Research on Interaction Design of Elderly Products from the Perspective of Embodied Cognition

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Abstract. To sort out the relevant research results of embodied cognition theory, interaction characteristics of the elderly, and product interaction design, to deeply understand the theoretical mechanism of embodied cognition, cognitive characteristics of the elderly, and key points of product interaction, and build the inevitable connection among the three. The purpose is to clarify the influence mechanism of body perception characteristics and behavioral data differences on embodied interaction for the elderly, and to provide theoretical driving for the establishment of embodied interaction design model for the elderly products. This paper puts forward the research idea of using embodied cognition theory to construct the interaction design method of elderly products, which provides a new practical direction for the interaction design of elderly products.

Keywords: Embodied Cognition · The Elderly · Perceptual · Body Behavior · Interaction Design

1 Introduction

Your With the continuous development of cognitive science research, embodied cognition theory has proved that human body behavior has cognitive function. On the one hand, for the elderly group, emotional, cognitive, physical and other changes brought with age make them have different degrees of cognitive and behavioral disorders. On the other hand, due to the intervention of modern technology, the way of interaction between the elderly and products has changed, while the instinct of the elderly to explore the world with their bodies has not changed. The embodied cognition theory is applied to the interaction design of products for the elderly, so as to seek a more reasonable, natural and direct interaction mode in the new ecological environment of people, technology, products and environment [18].

2 Research on Embodied Cognition Theory

2.1 Embodied Cognitive Concepts

Embodied cognition theory comes from perceptive phenomenology, whose author Maurice Merleau-Ponty believes that human cognition is generated by the perception and

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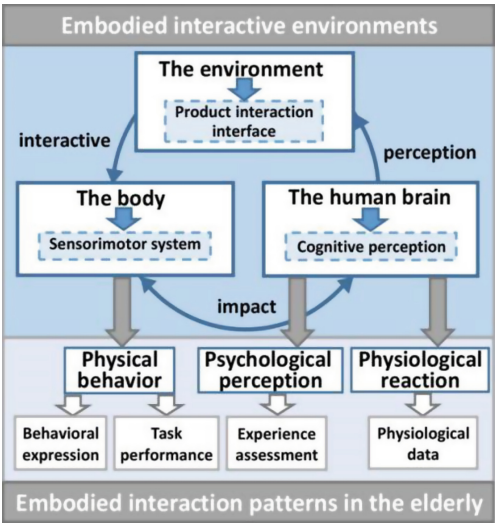

Fig. 1. Embodied interaction patterns in old age.

behavior of human body. Physical behavior plays an irreplaceable role in the process of people's gradual cognition of the world. In other words, embodied experience promotes the formation of cognition [10], as shown in Fig. 1. In recent years, significant progress has been made in integrating embodied cognition theory into interdisciplinary fields such as psychology and cognitive science. Varela FJ's [16] clarified the definition of embodied cognition theory and emphasized that the generation of embodied cognition depends on personal experience, which comes from the body with the ability of "sensorimotor". At present, cognitive science, behavioral science and neuroscience research has confirmed that physical behavior activities and cognition have a certain connection. In fact, the factors that play an important role in cognitive activities are not only the characteristics of physical behavior, but also the interaction between the body and the surrounding environment when cognition is produced. Embodied cognition theory emphasizes that the body plays a very important role in the process of human cognition, and human cognition is composed of physical experience and corresponding behavior and activity modes [9]. Therefore, it can be understood that cognition, as an adaptive activity of people to the environment, is produced by the joint action of body, behavior and environment.

According to the above analysis, embodied cognition referred to in this study is defined as cognitive and behavioral activities with physical participation in specific situations.

2.2 Research Status of Embodied Cognition

Since 2000, in the general database of "CNKI (www.cnki.net)" journals, the annual total number of papers published on the topic of "embodied cognition" has gradually increased, as shown in Table 1. At present, the research results of embodied cognition

Table 1. Annual number of CNKI papers on "embodied Cognition".

Time	Number of post	Time	Number of post	Time	Number of post
2000	8	2008	56	2016	426
2001	14	2009	78	2017	449
2002	12	2010	132	2018	540
2003	5	2011	160	2019	580
2004	12	2012	233	2020	460
2005	13	2013	291	2021	555
2006	35	2014	408		
2007	40	2015	448		
Total	4955				

mainly involve psychology, foreign language and literature, computer technology and other disciplines, and its application in the field of design is still in a relatively early stage.

