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Embodied Cognition and Cultural Memory Awakening in Elderly Mortise-and-Tenon Puzzle Toy Design: A Three-Layer Progressive Model

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Abstract: Under the dual pressures of global population aging and the urgent need for cultural heritage preservation, leveraging innovative product design to activate the cultural memories of elderly populations has emerged as a critical focus. Addressing both cognitive health and emotional needs is now a significant issue within design psychology and age-friendly product development. This study adopts embodied cognition theory as its core theoretical framework, systematically integrating multisensory experience design and reminiscence therapy. Specifically, it utilizes the traditional Luban Lock mortise-and-tenon puzzle toy as an in-depth analytical case study to explore these dynamics. A comprehensive three-layer progressive model is constructed, comprising multisensory collaborative activation, action schema construction, and emotional memory awakening. These layers directly correspond to the sequential cognitive pathways of bodily perception, cognitive engagement, and profound emotional resonance. The study conclusively demonstrates that the unique sensorimotor properties of natural wooden materials, when combined with the rich cultural symbol system inherent in mortise-and-tenon structures, can highly effectively activate elderly users' procedural and emotional memories. Furthermore, this embodied learning process provides a unique, highly accessible channel for the internalization of cultural knowledge that successfully transcends conventional linguistic and visual media limitations. Ultimately, the findings offer robust theoretical foundations and actionable practical references for advancing age-friendly product design based on embodied cognition, while simultaneously promoting the contemporary revitalization and sustainable transmission of traditional craftsmanship.

Keywords: embodied cognition; multisensory experience; cultural memory; product design; aging population

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1. Introduction

According to the Seventh National Population Census, China's population aged 60 and above has reached 264 million, accounting for 18.7% of the total population, and is projected to exceed 300 million within the next five years. Under the policy orientation of "healthy aging," the needs of elderly populations have expanded from basic material support to multi-dimensional directions, including cognitive maintenance, spiritual culture, and social participation [1]. Research highlights that puzzle toys can play a significant role in delaying cognitive decline and alleviating the sense of loneliness among elderly populations. However, the current market is predominantly dominated by children's toys, with products specifically designed for elderly users remaining notably deficient. These deficiencies are particularly evident in areas such as cultural adaptability, emotional attentiveness, and systematic design, which are crucial for meeting the complex needs of aging populations.

Meanwhile, traditional Chinese craftsmanship, exemplified by mortise-and-tenon joinery, faces a dual challenge of "museumification" and "symbolization." Conventional exhibition methods often reduce this craft to static artifacts intended for passive

observation, thereby severing the organic connection between craft knowledge and bodily experience. Additionally, the superficial extraction of symbols diminishes the profound craft wisdom and cultural depth embedded within these practices. A shared underlying issue is that traditional craftsmanship lacks physical carriers that enable contemporary elderly populations to actively engage and participate [2]. This disconnect limits the potential of such crafts to serve as meaningful tools for cultural engagement and personal enrichment among older adults.

Existing research has explored the functional design of elderly toys, the cultural value of mortise-and-tenon craftsmanship, and the positive effects of reminiscence therapy on the psychological health of elderly individuals. However, a systematic integration across these three domains remains absent. At the product interaction level, the mechanisms through which mortise-and-tenon craftsmanship mediates the activation of cultural memory through users' bodily perception and operational processes have not been adequately examined. Furthermore, the specific design features that play pivotal roles in this process require deeper investigation. This study adopts embodied cognition theory as its core framework, integrating multisensory experience design and reminiscence therapy. Using the Luban Lock as a design case, the study systematically analyzes the internal mechanisms through which mortise-and-tenon puzzle toys activate the cultural memories of elderly populations [1]. The findings aim to distill theoretical models and practical implications for the development of age-friendly product designs that are both culturally enriching and functionally effective.

