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Metaphor and Synaesthesia: Cross-Generational Design Research on Digital Product Information

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Abstract: This study aims to summarize the theory of transgenerational design to achieve the sharing and communication of digital product information across different age groups of users, with a particular focus on enhancing the interactive experience of information. Based on the context of aging, the intrinsic relationships between transgenerational design, user perception, and information delivery are elaborated. Methods such as multi-associated metaphors for parallel transgenerational users and multi-dimensional synesthesia for overlapping transgenerational users are analyzed. Using the optimization of information in a digital APP product as an example, the feasibility of this theory is verified, and a new strategy for transgenerational design of product information is constructed to address the cross-generational challenges faced by digital product information in the context of aging.

Key words: Metaphor; Synaesthesia; Cross-Generational Design; Digital Intelligent Information Interaction

1. Aging and Cross-Generational Design

The "Report on the Development of the Aging Society and Old-age Security of China (2013)" shows that China entered an "aging" society in 2000. By 2015, the population aged 60 and above had reached 14.9%, and it was projected to reach 19.3% by 2020[1]. the decline in functional abilities among the elderly and their individual capacity for learning cannot keep pace in real time with the exponential proliferation of information. This imbalance leads to sensory friction during the elderly population's processes of perceiving, understanding, deciding, implementing, and providing feedback on product-related information [2]. In the initial period after World War II when aging issues began to emerge, concepts such as universal design and transgenerational design successively arose.

Transgenerational design was proposed in 1986 by Professor James Pirkl and his colleagues at Syracuse University in the United States. It advocates that products, services, and environments should simultaneously meet the needs of people of different ages and abilities, emphasizing that the elderly should be able to work alongside younger people in the same environment [3]. In essence, "transgenerational design" is the true pioneer of aging-focused design concepts [4]. Pirkl believes that as age increases, physical state and sensory impairment become interrelated: young people become old; old people can become disabled [5], see Figure 1. Therefore, the core issue of transgenerational needs lies in responding to their wide-ranging perceptual and behavioral differences through "intergenerational" design, achieving effective product information delivery, reception, and experience, thereby preserving personal dignity and sense of self-worth [6].

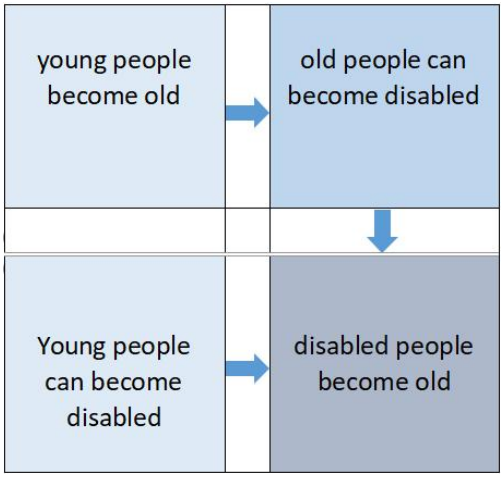

Figure 1. Pirkl's Aging Correlation Diagram

2. Metaphor and Synaesthesia Design Types of Product Information based on Cross-Generational Design

2.1 Horizontal - Multi-Perspective Metaphor Based on Parallel Transgenerational Users

In his research "The Philosophy of Rhetoric, " Richards viewed metaphor as existing in the

"borrowing and communication between different thoughts and the transformation between different contexts. " Pirkl designed a simple dual-handle watering can suitable for transgenerational users [7], see Figure 3. This product fully considers the issues of gripping the can body and controlling the watering process after the decline in limb strength and fine motor skills of elderly users. When studying linguistic metaphor phenomena, Johnson and Lakoff found that beneath seemingly unrelated linguistic expressions lies a common experiential internal structure shared by the source and target domains of information[8]. the physical movements of watering - extending, lifting, gripping, tilting, pouring, controlling - represent different relationships between the product and users of different ages, different wrist strength controllers, and different levels of motor skill fineness. Through differences in the number, shape, and direction of the handles compared to a conventional watering can, it implicitly suggests that the integrated, arm-like longitudinal handle is a metaphor for the hand's lifting and pouring information; the plug-in, railing-like horizontal handle is a metaphor for the hand's gripping and controlling information. Clearly, the instability of single-handle operation due to decreased wrist strength is the main problem for aging users when using a watering can. the dual-handle design addresses this need and highlights the corresponding information implicitly and uniquely from multiple perspectives. Non-aged users can also continue their original habit of controlling the can with a single handle. Thus, different target domains intersect, and product information communication takes a new turn, as shown in Figure 3.

