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Experimental Study on the Preference Characteristics of children with ASD for Product Design Materials

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Abstract. In recent years, individuals with ASD have attracted increasingly great attention from all circles of the society, but the studies concentrating on the life product design for these special users are rare. This study adopted the paired comparison method and involved three groups of Chinese children aged 3-6 years (children with ASD, children with mental retardation and normal children), with seven of the most common materials in life products as the evaluation objects, to investigate the preference characteristics of children with ASD for product design materials. The results indicated that the preference order and preference degree of children with ASD were both highly different from those normal children at the same age. The preference order of children with ASD was similar to the children with mental retardation, while the preference degree was different. This study provides designers and researchers with a more comprehensive understanding of the psychological features of children with ASD, and it can be the theoretical basis for designers to develop further guidelines encouraging upgraded humanized product design for this special population.

1. Introduction

Autism pedigree disorder (ASD), known as autism or autism in a broad sense, is one of children's extensive series of complex neurodevelopmental disorders^[1]. The individuals with ASD are associated with disorders of social, behavioural and communication abilities. In 2016, a report released by the National Centre for Health Statistics showed that the incidence of autism among children aged 3 to 17 was estimated at 1/45. Additionally, according to the latest data published in the Report on the Development of China's Autism Education and Rehabilitation Industry in 2017, it is conservatively estimates that there are at least 10 million autistic people and 2 million autistic children in the 1.3 billion populations in China, and the annual growth rate is nearly 200,000^[2]. Therefore, it is particularly important to provide innovative life products that really meet the special needs of ASD children in view of their intellectual features and living conditions.

On the basis of the current findings, although the related comments from individuals with ASD were broad to some extent; few valuable insights of product design in this field were obtained. There are almost no specific products developed for this group in the market, and most of the products still originate from the concept of normal children's product design. The current research on products for children with ASD is mostly confined to product appearance and entertainment. Specifically, it is rare



to explore the material preference of this special group so far, which is an important content related to their physical and mental health development.

In industrial design, materials are substances used to form products that exist objectively and independently of human consciousness. Whether traditional or modern materials, natural or artificial materials, single or composite materials, they are all the material basis of industrial design and the basic elements for products to satisfy functional requirements and reflect structures^[3]. Thus, it is necessary for designers to consider not only the materials performance characteristics, the corresponding process conditions, costs and material resources, but also the psychological impacts on users in the selection of materials for product design. Furthermore, with the continuous advancement of technology, the improvement of people's living standards, the combination of materials and design are combined more closely, as the user's demand for products has gradually improved from material satisfaction to spiritual and psychological satisfaction^[4].

The particularity of children with ASD results in the particularity of the products they use. Material selections of products for this group need to satisfy their special visual and psychological preferences in order to design life products that truly meet their physiological and psychological demands, so as to create a comfortable and meaningful living environment for them, which will promote their physical, intellectual and spiritual development.

In view of this, this study adopted the paired comparison method to study the material preferences of three groups of children aged 3-6: children with ASD, children with mental retardation with matching physical age and psychological age and normal children with matching physiological age. This study attempts to explore the following two problems:

- What are the material preference characteristics of children with ASD, and what is the order of their material preference?
- Whether there are significant differences of material preference between children with ASD and the other two types of children, and what are the results?

2. Data Collection

2.1. Participants

Basic characteristics of the subjects are shown in Table 1. The experimental group consisted of 15 children with ASD from the rehabilitation centre of Xi'an Children's Hospital. They were all diagnosed as autistic children by Xi'an Children's Hospital according to DSM-IV criteria, and were further identified by the convergent evaluation of doctors and researchers. The control group consisted of 15 children with mental retardation who came from the same institution and had no characteristics of autism. The matching discrepancy of verbal and operational intelligence between the experimental group and control group was ± 10 percentage points^[5]. Another 15 normal children came from ordinary kindergartens in Xi'an, matching the physiological age of the experimental group and control group. All three groups of children were excluded from visual and auditory diseases.

