Young children's empathy towards robot dog in relative to stuffed toy dog

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Abstract. This study examined young children's empathy towards interacted entity and none interacted agent, and whether the interaction or the appearance of the agent is more relevant on children's the empathy, the entities include an interacted robot, a stuffed toy dog and a stone. Preschoolers (5-6 years of age, N=69) watched videos of three agents, including agent introducing cuts, agent struck by human hands cuts, agent placing in a box struck by human hands cuts. All of these three agents are non-living entities, an interacted robot dog with metal surface, a non-interacted stuffed toy dog (appearance alike a real dog), a stone. The preschoolers were required to ask a list of questions to obtain the data indicating their empathy towards each agent. The results revealed that the young children ascribe more anthropomorphism to robot dog relative to stuffed toy dog, while the empathy to both have no significance difference.

1 Introduce

The Tesla CEO Elon Musk recently claimed that he has already uploaded his brain to cloud, related people guessed that it might be the semiconductor chip planted. While inevitably during the information age, the artificial intelligence (AI) has been widely applied in many fields for the time being, AI as well as the robot based on it entered into people's daily life not just stay in the lab, the most fundamental feature of the AI product is "interactive". Due to this interaction feature the relationship between human and robot incurred many researchers' interest. As is well-known people have social emotions towards computers naturally [1], and social behaviors, such as praise and criticism, reciprocity, stereotypes, flattery or politeness [2]. With regards to the negative behaviors, human's abusing and destructive actions to computers reduced due to their intelligence [3], this made researchers turned to focus on the why people show empathy to the computer [4] and how it is generated [5]. As technology improves, the experimental subject changes from computer to more intelligent robots, the methods measuring empathy became diverse, such as fMRI and electroencephalo-graph (EEG). By using EEG proved that people have empathy to robots. Children also believed a human-like robot "Robovie" has mental states and show empathy when it was treated unfairly after engaging in physical and social behaviors with Robovie [6]. The similar effect generated on non human-like robot, such as robot dog or robot dinosaur, children express sad feelings when they saw the robot dog Aibo was abused for experimental

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purpose [7]. Now we have some researches about children's cognitive, emotion and behaviors towards robots and these relative to living entities such as human beings or live animals.

Most of the researches revealing empathy between human and robots focused on adults or children age more than 9 years, very a few of them investigated young children such as preschoolers. Since young children's pantheism [8] they are not capable to distinguish subject-object relationship, their understanding of ontology is absurd so they can not identify the living and non-living entities very clearly, under such circumstance they are more likely to embrace unreality and imaginary things and it gets better with age, such as they are able to consider the toys as non-living entities with age [9]. Now our young children encountered all kinds of intelligent robot toys as the costs of semi-conduct chips decreased, young children's cognitive is affected by pantheism and their communication relies on interaction, so it's worth investigating whether young children show higher level of empathy, whether children's Concrete image thinking has influence on their empathy towards interacted robot in relative to non-interacted but apparent-like toy, such as a robot dog and stuffed toy dog. And this is the study investigated.

Empathy is an innate ability, that is closely bound up with human survival and reproduction. However, the concept of empathy is not derived from humankind rather than from a piece of artwork [10]. Empathy involves the ability to sense, understand, and share the feelings and emotions of others from their perspective [11]. People are unable to develop and nurture any interpersonal connection without empathy, leading to strained relationships, broken trust, loss of relationships, and isolation [12]. It is very important for preschoolers as it serves as a motivator of prosocial, or altruistic, behavior-actions that benefit another person without any expected reward for the self [13]. Two primary forms of empathy are cognitive empathy and emotional empathy [14], both are equally important for helping people to connect with others in quite different ways. Cognitive empathy is also considered as perspective thinking, trying to tap into the idea of placing someone in others' situation and gaining a better understanding of their experience [15]. Hodges and Myers put emotional empathy in three parts: Feeling the same emotion as the other person, feeling our distress in response to their pain, and feeling compassion toward the other person [16]. Decety argues that empathy involves several components in the neurodevelopment aspect: affective arousal, emotion understanding, and emotion regulation. At an early age, such as in newborns and infants, their affective responsiveness is mainly based on mimicry and the same sensorimotor resonance between others and self, such as distress, joy, interest, and disgust [17]. 2-year-old toddlers can use emotion labels for facial expressions and talk about them [18], which is a kind of emotion-understanding ability. Early emotion regulation is mainly affected by innate physiological mechanisms which are proven at 12 months [19]. Empathy's development relies on ego and emotional development [20]. 4-year-old children are qualified with self-judgment and their dynamic ability advances, they can distinguish others' emotions. Since our young children live in an intelligent world full of hi-tech, varieties of robots enter into their life, thus it's important to know about the relationship between preschoolers and intelligent robots relative to traditional non-interacted stuffed toys, and empathy could be a good point of penetration used in the present study.