2. Literature Review

2.1. Cognitive Characteristics and Memory Structure of the Elderly

Research on cognitive aging highlights the uneven progression of changes within the memory system of elderly individuals. As people grow older, their near-term memory capabilities tend to deteriorate progressively, whereas remote memory—encompassing long-term cultural knowledge and early autobiographical experiences—remains comparatively preserved [2]. This disparity indicates that traditional cultural symbols, which are deeply rooted in the formative memories of older populations, are more effective than novel stimuli in eliciting the activation of profound memories. Such findings underscore the importance of leveraging culturally familiar elements in interventions aimed at engaging elderly individuals cognitively and emotionally.

At the sensory channel level, elderly individuals face age-related declines in visual and auditory sensitivity, while tactile perception and proprioception exhibit greater stability, continuing to serve as vital cognitive gateways even as other sensory abilities diminish. Interaction designs that emphasize tactile channels, complemented by multisensory integration, demonstrate strong functional compatibility with the needs of elderly populations [3]. On an emotional level, nostalgic feelings act as a valuable psychological resource, capable of activating autobiographical memory, reinforcing self-identity, and imbuing present experiences with meaning. This suggests that product designs incorporating culturally familiar elements can effectively reduce cognitive and emotional barriers for elderly users, thereby enhancing their willingness to engage and interact with such designs. By prioritizing these sensory and emotional considerations, designers can create solutions that are both accessible and meaningful for aging populations.

2.2. Design Value and Cultural Significance of Mortise-And-Tenon Craftsmanship

Mortise-and-tenon joinery represents the foundational connection technique in traditional Chinese timber architecture and furniture production. This method achieves durable and stable structural connections by interlocking convex and concave components without relying on nails or adhesives [4]. It exemplifies the Eastern philosophy of respecting the inherent properties of materials and shaping them through form. Academic exploration has expanded beyond its historical and architectural significance to its application in modern design practices. Mortise-and-tenon joinery

demonstrates remarkable adaptability in structural design and formal versatility, making it highly suitable for integration into contemporary product development. Through modular decomposition and functional abstraction, this craftsmanship can be innovatively applied to create modern designs that retain traditional essence while meeting contemporary needs.

The Luban Lock serves as an intellectual adaptation of mortise-and-tenon principles, comprising interlocking wooden components that achieve overall stability through precise convex-concave connections. This design allows for repeated assembly and disassembly, offering both functional and cognitive benefits. Research highlights that the process of disassembling and reassembling the Luban Lock engages users in iterative cycles of hypothesis formation, verification, adjustment, and completion. These activities effectively enhance spatial reasoning, working memory, and hand-eye coordination. On a cultural level, the Luban Lock embodies the values of ingenuity and craftsmanship, serving as a meaningful artifact for elderly individuals who experienced the era of traditional handicrafts. It acts as an emotional bridge and a vessel for preserving collective memory, fostering a sense of connection to cultural heritage.

2.3. Embodied Cognition Theory and Its Applications in Age-Friendly Design

Embodied Cognition represents a significant theoretical framework within cognitive psychology, emphasizing that cognition extends beyond internal brain processes to encompass the dynamic interplay between the brain, body, and environment. This perspective challenges traditional cognitive science paradigms that separate the mind from the body, instead highlighting the integral role of the sensorimotor system in shaping perception, memory, and emotional processing. In the context of elderly research, this theory offers valuable insights into tactile memory and operational learning. The "action schema" developed through manual operations integrates sensorimotor experiences into a cohesive system, characterized by strong memory stability and contextual dependence. The process by which bodily-level operational practices activate associated cultural memories is referred to as "embodied simulation," wherein the body re-enacts past sensorimotor patterns to trigger corresponding memory traces [1]. While this theory has been extensively applied in the design of educational toys for children, its systematic application in creating age-friendly products remains underexplored. Mortise-and-tenon puzzle toys, which rely on bodily operations as their primary interaction mode, align closely with the core principles of embodied cognition. These toys not only engage the sensorimotor system but also have the potential to enhance cognitive and emotional well-being among elderly users by fostering meaningful interactions and stimulating memory recall through physical engagement.