At present, some scholars have begun to try to combine embodied cognition theory with design research to build a bridge between users' personal experience and products. Norman DA [2] proposed the concept of "ACD" (Activity Centered Design), emphasizing that only by understanding and paying attention to behavioral performance in Design can we better Design the interactive process and the product itself; He CQ [7] explored the relationship among embodied cognition, mental model and unconscious behavior, and explored the key points of design based on the characteristics of unconscious behavior, so as to improve the efficiency of interaction design and product availability; Gibson JJ's [6] research on the cognitive behavior theory of the elderly provides a reference for improving the user experience level of the product; Ompay TJLV [14] inspired by embodied cognition theory, discusses the influence of intention symbols on geriatric care products with the help of packaging design, which provides a reference for the study of product experience mode.

Embodied cognition theory mainly focuses on the influence of bodily experience, perception and behavior on cognition, while mature design research cases at present just ignore the important significance of senile perception and physical behavior factors for design practice exploration. Based on the existing results, the next research should summarize the correlation characteristics between seniority perception, behavior and interaction environment, and summarize the key points of embodied interaction design of elderly products combined with specific product information.

3 Copyright Form

As humans enter old age, their physical function, perception, and behavior will change. At this time, these people directly establish a connection with the surrounding environment through their physical behavior. On the one hand, they use their own body to

produce perception, on the other hand, they also perceive the environment through physical behavior. This study takes the body as the carrier, focusing on the specific discussion of the characteristics of the elderly from two aspects of perception and behavior.

3.1 The Characteristics of Embodied Perception in Old Age

In the field of psychology, the research on embodied cognitive characteristics of the elderly mainly discusses the dependence of cognitive behavior activities of the elderly on their body perception. According to Vallet GT's [15] research conclusion on embodied cognitive characteristics in the aging stage, the general characteristics of elderly people are as follows: human tissue, body sensory organs gradually aging, physical quality, behavioral ability gradually weakened. This directly leads to the change of the main sensory perception motor mode and the reduction of sensory sensitivity, which affects the formation of new perception motor experience and the re-application of past experience.

The decrease of visual acuity makes the interactive sensory function of the elderly significantly decline, and they can hardly see the icons and graphic details on the interface or feel some tiny or temporary changes on the interface [1]. Meanwhile, older people also lose hearing with age, mainly in the form of frequent loss of hearing for short periods of time and the ability to perceive lower levels of sound, but they are usually able to concentrate on sounds of interest [8]. At the tactile level, older people have lower metabolic rate, rougher skin surface, and decreased tactile sensation ability.

Older people have better memories of learning experiences and professional knowledge; the memory effect of things that have been seen, heard and learned for many times is better; memory declines earlier for unrelated content that requires rote memorization; to the information closely related to daily life to maintain a better memory law. Although the cognitive ability of the elderly is declining rapidly and in a large range, their abilities in language, semantics, autonomous attention or memory are still retained due to the relatively extensive and profound accumulation of semantic information, Peters J [12] verified this trend in her study on age characteristics of vocabulary recognition level.

3.2 Embodied Behavior in Old Age

In the old age, the physical behavior that people rely on is gradually weakened. Costello MC's [3] research on the relationship between perceptual processing, mental representation, behavior, perception and age change basically confirmed this inference. Compared with the young, the elderly rely more on visual information for cognitive processing, and weaken the influence of other physical factors such as touch, perception and movement. Firstly, physical limitations will greatly reduce the range of activities of the elderly; secondly, the deterioration of the body's sensory organs leads to a decrease in the rate of nerve information transmission; under the influence of cerebellar degeneration, dyskinesia and degenerative reaction mechanism will eventually appear, leading to a significant reduction in fine movement, body flexibility and operational accuracy in the elderly.

The changes of sensory perception and physical behavior experience and their matching with cognitive tasks directly affect embodied behavior in the elderly. Extract the embodied cognitive and behavioral characteristics of the elderly and apply them to the practice of product interaction design, effectively guide and assist the elderly's daily

operation behavior, improve their interaction with the product and enhance cognitive experience and feedback. It can not only achieve the goal of completing the task, but also reduce the cognitive load of the elderly in the process of product interaction.

4 Interaction Design of Elderly Products from the Perspective of Embodied Cognition

Embodied interaction refers to the generation, application and dissemination of cognition in the process of interaction among people, environment and products. Paul Dourish expounded this theory earlier, and his book Where the action is: the foundations of embodied interaction [5] explained the necessity of integrating embodied cognition theory with interaction design, which has a profound influence on the generation and practice of interaction design theory. Based on embodied cognitive mechanism, this chapter uses literature to explore the interaction between perception and behavioral characteristics of the elderly and the surrounding environment, and summarizes the embodied interactive design model of the elderly products based on the embodied cognitive characteristics and embodied behavioral characteristics of the elderly, as shown in Fig. 2. As a theoretical basis, this model can directly guide the embodied interaction design of related products from the three levels of embodied perception mechanism of the elderly, embodied interaction behavior of the elderly and embodied interaction environment.