2 Design

2.1 Participants

We have collected data from 69 5- to 6-year-old children. This experiment is conducted at X kindergarten based in Chongqing, China. All the participants were recruited from this

kindergarten and tested in a meeting room in the kindergarten. All the parents of the participants had previously been noticed by the kindergarten teachers and agreed to the research.

2.2 Procedure

This experiment is a within-participants design, the researcher is the experimenter. As a teaching assistant in the X kindergarten, I have been familiar with these children, so I didn't spend much time introducing myself, it only took a short time to explain the experiment, like what we were going to do and why. Afterward, the participants were shown to watch 9 stimulus sets and required to be asked a series of questions regarding their perceptions of empathy and anthropomorphism, these questions were displayed through the software on the laptop and I recorded their answers and responses manually. Each child watched each video set for 10s, the entities in the video are a robot dog, a stuffed toy dog, and a stone (Figure 1). Parents completed a survey about their children's prior exposure to robots and dogs after all the children finished the experiment. All the children have been given a small present as thanks to the participants.

1) Robot dog

2) Stuffed toy dog

3) Stone

Fig. 1. Robot dog, stuffed furry dog, stone.

3 Measures

3.1 Empathy

This study designed four questions to measure cognitive empathy and emotional(affective) empathy since both are primary components of empathy. Each question has five answers to select, rated in a 5-point Likert-type scale with sad face to smiling face (1=definitely OK to 5=definitely not okay) (Figure 2). The four questions are:

1) When you see it, how do you feel like? (emotional empathy)
2) When you see it, what do you think the agent feel like? (cognitive empathy)
3) Do you think it's ok to hit the entity?
4) Do you think it is ok to hit the entity inside the box?

Fig. 2. Empathy response scale.

3.2 Anthropomorphism

This study selected three IDAQ-CF questions to measure the tendency to ascribe mental states to the interacted agent and non-interacted agents. IDAQ-CF (IDAQ-Child Form) is a validated child version of the individual differences in the Anthropomorphism Questionnaire [21]. This is developed base on the Individual Differences in Anthropomorphism Questionnaire (IDAQ) [22]. The IDAQ-CF is a 12-item questionnaire designed for use with children to appro assess the anthropomorphism of technologies, inanimate nature, and animals in terms of consciousness, intentions, mindedness, and emotions (e.g., "Does a TV have feelings, like happy and sad? If yes, how much?") To meet with our study purpose the questions were reviewed by the experimenter in order for the preschoolers have a better understanding. The questions are:

1) Does the agent feel happy or sard? (emotion)
2) Does the agent do things on purpose? For example, they will take a shower when they feel smelly. (intention)
3) Does the agent think for itself? For example, why the birds can fly while I cannot, why is the moon always showing up when the sky turns black. (mind)

These answers to the questions were rated on a 4-point scale, by using circles ranging from largest to smallest, indicating scores from 1 to 4 relatively. (Figure 3)

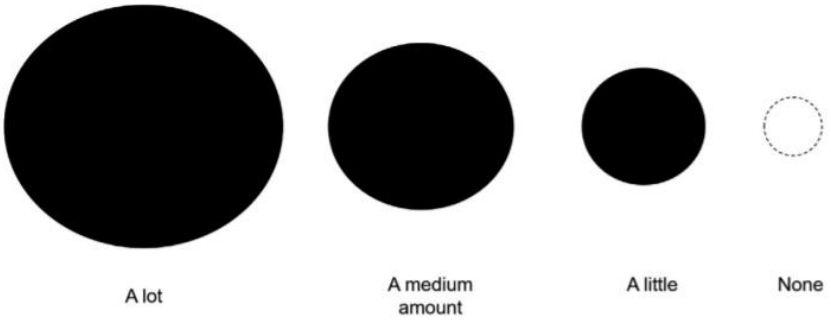

Fig. 3. Anthropomorphism response scale.