3. Theoretical Framework: A Three-Layer Progressive Model Based on Embodied Cognition

3.1. Framework Construction Logic

This study adopts embodied cognition theory as its foundational framework, integrating principles of multisensory experience design and cultural memory theory to develop a three-layer progressive model [4]. This model is designed to analyze the mechanisms by which mortise-and-tenon puzzle toys stimulate cultural memory in elderly users. The three layers of the model are defined as multisensory collaborative activation, action schema construction, and emotional memory awakening. These layers correspond to a progressive pathway of "bodily perception → cognitive engagement → emotional resonance" (see Figure 1). Importantly, the layers are not isolated but dynamically interconnected. Sensory activation establishes a sensorimotor basis that facilitates cognitive engagement. This cognitive engagement, in turn, enhances cultural understanding through iterative operational processes. Emotional resonance subsequently reinforces the intrinsic motivation of elderly users, encouraging sustained participation. This cyclical interaction creates a positive feedback loop, wherein each layer

strengthens the others, ultimately fostering a deeper connection to cultural heritage and memory.

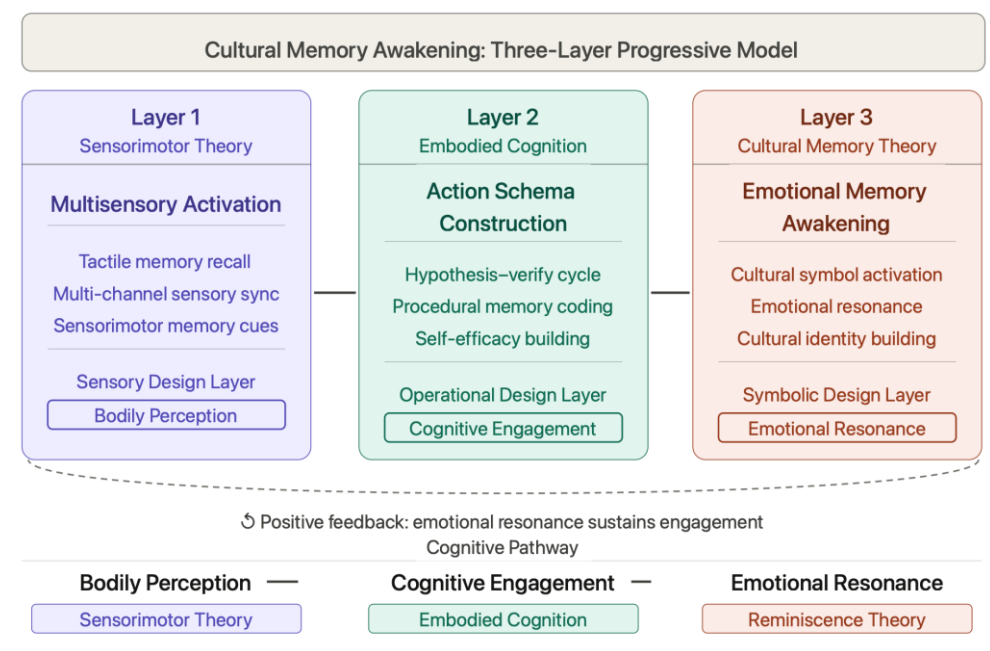


Figure 1. Three-layer Progressive Model of Cultural Memory Awakening Based on Embodied Cognition

3.2. Theoretical Basis of Each Layer

The first layer, "multisensory collaborative activation," is grounded in the mechanisms of memory activation within the sensorimotor system, as described in embodied cognition theories. Bodily perception is understood not merely as a passive reception of external stimuli but as an active and dynamic process of constructing meaning [5, 6]. Through the coordinated integration of multisensory information, memory networks associated with prior bodily experiences are activated, enabling individuals to engage with their environment in a more profound and interconnected manner. This layer emphasizes the importance of sensory collaboration in fostering cognitive engagement and enhancing memory recall, particularly in contexts where physical interaction plays a pivotal role in learning and adaptation.