4.1 The Perceptual Mechanism of Embodied Interaction

Based on the research of embodied interaction design based on perceptual features, it focuses on exploring the influence of perceptual structure characteristics in the elderly brain on human-computer interaction. Sense organ commutation is the body's self-regulation mechanism whereby when one of the senses is lost or impaired, other senses are enhanced to replace the compensation [17]. Multi-modal interaction method can effectively reduce the negative effects caused by aging, perceptual defects and lack of

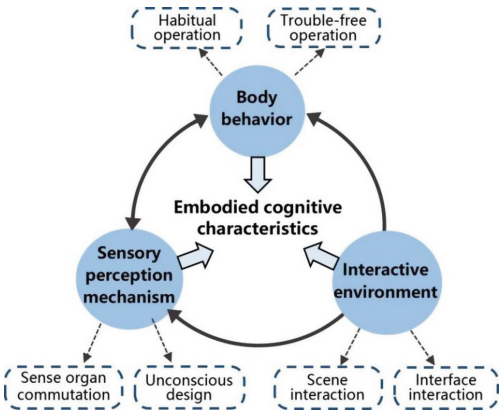

Fig. 2. Embodied interaction design model of elderly products.

Fig. 3. "Light bell" Smart lamps.

experience in using equipment when making deep sense organ commutation design for elderly products. A smart lamp called "Light bell" doubles as both a Light and a doorbell, when the door someone press the door bell, indoor lamps and lanterns will produce sound and light source changes, outside the visual and auditory double channel perception interactive reminder with the arrival of the visitors, this design for the deaf and hearing function decline in elderly life provides a convenient, as shown in Fig. 3. In addition to the main visual perception channels, auditory and tactile perception and feedback mechanisms should be added in the interaction design of products for the elderly to help the elderly read and feedback information, which can effectively improve the embodied experience effect of the elderly users using products.

In human computer interaction design, differences in perceptual experience will also trigger different body behavior motivations, resulting in changes in body experience and sensation. The instinctive reaction of unconscious behavior is more in line with the behavior characteristics of the elderly, and the interactive system of the elderly products should emphasize the behavioral differences of users. Naoto Fukasawa and Suri JF [13] took the lead in exploring unconscious behavior and applying it to design, the sand hammer seasoning bottle, a representative design work of Naoto Fukazawa, is shown in Fig. 4. When users see the seasoning bottle shaped like an hourglass, they naturally associate with it. They can use the product without instructions, which well explains the application of the relevance of memory in unconscious design. The operation process and operation structure design of elderly products need to make use of the unconscious characteristics of the elderly to achieve the effect of more convenient use, simpler operation and fewer mistakes. The interaction design method of elderly products, which deeply considers the characteristics of unconscious behavior, strictly follows the behavior habits and operation modes of the elderly, so that the elderly have a good interaction and emotional experience when operating the products designed by this method.

4.2 The Act of Embodied Interaction

The overlap of body and environment promotes cognition, and the physical experience of embodied interaction in the elderly is mainly related to how the state of body perception affects cognition in a specific environment [4]. The embodied interaction design in line with the physical behavior characteristics of the elderly focuses on two aspects: On the one hand, the habitual way of operation, the elderly's physical endurance becomes weaker, the range of activities becomes smaller, and the precision of movement

Fig. 4. Fukuzawa Naorensa's the sand hammer seasoning bottle.

and reaction ability are getting worse and worse. Selecting a product interaction mode that conforms to the behavior characteristics and habits of the elderly can promote the natural interaction between the elderly and the product; on the other hand, for the barrier free operation path, when designing the product interaction mode in line with the characteristics of the.

After the age of 60, the elderly will show the physical characteristics of height contraction, weight loss, other body size and joint mobility tend to be stable. Therefore, before the implementation of the above embodied interactive behavior design method, the body size of the elderly should be calculated by reducing about 6% based on the <GB 10000-88>, and percentile of the body dimension should be selected according to the <GB/T 12985-91>, percentiles are represented by the symbol P_K, a percentile divides the sample's total observations into two parts, there are K% observations equal and less than it, and (100-K)% observations greater than it. When human dimensions are expressed in percentiles, they are called percentiles of human dimensions, the data are shown in Table 2. So as to reasonably design the size of each part of the elderly product and make the product fit the elderly's physical interaction behavior.

4.3 The Environment of Embodied Interaction

The interactive environment based on embodied cognition theory refers to the specific situation or environment covered by human cognition in the process of interaction, which dominates or influences human perception and behavior. Ecological psychology emphasizes that visual characteristics of people in the specified environment will guide and imply human behavior, and determine and influence the interaction of the body. In addition to the interactive scene, the embodied interactive environment should also include the product entity and operation interface dominated by visual perception.