3.3 Exposures

Past researches investigate that children who have a dog at home not only show more prosocial behaviors relative to those who haven't but also ascribe higher moral worth to robot dogs. One goal of the survey in the present study is to examine whether preschoolers having a dog in their household show a higher level of empathy towards a robot dog or a stuffed toy dog, another goal is to check if the preschoolers' experience with an interacted robot influences the empathy to the robot dog. This survey is made up of a questionnaire, which was filled up by preschoolers' parents. The Main questions are:

1) Have your children interacted with robots? (E.g. talk with robots, give an oral order to robots, such as, child: "Ledie!" Ledie: "Hello, may I help you?" Child: "Play music!")
2) Have your children ever interacted with dogs?
3) If yes - What could be the frequency of the interaction between your children and robots [dogs]?
4) Please describe what's the attitude when your children interacted with robots [dogs]? Positive, negative or neutral?
5) Can you please explain the reason why he/she is negative?

4 Coding

All the data were processed and analyzed via SPSS 26.0 statistic software. If the statistical data are in line with normal distribution, then will be represented by `x±s. The comparison between the two groups was performed by two independent samples t-tests. $P<0.05$ was considered statistically significant. Friedman test was used for intra-group comparison and the Bonferroni test was used for pairwise comparison. Spearman correlation analysis was used for correlation analysis. $P<0.05$ was considered statistically significant.

5 Results

As an initial analysis, the results of the survey showed that either the young children's preliminary experience with an interacted robot or the experience of raising a dog at home does not correlate with anthropomorphism or empathy (Figure 4). Only the "introduction" dimension of the problem "stone" was negatively correlated with the "interaction with machine products" ($r=-0.287$, $P<0.05$), while the other basic information of children did not correlate with each problem dimension ($P>0.05$). The descriptive statics of empathy shows

that the children show the highest level of empathy towards the robot dog (=6.01). The degree of empathy towards stuffed toy dogs and stones decreased across the age (Figure 5). With regards to stuffed toy dog, Age five (6.47, 6.91) < Age six (8.23, 8.38), stone, Age five (11.02, 9.21) < Age six (11.65, 11.08). The descriptive statics of Anthropomorphism reveal that the robot dog crediting the lowest scores means it has the highest level in anthropomorphism (Robot dog=5.55, Stuffed toy dog=8.13, and stone=10.09) (Figure 6). When asked why the children generally said that because it can understand people's instructions, and make corresponding behavior, so it's more looks like the interacted robot dog has its thoughts, that is to say, interactivity can arouse children's judgment of anthropomorphic more than appearance, and the level of anthropomorphism towards robot dog and stuffed toy dog decreased across the age. With regards to Robot Dog, Age five (5.35) < Age six (5.88), Stuffed toy dog, Age five (7.84) < Age six (8.62).