The second layer, "action schema construction," is built upon the foundational principle of embodied cognition, which highlights the concept of "learning by doing." Action schemas are sensorimotor programs developed through repeated bodily interactions with specific objects or environments. These schemas exhibit strong automaticity and stability, serving as a form of procedural knowledge distinct from declarative memory [7]. For elderly individuals, procedural memory tends to remain more intact compared to episodic memory, making embodied operations a particularly effective method for transmitting cultural knowledge. This approach leverages the preserved capabilities of procedural memory to facilitate meaningful engagement with cultural practices, ensuring continuity and accessibility of knowledge across generations.

The third layer, "emotional memory awakening," is informed by theories of cultural memory and therapeutic practices such as reminiscence therapy [8]. Cultural memory theory underscores the importance of physically fixed symbol systems in sustaining collective memory over time. Reminiscence therapy demonstrates that encouraging individuals to interact with cultural objects associated with positive past experiences can activate autobiographical memory, fostering a sense of self-integration and reinforcing social belonging. By engaging with these culturally significant objects, individuals can

reconnect with their personal histories and shared traditions, thereby enhancing emotional well-being and strengthening their connection to the broader community.

4. Cultural Memory Awakening Mechanisms of Mortise-And-Tenon Puzzle Toys

4.1. Layer One: Multisensory Collaborative Activation

Multisensory collaborative activation forms the perceptual basis and initial stage of the mechanism. Embodied cognition theory highlights the central role of the sensorimotor system in memory activation, where the body's interaction with material objects serves as a crucial trigger for memory retrieval. Wooden materials, as one of the primary sensory mediums of the Luban Lock, offer a warm tactile sensation, natural texture, and distinctive fragrance. These sensory attributes are deeply ingrained in the bodily experiences of China's elderly populations who lived during the 1950s to 1970s, a period when wooden implements were prevalent in household life. When elderly users interact with wooden puzzle toys, these sensory characteristics act as embodied memory triggers, reawakening sensorimotor memories tied to traditional life scenes. This process underscores the profound connection between material properties and cultural memory, emphasizing the importance of sensory engagement in design strategies aimed at memory activation.

The interaction process of the Luban Lock delivers multichannel sensory feedback, enhancing the user's experience and memory activation. The crisp "click" sound produced when components interlock provides immediate auditory confirmation, while the moderate resistance of the mortise-and-tenon structure offers tactile feedback that communicates structural precision. Additionally, the dynamic adjustments of posture and force during assembly create a continuous kinesthetic experience. This coordinated integration of sensory information compensates for age-related declines in single-channel perceptual sensitivity, thereby broadening and intensifying sensory memory activation. From a design perspective, the calibration of friction ensures moderate resistance without exceeding the hand-strength limits of elderly users, while the optimization of grip affordances adapts component size and form to the physical characteristics of elderly hands. Furthermore, the systematic design of rhythmic feedback enhances the overall sensory experience, making the Luban Lock an effective tool for multisensory collaborative activation. These design elements collectively contribute to a more inclusive and engaging interaction, fostering deeper connections to cultural memory through sensory engagement.

4.2. Layer Two: Action Schema Construction

Building on multisensory activation, the assembly process of the Luban Lock initiates the embodied construction of action schemas. The action schema is a core concept in embodied cognition theory, referring to the sensorimotor pattern with procedural characteristics formed through the body's repeated interaction with specific objects or tools. For elderly populations, procedural memory demonstrates greater resilience compared to episodic memory, making the construction of action schemas an effective channel for transmitting cultural knowledge. The iterative process of Luban Lock disassembly and reassembly involves a typical cognitive cycle: users form predictive hypotheses regarding component orientation and interlocking positions, test these hypotheses through hands-on operation, refine their mental models based on structural feedback, and ultimately complete the assembly. This embodied reasoning process of "hypothesis---verification---revision---completion" aligns well with the relatively intact procedural memory systems of elderly individuals. It simultaneously enhances spatial reasoning, working memory, and hand-eye coordination, while embedding the structural logic of mortise-and-tenon craftsmanship into muscle memory through physical interaction. By engaging in this process, participants not only acquire practical skills but also internalize cultural heritage in a deeply experiential manner, fostering a meaningful connection to traditional craftsmanship.