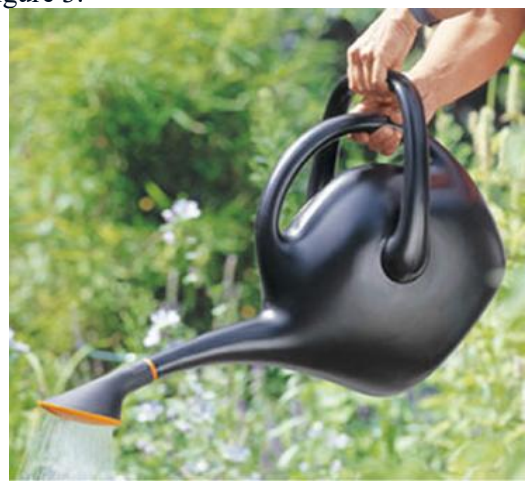

Figure 2. Transgenerational Pot

User side			Product side		
	Elderly users	Non-aging users		Traditional style	Transgenerational style
Physiological comparison	Decline in physical strength;	Appropriate physical strength	Product comparison	Single-handle	Double-handle
	Decline in stamina;	Have some persistence		Vertical	Horizontal and vertical
	Control ability when controlling and holding with one hand is unstable.	Control ability when controlling and holding with one hand is relatively stable.		Certain volume and capacity	Certain volume and capacity
Problems	The controllability of one-handed operation gradually deteriorates.	One-handed operation is preferred	Solutions		Single hand (vertical)—double hand(vertical, horizontal)
	Assistance with two hands gradually increases.	Give preference to more comfortable way of operation (latent requirement)			Vertical(lifting and pouring)—horizontal(holding, controlling)
					(unstable)—double hand(save effort, easy to control)
Physical performance characteristics and problems of different users			Multi-perspective metaphors between the lifting, stretching out, holding and controlling of the hands and the horizontal and vertical handles based on the requirements of cross-generational users		

Figure 3. Cross-Generational User Analysis and Metaphor Illustration

2.2 Vertical - Multi-Dimensional Synesthesia Based on Intersecting Transgenerational Users

User side			Product side	
	Elderly users	Adolescent users	Improvement strategies	Solutions
Comparison	Blurring of image, presbyopia, glaucoma	Shortsighted, asthenopic	Reduce the information acquisition difficulty, and improve the information readability on media side	The phone has a built-in magnifier; adjustable locally
	The cognitive load caused by the limitation of cultural knowledge level and declines in memory	The cognitive load caused by insufficient knowledge reserves	Reduce cognitive load of users; increase multiple perceptive interconnection-voice (hearing)	Voice and add generally known information, strengthen the universality of different information
	Slow in movement; Perceptual insensitivity	Unskillful, perceptive but uncertain		
Problems	The font is small; cannot see clearly the light and shadow and color	The font is small, which can't be seen clearly	Strengthen the accessibility of information; increase body touching sense, reduce intermediate link—attainability (touch)	Fault tolerant design, delay design, timely behavior feedback
	Don't know the icon;hard to remember and distinguish; forgetful; relearn	Have cognitive difficulties in terms of icons,etc.; take time to learn		
	Touch is insensitive, repeat for many times	Sensitive but quick, repeat the same action for many times		
Physical performance characteristics and problems of different users			Multi-level synaesthesia of vision, hearing and touch based on parallelism of cross-generational users	