Table 1. Basic characteristics of group with ASD, control group and ordinary group

	Sex Ratio	Age (years)		Verbal IQ (WISC-CR)		Performance IQ (WISC-CR)		Full IQ (WISC-CR)	
	Male/Female Ratio	Mean	Range	Mean	Range	Mean	Range	Mean	Range
ASD Group (n=15)	10:05	4.88	3-6	60.43	46-74	66.65	48-100	60.22	45-85
Control Group (n=15)	9:06	5.08	3.5-6	66.88	42-87	66.23	35-96	63.02	45-90
Normal Group (n=15)	9:06	4.2	4-6	—	—	—	—	—	—

2.2. Experimental materials and tasks

A great variety of materials are used in actual products, and seven of the most commonly used materials for actual children's products are selected as evaluation objects in this experiment : glass, wood, metal, plastic, rubber, silicone and felt. Each material is presented as a sphere with a diameter of 4 cm, as shown in figure 1. Seven material balls are combined in two pairs, a total of 21 combinations. Considering that most of the children with ASD have language function barrier but strong operation abilities, the operation of the entire experimental system is effective. The subjects were asked to select one of the two material balls presented in the experiment and put them into a black foam board with a hole in the middle. The surface of the foam board is black, with a circular hole in its Centre (white around, so that the hole will be found easily). The diameter of the foam hole is 4 centimetres, which is available to hold a material ball.



Figure 1. Evaluation objects: seven material balls

These seven evaluating material balls were presented in two groups of presentation sequence (group A and group B). Group A: glass-wood, glass-metal, wood-metal, wood-plastic, metal-plastic, metal-rubber, plastic-rubber, plastic-silicone, rubber-silicone, rubber-felt, silicone-felt, glass-plastic, glass-rubber, wood-rubber, wood-silicone, metal-silicone, metal-felt, plastic-felt, Glass-silicone Glue, glass-felt, wood-felt. Group B: felt-wood, felt-glass, silicone-glass, felt-plastic, felt-metal, silicone-metal, metal, silicone-metal, silicone-metal, silicone-wood, rubber-wood, rubber-glass, plastic-glass, felt-silicone-rubber, silicone-plastic, rubber-plastic, metal-wood, wood, metal-glass, wood-glass. In order to balance the sequential order presented by the 15 combinations, stepwise approach was used to arrange the presenting order of material balls, as shown in Table 2.

Table 2. Material presentation sequence

Material	Glass	Wood	Metal	Plastic	Rubber	Silicone	Felt
Glass	—						
Wood	1	—					
Metal	2	3	—				
Plastic	12	4	5	—			
Rubber	13	14	6	7	—		
Silicone	19	15	16	8	9	—	
Felt	20	21	17	18	10	11	—

2.3. Experimental Procedure

In order to ensure the quietness of the surrounding environment and the emotional stability of the subjects, all experiments need to be conducted in different rooms. Firstly, the experimenter explained the demonstration method in detail to the subjects: choose a preferred one from the two stimuli presented and put it into the test board. The formal experiment was started until the understanding and operation of the subjects were confirmed after several demonstrations. The experimenter presented two material balls in a preset order each time, and then the subjects are asked to select one of them to put into the black foam board. After placing one material ball, means a selection is completed. Each participant completed 42 judgments in Group A and Group B.

3. Data Analysis

Table 3. Average Number of Material Selection for Three Groups of Children

	Order	1	2	3	4	5	6	7
Group with ASD	Material	Glass	Metal	Felt	Silicone	Plastic	Rubber	Wood
	M	8.53	8.33	8.13	6.93	5.47	2.47	1.93
Control Group	Material	Silicone	Glass	Metal	Felt	Plastic	Wood	Rubber
	M	8.93	8.27	7.47	6.87	4.00	3.33	2.80
Normal Group	Material	Felt	Silicone	Rubber	Metal	Wood	Plastic	Glass
	M	8.27	7.20	6.07	5.67	5.67	4.20	3.93

(Note: Average M = cumulative number of times each material ball is selected / number of children in the group)

Table 3 shows the orders and the degrees of material preference of three groups of children. Firstly, as listed in table 3, the children with ASD in this experiment preferred glass and metal most, followed by felt, silicone and plastic, and rubber and wood at last. They preferred smooth and bright materials to rough materials. The material preference order of children with retarded intellectual development in the control group was silicone, glass, metal, felt, plastic, wood and rubber. By contrast, the most favourite materials for normal children were felt, silicone and other soft materials, which was consistent with recent research results. Nevertheless, there was a higher preference for metal materials in normal group children, and it was possible because that the gender of the majority of participants in normal group was male, which was in order to match the ASD group. Then, the preference order comparisons of the three groups were analysed using the Pearson's correlation coefficient method, as in equation (1). The results indicated that the material preference order of ASD group and control group were similar, with the rank correlation coefficient $r = 0.878$, $P < 0.01$. However, the order differences between ASD group and normal group were highly significant, with rank correlation coefficient $r = 0.077$, $P > 0.05$.

