practice. In the future, the design field may witness more interdisciplinary collaboration and the integration of new technologies, such as augmented reality and artificial intelligence, to address these challenges.

The new paradigm of Embodied Cognition Theory has profoundly impacted the design field. It encourages designers to start from users' bodily and emotional experiences to create more attractive and human-centric design works. Future research should further explore the application of this theory across different cultural and social backgrounds and how to effectively integrate emerging technologies to create more innovative and inclusive design solutions.

References

Alexander, T. M. (2013). *The human eros: Eco-ontology and the aesthetics of existence*. New York: Fordham University Press.
Anderson, M. L. (2021). *After phrenology: Neural reuse and the interactive brain*. Cambridge: MIT Press.

Barrett, L. F. (2017). *How emotions are made: The secret life of the brain*. Boston: Houghton Mifflin Harcourt.

Desai, S., Blackler, A., & Popovic, V. (2019). Children's embodied intuitive interaction—Design aspects of embodiment. *International Journal of Child-Computer Interaction, 21*, 89-103.

Feest, U. (2021). Gestalt psychology, frontloading phenomenology, and psychophysics. *Synthese, 198*(Suppl. 9), 2153-2173.

Ferreira, B. M. (2019). Packaging texture influences product taste and consumer satisfaction. *Journal of Sensory Studies, 34*(6), e12532.

Gallagher, S., & Zahavi, D. (2020). *The phenomenological mind*. New York: Routledge.

Groth, C. (2016). Design-and craft thinking analysed as embodied cognition. *FormAkademisk, 9*(1), 1-21.

Heylighen, A., & Dong, A. (2019). To empathise or not to empathise? Empathy and its limits in design. *Design Studies, 65*, 107-124.

Ihde, D. (2002). *Bodies in technology (Vol. 5)*. Minneapolis: U of Minnesota Press.

Johnson, M. (2015). Embodied understanding. *Frontiers in Psychology, 6*, Article 875.

Kwon, J., & Iedema, A. (2022). Body and the senses in spatial experience: The implications of kines-thetic and synesthetic perceptions for design thinking. *Frontiers in Psychology, 13*, 864009.

Li, Z. (2019). Design and development of virtual simulation experiments from the perspective of embodied cognition (Master's thesis, Shandong Teachers' University, 2019).

Lu, P., Li, Z., Li, J., & Hsiao, S. W. (2023). A consumer-oriented design thinking model for product design education. *Interactive Learning Environments, 31*(8), 4753-4771.

Makransky, G., & Petersen, G. B. (2021). The cognitive affective model of immersive learning (CAMIL): A theoretical research-based model of learning in immersive virtual reality. *Educational Psychology Review, 33*(3), 937-958.

Poulsen, S. B., & Thøgersen, U. (2011). Embodied design thinking: A phenomenological perspective. *CoDesign, 7*(1), 29-44.

Shapiro, L. (2019). *Embodied cognition*. New York: Routledge.

Stach, J. (2019). Meaningful experiences: An embodied cognition perspective on brand meaning co- creation. *Journal of Brand Management, 26*(3), 317-331.

Stetsenko, A. (2017). *The transformative mind: Expanding Vygotsky's approach to development and education*. Cambridge: Cambridge University Press.