Figure 4. Cross-Generational User Analysis and Synaesthesia Illustration

Synesthesia has two objective bases: first, the interconnectivity of information across different sensory domains; second, the similarity in nature or form between a currently perceived object and previously perceived objects [9]. This also forms multiple forms of synesthesia: first, the same

user, same sensory domain; second, different users, different sensory domains; third, the same user, different sensory domains; fourth, different users, the same sensory domain, and similarities established through nature or form. the first and second forms are the most common, easier to unify and categorize, and can be considered the first level of synesthesia. the third and fourth forms are more complex, involving both the organization of information across different sensory domains and the intersection of perceptual variables among different users, constituting the second level of synesthesia. Unlike the general stability of conventional users, elderly users, due to their physiological and psychological specificities, introduce more variables into information transmission in transgenerational design. If metaphor is the code created by designers after fully anticipating the information stored in the user's cortex and accumulated practical experience, then synesthesia is the grouping of codes within this process. It is the transfer of information from the source domain for transgenerational users as different target subjects under the same goal, representing the intersection of information either through interconnection between different users vertically or within similar sensory domains，as shown in Figure 4.

2.3 Summary

Metaphor and synesthesia are studies of design methodology; they are both independent and closely linked. Metaphor establishes appropriate ways of expressing information from the digital product's side, while synesthesia seeks effective methods for receiving information from the user's side.The design methods are summarized as follows: First, parallel multi-relational metaphor. It both maps the information encoding driven by the different needs of transgenerational users and appropriately presents the product's semantics from more angles, satisfying users' implicit needs; it is a transformation in information delivery. Second, layered multi-level synesthesia. Facing transgenerational differences, on one hand, users may have similar levels of perception leading to relatively unified information coding, while on the other hand, their perceptual abilities differ. Relying on multi-level synesthetic shifts to establish perceptual intersections represents information transfer across multiple user ends. Third, within transgenerational design, metaphor and synesthesia form intersecting horizontal and vertical methods. Multi-angular metaphor is oriented toward the horizontal, achieving a symbiosis of information for diverse users and perceptions; multi-level synesthesia, in contrast, addresses transgenerational commonalities through vertical generalization. Therefore, metaphor and synesthesia can achieve communication of digital product information across different dimensions in transgenerational design, see Figure 5.

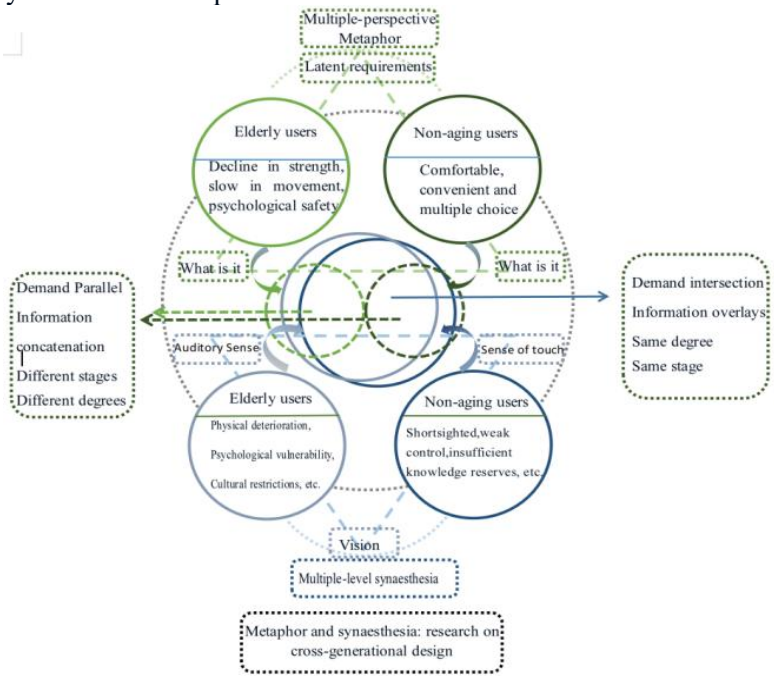

Figure 5. Metaphor, Synaesthesia: Diagram of Summary of Cross-Generational Design