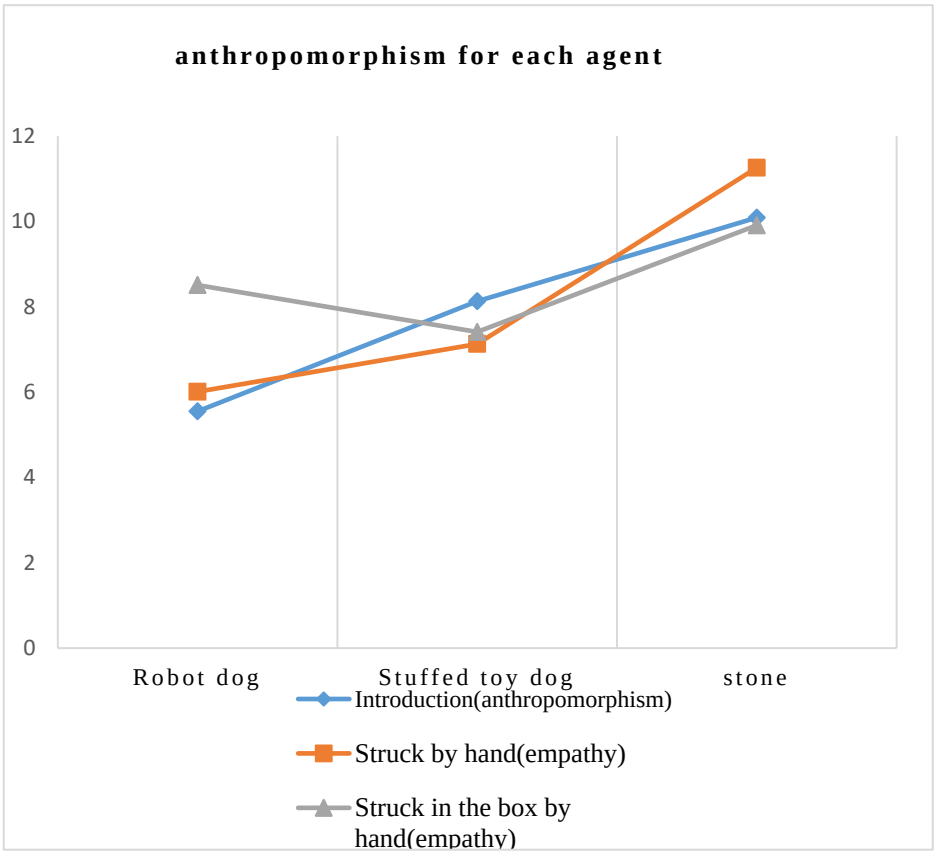

Fig. 4. Scores of introduction, struck by hand and struck in the box by hand.

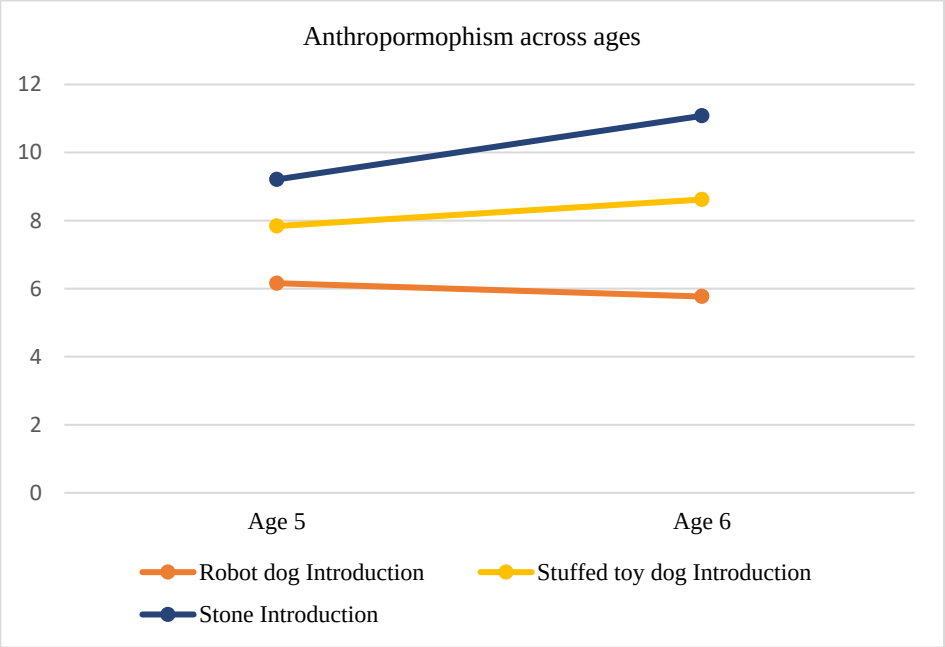

Fig. 5. Scores of introduction for each agent across ages.

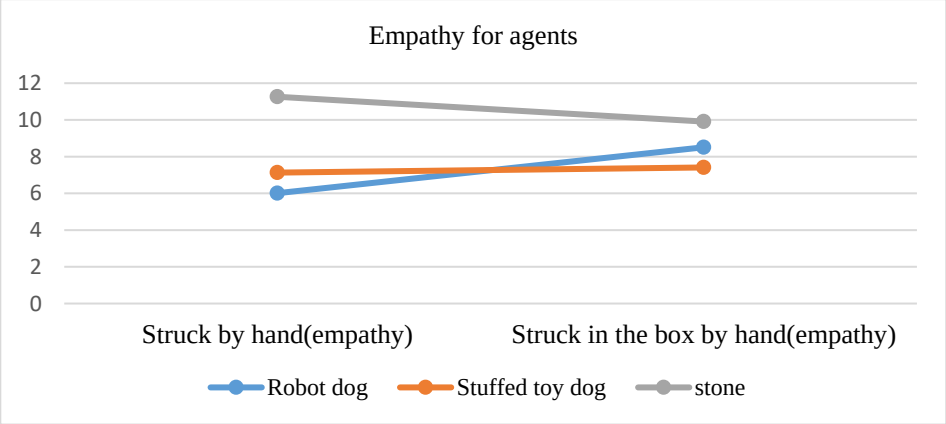

Fig. 6. Scores of empathy for each agent on Struck by hand and stuck in the box by hand.