Interface is the carrier of information exchange between human and product. There are three main research directions in product interface interaction design: The first is to reduce the difficulty of using the interface through easier methods, more concise gestures, fewer choices and keyboard usage; the second is to provide additional functions, setting up operation guidance, error warning, automatic assistance and other functions, to assist the elderly to carry out interactive operation, reduce operating pressure; the third is to strengthen the body feedback, emphasize the information content in the interactive interface to enhance the perception of the elderly, or combine a variety of sensory channels to strengthen the information feedback, for example, the vision of the elderly

Table 2. Revised body size table for older people over 60 years old.

Measured parameters	18~60 years old male			Elderly men			18~60 years old female			Elderly female		
	5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%
	GB10000-88 human body dimension (mm)			Dimensions after shrinkage of 6%			GB10000-88 human body dimension (mm)			Dimensions after shrinkage of 6%		
Height	1583	1678	1775	1488	1577	1669	1484	1570	1659	1395	1476	1559
Upper arm length	289	313	338	272	294	318	262	284	308	246	267	290
Forearm length	216	237	258	203	223	243	193	213	234	181	200	220
Thigh length	428	465	505	402	437	475	402	438	476	378	412	447
Calf length	338	369	403	318	347	379	313	344	376	294	323	353
Standing eye height	1474	1568	1664	1386	1474	1564	1371	1454	1541	1289	1367	1449
Standing shoulder height	1281	1367	1455	1204	1285	1368	1195	1271	1350	1123	1195	1269
Standing elbow height	954	1024	1096	897	963	1030	899	960	1023	845	902	962
Standing perineal height	728	790	856	484	743	805	673	732	792	633	688	744
Standing tibial height	409	444	481	384	417	452	377	410	444	354	385	417
Sit high	853	904	952	802	850	895	811	858	903	762	807	849
Sitting cervical spine high point	615	658	700	578	619	658	581	618	658	546	581	619
Eye height	745	795	841	700	747	791	636	741	785	598	697	738
Sitting shoulder height	556	597	639	523	561	601	517	555	593	486	522	557

(*continued*)

Table 2. (*continued*)

Measured parameters	18~60 years old male			Elderly men			18~60 years old female			Elderly female		
	5%	50%	95%	5%	50%	95%	5%	50%	95%	5%	50%	95%
Sitting elbow height	226	263	299	212	247	281	214	249	283	201	234	269
Sitting thigh thickness	110	131	152	103	123	143	113	129	148	106	121	139
Sitting knee height	455	490	527	428	460	495	428	461	494	402	433	464
Leg heightening	380	409	442	357	385	416	346	384	408	325	361	384
Sitting deep	420	457	494	395	430	464	401	433	468	377	407	440
Hip knee distance	515	554	596	484	521	560	495	529	568	465	497	534
Sitting posture lower limb length	922	992	1060	868	868	996	854	914	978	803	859	919
Hand length	170	183	196	160	172	184	170	182	196	127	171	184
Hand width	76	82	89	71	77	84	75	82	89	71	77	84
Index finger length	63	69	76	59	65	71	63	69	76	59	65	71

will decrease or even lose with age. At this point vibration and static stimulation through touch to achieve the effect of transmitting information is more effective than visual feedback alone. Digital products have more interaction design space and possibilities than traditional products, and good age-appropriate interaction design can bring better use experience to the elderly than traditional products.

Scene interaction is a new interaction mode gradually mature with the development of interaction design, focusing on the interaction between the specific scene and behavior [11]. When designing the embodied interaction of elderly products, the interaction needs of the elderly should be considered from two perspectives: natural scene and user scene.

5 Conclusion

Embodied cognition is the theoretical basis for understanding the value of physical behavior, analyzing the characteristics of physical behavior and the interaction of products, it provides a brand-new research perspective for exploring the interactive significance of the interaction between the elderly group and the environment, optimizing the interactive experience of the elderly products and improving the overall interaction efficiency. The theory asserts the interaction of perception, behavior, and environment, thus confirming the correlation between physical behavior and cognitive processes. The application of the research results of elderly interaction in product design includes product appearance design, product semantic exploration and so on. In future studies, the elderly's perception and behavior characteristics can be further utilized to explore typical elderly interaction behaviors associated with embodied cognition from the three levels of embodied interaction perception mechanism, embodied interaction behavior and embodied interaction environment. By exploring the embodied cognitive value of elderly interaction behaviors, reliable and feasible interaction design methods are summarized, providing strong theoretical support for future research on interaction design of elderly products.

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