3. Case Design

3.1 Current Case Status

Based on the above research, considering the stability and universality of digital products, a navigation product was selected as the research object. Research on the navigation product's information situation was conducted online and offline, collecting 93 valid online questionnaires and 25 valid interview questionnaires. the average age of the elderly respondents was 67.5 years, belonging to the low-old age stage, and the average age of non-elderly respondents was 37 years, belonging to the middle-young age stage. Among them, 82.4% of elderly users were male, and 85.7% of non-elderly users were female. Analysis focused on digital product information (interface, usage, etc.), user journeys (walking, public transport, etc.), and hotspots and pain points. the experimental results identified the following main issues:

From the elderly users' perspective: First, icons cannot accurately express corresponding functions, making elderly users unable to understand their purpose. Second, tactile feedback from buttons is not obvious, and information perception methods are relatively singular. Sound prompts are infrequent, short-lived, lack distinctiveness, and cannot be accurately acquired in outdoor spaces. Third, they hold a negative attitude towards function keys that require judgment to operate. the survey found that elderly people who use navigation are more familiar with new urban areas than those who do not, indicating that navigation expands their travel space. Some desire better functions, such as having a photo instead of a name for the destination, or route recommendations that minimize walking; others hope to solve various information cognition conversion problems like unclear text, inaudible sound, difficulty discerning direction, and incomprehensible maps. Fourth, there is a subjective desire to learn and contact new information, but declining memory leads to rejection of complex methods and usage paths. the existing interface has numerous icons and a high misoperation rate.

From the non-elderly users' perspective: First, the main use is for driving navigation, preferring voice input over typing while driving. Second, commonly used functions are relatively fixed, unwilling to spend much time learning and using new features. Third, they know the paths for common functions but the interface has many icons, which don't conform to intuitive thinking, leading to misoperations and occasional route changes. Fourth, they desire more vivid, interesting, and diverse operation methods. the above issues lead to low information acquisition rates when transgenerational users use the product, preventing the product from functioning fully.

3.2 Transgenerational Design Optimization

Metaphor-based information optimization: Enhance the metaphorical function of icons to highlight information signification. Based on principles of graphic recognizability and universality, as well as elderly users' cognitive habits, functions adopt more concrete, flat visual representations, simplify text instructions, and strengthen the metaphorical effect of graphics. Strengthen the metaphorical direction of paths. Arrange button positions vertically "from top to bottom" according to the user's usage path, making behavioral habits correspond one-to-one with information direction. This implicitly guides elderly users' operational paths, reducing misoperations. Augment information delivery through voie assistance, ultimately enhancing the organization and encoding of information at different levels, helping transgenerational users understand and operate more simply and vividly. This aids migrant elderly or local elderly in unfamiliar environments with the transition from real-world scenes to digital space, ensuring the perceptual availability of surface-level information on digital media. Features like intersection prompts provide information communication channels for migrant elderly to receive timely help reaching destinations in unfamiliar environments, meeting the usage needs of elderly with different attributes, increasing informational satisfaction in the emotional interaction dimension, and also indicating that the studied elderly users wish to establish a closer connection with the product. This is an information design strategy at the demand layer for primary-stage elderly users within the context of metaphorical perception loss compensation.

Information optimization based on synesthesia: Increase synesthetic information expression modes combining visual-auditory and visual-tactile senses. Add sound information consistent with visual information. Provide more diverse information perception methods. Based on

transgenerational user habits and behavioral feedback, functions are categorized using a "one-key, multiple-displays" approach, with sub-menus hidden under main menus, reducing user information cognitive load and providing immediate feedback for button actions. Incorporate better experience design and fault-tolerant design. Change the mechanical sounds for button reaction, activation, and completion to natural simulated sounds, strengthening the resonance and perceptual impact of visual and auditory information, reducing information asymmetry. The synesthetic approach helps increase the proportion of user control over digital product information and establishes a stable sense of security, conducive to compensating for perception loss. When a product possesses these attributes, user perceptual needs are significantly met; the more attributes possessed, the better the information perception state. These attributes are proportional to user needs; while not essential, they represent the latent hopes of transgenerational users, as shown in Figure 6.7. 8.