$$r = \frac{\sum (X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum (X - \bar{X})^2 \sum (Y - \bar{Y})^2}} = \frac{l_{XY}}{\sqrt{l_{XX}l_{YY}}} \quad (1)$$

Secondly, the degree of material preference was expressed by the mean value M. For example, the glass score of group with ASD was 8.53, which means that there were 8.53 person-times choosing glass when it was compared with other materials in that group. Then, the preference degree comparisons of the three groups were analysed using the chi-square test, and the following conclusions had been obtained:

- Overall, the numbers of material selection among the three groups were significantly different, with $X^2(12) = 37.07$, $P < 0.01$;
- There were large differences in selection times between ASD group and control group, with $X^2(6) = 14.098$, $p < 0.05$;
- There were highly significant differences between ASD group and normal group, with $X^2(6) = 30.062$, $p < 0.01$;
- There are relatively remarkable differences between control group and normal group, with $X^2(6) = 13.373$, $p < 0.05$.

As shown in the analysis of the above, children with ASD aged 3-6 were similar to children with mental retardation in material preference order, but their material preference degree (selection times) were significantly different, for example, rubber and wood were all at the end, but the ASD group made fewer choices of them, with the average of 2.47 and 1.93 respectively, while the control group with the average of 2.80 and 3.33 respectively. Furthermore, it also indicated that there were great remarkable differences both in material preference order and preference degree between children with ASD aged 3-6 and normal children of the same age. Overall, children with ASD preferred bright and smooth materials, while ordinary children preferred soft and warm materials.

4. The Pedagogical Implications of This Study

For educational application, the materials preferred by children with ASD can be used in design products for early interference treatment. Amotivational syndrome is one of the important characteristics of children with ASD, especially learning new information and executing new tasks^[6]. Appropriate products will not only attract their attention and stimulate their intrinsic interest, but also maintain their motivation to participate in activities, rather than relying on external reinforcements or rewards. Barker believes that paying attention to children's interests and choices will improve their social motivation and promote their common attention.^[7] Robert L. Koegel also found that low motivation level of children with autism is usually manifested in the form of grumpy temper, refusal to cooperate, inability to concentrate and avoidance of problems^[8]. Laski's research shows that stimulating the motivation of children with ASD in natural situations will not only improve their language and game skills, but also create effective and positive emotional effects. Therefore, motivation has become a critical area^[9], and it is one of the important measures for effective intervention in children with ASD.

In addition, the intervention method of motivation stimulation strategy is the core content of Pivotal Response Treatment (PRT)^[10], which was proposed by Robert L. Koegel and Lynn Kern Koegel, and firstly published in the 1980s as a form of naturalistic behavioural intervention based on Applied Behaviour Analysis (ABA)^[11]. PRT is child-led, emphasizing natural situations and improving motivation to help children with ASD learn key skills, conducting multiple clue analysis, and integrating feedback on natural events. It aims at guiding children to promote their own abilities in an active way, in order to promote generalization to cope with the real living environment^[12]. PRT has been recognized gradually in theory and practice, and has been promoted in various fields all over the world in recent years. The National Project Standards of the American Centre for Autism Professional Development and the National Centre for Autism Research have repeatedly identified PRT as the most scientific and empirical method of autism intervention^[13]. Therefore, keeping insight into the preferences and interests of children with ASD and design products that will satisfy their physiological and psychological needs in the real sense will be helpful for their effective rehabilitation promotions.

5. Conclusions

Autism Spectrum Disorders (ASD) brings tremendous mental and economic pressure to the society and families. Children with ASD are usually hardly be integrated into normal social life, and long-term training and care will be necessary^[14]. As a result, products in living environment play an important role in the psychological development for children with ASD. This paper explored the material preference of children with ASD aged 3-6 years in China by method of paired comparison. As shown in the results that children with ASD generally prefer bright and smooth materials, and the material preference order is: glass, metal, felt, silica gel, plastic, rubber and wood. Their material preference order is significantly different from that of normal children, but there is no significant difference with the retarded children matched by age and IQ. In addition, the material preference degree of ASD group children is remarkably different from the other two groups of children.

Overall, the results provide a theoretical basis for researchers and designers to develop further guidelines to encourage products that satisfy the special needs of children with ASD in real sense. Nevertheless, continuous investigation on different aspects of their preference characteristics is lacking. Further research should investigate more effective and diversified innovation approaches for product design practices.

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