5.1 Scores of introduction, struck by hand and struck in the box by hand regarding each agent: robot dog, stuffed toy dog and stone, please see the Table 1

After the children watched all the videotapes, the robot dog crediting the lowest scores on the introduction and struck by hand mean it has the highest level of anthropomorphic and empathy compared to other agents, and the stone as a comparative non-living agent get the highest scores, which also means the 5-6 children have already been able to recognize the living entity and non-living entity (Figure 7).

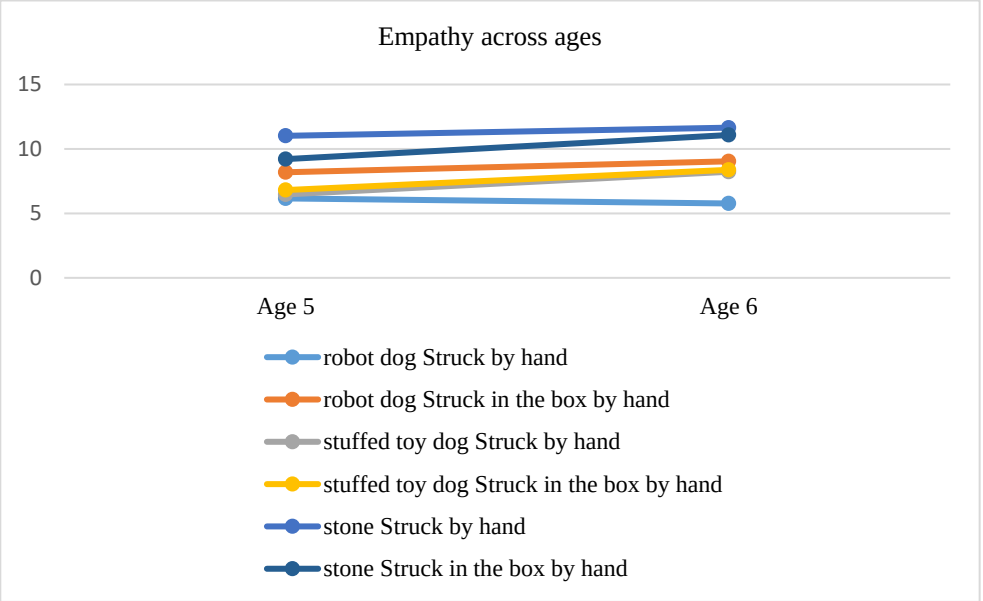

Fig. 7. Scores of empathy for each agent on Struck by hand and stuck in the box by hand across ages.

Table 1. Descriptive statistics of introduction, struck by hand and struck in the box for each agent.

Item	No.	Introduction	Struck by hand	Struck in the box by hand
Robot dog	69	5.55±2.52	6.01±2.08	8.51±2.58
Stuffed toy dog	69	8.13±2.26	7.13±2.85	7.41±3.11
stone	69	10.09±2.25	11.26±4.27	9.91±3.85

5.2 Age comparison of introduction, struck by hand and struck in the box by hand regarding each agent: robot dog, stuffed toy dog and stone, please see the Table 2

Two independent samples t-test showed that there was no significant difference between the robot, dog, and the stone group ($P > 0.05$), and the scores of the stuffed toy dog (struck) and (struck in the box) at the age of 5 were lower than those at the age of 6 ($P<0.05$), as shown in Table 2. It indicates that younger children have a higher level of empathy for non-living objects, which may be related to animism in their thinking.

5.3 Gender comparison of introduction, struck by hand and struck in the box by hand regarding each agent: robot dog, stuffed toy dog and stone, please see the Table 3

Two independent samples t test showed that there was no significant difference among the robot dog, stuffed toy dog and stone groups ($P > 0.05$). As shown in the Table 3.