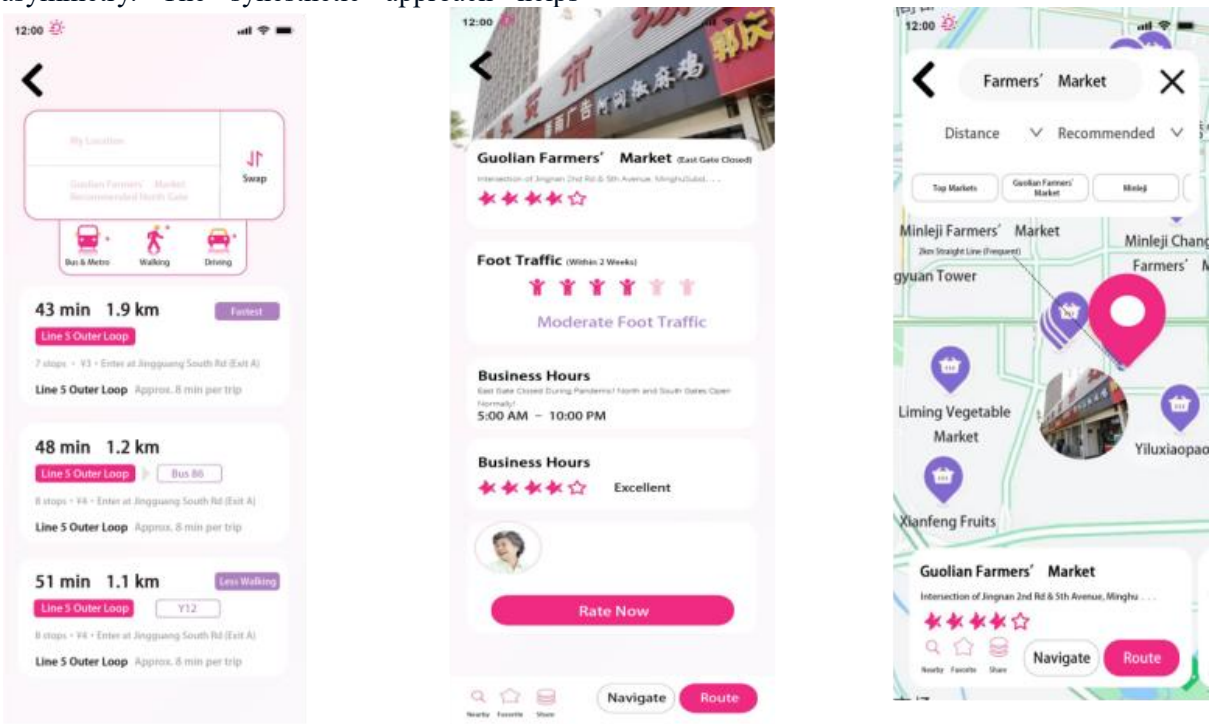

Figure 6.7.8. Intergenerational Navigation Page Design

4. Conclusion

Using aging as the background, analyzing product information design and user experience by learning strategies from transgenerational design is targeted towards elderly users. Analyzing digital product information design based on the two methodologies of metaphor and synesthesia helps summarize different information design strategies—user parallelism and user superposition—in transgenerational design. This method was then applied to analyze and study a specific product. the case study demonstrates that metaphor and synesthesia can effectively reduce information asymmetry, strengthen information expressiveness and communication power, improve information reception among transgenerational users, and lower the perceptual and cognitive costs for users across different angles and levels, thereby achieving optimized experience outcomes and further increasing the usage rate of digital products. In-depth research and advancement of the transgenerational design concept construct a new research perspective for aging studies and the "intergenerational" interaction of digital information.

Acknowledgements

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