"Learning by doing" offers distinct advantages at the cognitive encoding level. Compared to visual or linguistic instruction, memory traces formed through operational

learning are deeper, retrieval pathways are more stable, and resistance to age-related forgetting is significantly stronger. When elderly individuals master mortise-and-tenon structures through repeated assembly, they acquire not only operational skills but also cultural knowledge that is mediated through physical interaction. This form of knowledge transmission is irreplaceable by verbal explanation or visual display, as it engages the body in a way that reinforces understanding and retention. Furthermore, the sense of self-efficacy generated by each successful assembly provides critical psychological support for cognitive engagement. This sense of accomplishment strengthens motivation for continued participation, creating a positive feedback loop where cognitive training and emotional encouragement mutually reinforce one another. Over time, this process not only enhances cognitive abilities but also fosters a sense of purpose and connection, making it a valuable tool for promoting both mental and emotional well-being in elderly populations.

4.3. Layer Three: Emotional Memory Awakening

Emotional memory awakening constitutes the deepest level of the entire mechanism and is the core feature that distinguishes mortise-and-tenon puzzle toys from ordinary cognitive training tools. The "embodied simulation" mechanism in embodied cognition theory suggests that when the body re-enacts sensorimotor patterns associated with specific cultural contexts, it not only activates procedural memory but simultaneously triggers autobiographical memory intertwined with emotional experiences. The cultural symbol system embedded in mortise-and-tenon puzzle toys—such as the precise logic of timber-frame structures, the Eastern philosophical metaphor of convex-concave interlocking, and the craft values emphasizing resourcefulness and ingenuity—serves as an emotional anchor. This connection links elderly users' bodily sensations during operation to their personal and collective historical memories, fostering a profound sense of cultural resonance and emotional engagement.

This mechanism aligns closely with the psychological principles of reminiscence therapy, which encourages individuals to interact with objects that evoke positive past experiences. Such interactions help elderly individuals reintegrate memories, strengthen their self-identity, and consolidate their sense of social belonging [9]. Studies have demonstrated that reminiscence therapy effectively alleviates negative emotions and enhances subjective wellbeing and self-worth. Furthermore, systematic analyses of this therapeutic approach have shown its stable effects in fostering a positive self-identity and reinforcing social connections, making it a valuable intervention for elderly individuals seeking emotional and social enrichment.

The intergenerational communication dimension further amplifies the social function of emotional memory awakening. In family interaction contexts, mortise-and-tenon toys can act as a medium for dialogue between elderly individuals and younger family members. Through these interactions, elderly users share their experiential understanding of the craft, transforming the toy from an individual emotional memory activator into a social conduit for intergenerational cultural transmission. This process extends the activation of cultural memory beyond the individual level, fostering connections within families and communities and promoting a shared appreciation for traditional craftsmanship and cultural heritage.

5. Design Implications

Based on the mechanistic analysis of the three-layer model, this study identifies essential design implications for creating age-friendly mortise-and-tenon puzzle toys from the perspective of embodied cognition. These implications aim to enhance usability, engagement, and emotional resonance for elderly users, ensuring that the toys are both functional and meaningful [10, 11].

At the sensory design level, materials should be carefully selected to optimize sensorimotor properties, with natural wood being a preferred choice due to its cultural familiarity and tactile appeal. Designers must pay close attention to texture, temperature

sensation, and weight calibration to ensure comfort and ease of use. The interlocking resistance and rhythm of components should be meticulously adjusted to provide clear tactile feedback while remaining within the hand-strength capabilities of elderly users. Additionally, the auditory experience of assembly, including the clarity and pleasantness of sounds produced during interlocking, should be integrated into the design to promote multisensory engagement and collaborative activation.

At the operational design level, a structured progression of difficulty should be implemented to accommodate elderly individuals with diverse cognitive abilities. Component dimensions and grip affordances must be tailored to the physiological characteristics of aging hands, ensuring ease of manipulation [12]. Clear operational guidance and intuitive structural logic are essential to minimize initial cognitive load, thereby improving early engagement success rates. This approach fosters a sense of accomplishment and strengthens self-efficacy, encouraging sustained interaction with the puzzle toys.

At the cultural symbol level, traditional cultural elements that evoke emotional resonance for elderly users should be thoughtfully integrated into both visual and tactile aspects of the design [4]. Superficial decoration must be avoided, and the selection of cultural symbols should be informed by comprehensive research into generational memory resources. This ensures an authentic connection between the symbols and the users' emotional histories, enhancing the overall appeal and meaningfulness of the puzzle toys.

6. Discussion

6.1. Theoretical Contribution of the Embodied Cognition Perspective

This study integrates embodied cognition theory into the exploration of age-friendly puzzle toy design, presenting a novel perspective that diverges from traditional functionalist paradigms. Conventional research in age-friendly product design has largely emphasized physiological compensation, such as addressing perceptual decline and simplifying operational complexity. In contrast, the embodied cognition framework highlights the elderly users' bodies as dynamic conduits for cultural knowledge transmission. This approach underscores the importance of designing products that not only accommodate physical limitations but also stimulate the cultural memory embedded within the users' bodily experiences. By activating these latent cultural resources, this perspective broadens the theoretical scope of age-friendly product design, offering innovative pathways for creating more meaningful and engaging interactions tailored to the elderly population.

6.2. Limitations of the Three-Layer Model and Future Research Directions

The "multisensory activation---action schema construction---emotional memory awakening" three-layer model demonstrates strong theoretical coherence, yet its underlying mechanistic assumptions require systematic empirical validation. It remains uncertain whether the sequential progression between these layers is universally applicable or contingent upon specific individual and contextual factors. Variables such as cognitive function levels, cultural background differences, and the frequency of toy use may significantly influence this process, but direct empirical evidence is currently lacking. Future research should adopt participatory design methodologies and longitudinal user studies to rigorously test these assumptions. Prototype testing combined with psychophysiological measurements, including emotional self-assessment scales and cognitive function evaluations, can provide valuable insights. Additionally, identifying key design variables with the highest predictive power for cultural memory activation will be essential for refining the model and enhancing its practical applications in diverse contexts.

6.3. Research Scope and Boundary Conditions

This study primarily focuses on theoretical construction, utilizing case analysis and literature integration methods while deliberately excluding first-hand empirical data. The findings provide direct reference value for the design of mortise-and-tenon puzzle toys within the framework of embodied cognition theory. However, when attempting to generalize these findings to other traditional craft forms or across diverse cultural contexts, it is essential to conduct a thorough evaluation tailored to the specific circumstances and variables of each unique scenario to ensure applicability and relevance [1].

7. Conclusion

This study, grounded in embodied cognition theory and integrating multisensory experience design with reminiscence therapy, systematically investigates the Luban Lock mortise-and-tenon puzzle toy as a case study to elucidate the mechanisms through which such toys activate cultural memory in elderly populations. By constructing a three-layer progressive analytical model of "multisensory activation---action schema construction---emotional memory awakening," the research highlights how sensory engagement with traditional materials and interactive processes fosters deeper connections to cultural heritage. The findings emphasize the importance of tactile and sensory stimuli in triggering cognitive and emotional responses, which are essential for memory activation and cultural identity reinforcement. This approach not only provides insights into the cognitive and emotional benefits of traditional craft-based activities but also underscores their potential in enhancing intergenerational communication and cultural continuity.

The study reveals that the sensorimotor perception of wooden materials forms the foundational layer for activating cultural memory, while the embodied operational process of assembling the puzzle internalizes craft cultural knowledge as procedural memory. This procedural memory serves as a medium for cultural transmission that bypasses traditional linguistic and visual channels, making it accessible to diverse populations. Furthermore, the emotional resonance and sense of accomplishment derived from successfully completing the puzzle strengthen cultural identity and foster a sense of self-efficacy. These outcomes not only enhance individual well-being but also create a natural social context for intergenerational cultural exchange, demonstrating the broader societal value of integrating traditional crafts into age-friendly product design. The findings suggest that such activities can serve as powerful tools for promoting cultural preservation and fostering meaningful social interactions.

The theoretical contributions of this study lie in the systematic application of embodied cognition theory to the design and analysis of age-friendly puzzle toys, offering a novel perspective on how bodily perception mediates cognitive training and cultural identity formation. The proposed three-layer progressive model provides a practical analytical framework for designers, gerontology researchers, and cultural heritage practitioners, enabling them to create products that are both cognitively stimulating and culturally enriching. Future research should focus on validating the empirical robustness of this model through controlled experimental studies and participatory design methodologies. Additionally, exploring its applicability across other traditional craft forms and diverse cultural contexts could further expand its utility. Investigations into the integration of digital technologies, such as augmented reality, with traditional crafts may also reveal new pathways for enhancing multisensory engagement and cultural transmission, paving the way for innovative approaches to preserving intangible cultural heritage.

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References

1. L. Foglia and R. A. Wilson, "Embodied cognition," *Wiley Interdisciplinary Reviews: Cognitive Science*, vol. 4, no. 3, pp. 319–325, 2013.

2. J. Assmann, *Cultural memory and early civilization: Writing, remembrance, and political imagination*. Cambridge: Cambridge University Press, 2011.
3. H. Ye, "Embodied cognition: a new orientation of cognitive psychology," *Adv. Psychol. Sci.*, vol. 18, no. 05, pp. 705–710, 2010.
4. J. Song et al., "Review and Reflection on Reminiscence Therapy: A Bibliometric-Based Visualization Analysis Approach," in *Positive Psychology 2.0 International Conference 2025 (PP 2.0 2025)*, Atlantis Press, Dec. 2025, pp. 79–100.
5. Z. Liu, F. Yang, Y. Lou, W. Zhou, and F. Tong, "The effectiveness of reminiscence therapy on alleviating depressive symptoms in older adults: A systematic review," *Frontiers in Psychology*, vol. 12, p. 709853, 2021.
6. Z. Zeyuan and J. Euitay, "Understanding Museum Experience from the Perspectives of Embodied Cognition and Multisensory Design," in *International Conference on Design and Digital Communication*, Cham: Springer Nature Switzerland, Nov. 2024, pp. 329–340.
7. A. Joy and J. F. Sherry Jr, "Speaking of art as embodied imagination: A multisensory approach to understanding aesthetic experience," *Journal of Consumer Research*, vol. 30, no. 2, pp. 259–282, 2003.
8. J. Baumard and F. Osiurak, "Is bodily experience an epiphenomenon of multisensory integration and cognition?," *Frontiers in Human Neuroscience*, vol. 13, p. 316, 2019.
9. P. König et al., "Embodied cognition," in *2018 6th International Conference on Brain-Computer Interface (BCI)*, IEEE, Jan. 2018, pp. 1–4.
10. V. Gallese and S. Ebisch, "Embodied simulation and touch: The sense of touch in social cognition," *Phenomenology and Mind*, no. 4, pp. 196–210, 2013.
11. L. Lin and L. Lu, "Research on the design of multisensory interactive experiences in museums based on embodied cognition," in *International Conference on Human-Computer Interaction*, Cham: Springer Nature Switzerland, Jun. 2024, pp. 204–211.
12. S. Sanchez, T. Dingler, H. Gu, and K. Kunze, "Embodied Reading: A Multisensory Experience," in *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, May 2016, pp. 1459–1466.

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