5.4 Correlation and intra-group comparison on each question

Friedman test showed that there were statistically significant differences among robot dog, toy dog, and stone in the three dimensions of introduction, being beaten, and being beaten in

the box (P<0.05). In the dimension of "introduction", the score of stone > the score of stuffed toy dog > the score of robot dog (P<0.05), that is to say, compared with interaction, interaction is more likely to make children think that something is a living body compared with appearance simulation; In the dimension of "struck by hand", the score of stone was higher than that of toy dog and robot dog (P<0.05). In the dimension of "struck in the box by hand", the score of the stone and robot dog was higher than that of the toy dog (P<0.05). As shown in Table 4.

Table 2. Analysis of age effect on empathy and anthropomorphism for each agent.

Group	No.	Robot dog			Stuffed toy dog		
		Introduction	Struck by hand	Struck in the box by hand	Introduction	Struck by hand	Struck in the box by hand
Age 5	43	5.35±2.40	6.16±1.98	8.19±2.30	7.84±2.29	6.47±2.10	6.81±3.10
Age 6	26	5.88±2.73	5.77±2.25	9.04±2.95	8.62±2.17	8.23±3.56	8.38±2.93
T value		-0.853	0.761	-1.340	-1.395	-2.300	-2.084
P value		0.397	0.5449	0.185	0.168	0.027	0.041

Group	No.	Stone		
		Introduction	Struck by hand	Struck in the box by hand
Age 5	43	10.09±2.33	11.02±4.47	9.21±3.62
Age 6	26	10.08±2.17	11.65±3.95	11.08±4.01
T value		0.029	-0.592	-1.993
P value		0.977	0.556	0.050

Table 3. Analysis of comparison between empathy and anthropomorphism for each agent.

Group	No.	Robot dog			Stuffed toy dog		
		Introduction	Struck by hand	Struck in the box by hand	Introduction	Struck by hand	Struck in the box by hand
Girl	34	5.71±2.61	5.97±2.12	8.41±2.31	8.00±2.57	6.88±2.63	7.35±3.18
Boy	35	5.40±2.46	6.06±2.06	8.60±2.84	8.26±1.95	7.37±3.07	7.46±3.08
T Value		0.501	-0.172	-0.301	-0.469	-0.710	-0.138
P Value		0.618	0.864	0.764	0.640	0.480	0.890

Group	No.	Stone		
		Introduction	Struck by hand	Struck in the box by hand
Girl	34	10.15±2.30	11.79±4.10	9.82±3.67
Boy	35	10.03±2.24	10.74±4.42	10.00±4.07
T Value		0.217	1.024	-0.189
P Value		0.829	0.310	0.851

Table 4. Correlation and intra-group comparison on empathy and anthropomorphism (n=69).

Question	Introduction	Struck by hand	Struck in the box by hand
Robot dog	5.55±2.52	6.01±2.08	8.51±2.58
Stuffed toy dog	8.13±2.26a	7.13±2.85	7.41±3.11a
Stone	10.09±2.25ab	11.26±4.27ab	9.91±3.85b
F	66.780	60.961	24.033
p	<0.001	<0.001	<0.001

Compared with robot dog, a P＜0.05 ; Compare with stuffed toy dog, b P＜0.05.

5.5 Correlation between 3 questions and children's profile (in the questionnaire)

The questionnaire collected Children's profiles, including children's gender, interaction experience with robot/dog (Yes or No), frequency of interacting with robot/dog, the attitude of interacting with robot/dog, negative attitude toward interacting with robot/dog and their correlation with three groups (introduction/struck by hand/struck in the box by hand) of questions for each agent "robot dog", "stuffed toy dog" and "stone" processed by Spearman correlation analysis. The results showed that only the "introduction" dimension of the problem "stone" was negatively correlated with the "interaction with machine products" ($r=-0.287$, $P<0.05$), while the other basic information of children did not correlate with each problem dimension ($P>0.05$). As shown in Table 5. ($P>0.05$)

Table 5. Analysis of children's experience correlated with empathy and anthropomorphism.

Item	Robot dog			Stuffed toy dog			Stone		
	Introduction	Struck by hand	Struck in the box by hand	introduction	Struck by hand	Struck in the box by hand	Introduction	Struck by hand	Struck in the box by hand
Gender	0.100	-0.050	-0.043	-0.218	-0.142	0.009	0.101	-0.101	-0.029
Interaction experience (robot)	-0.055	0.119	0.145	-0.097	-0.099	0.148	-0.287	0.117	0.135
Interaction Frequency(robot)	-0.140	0.096	-0.065	-0.059	-0.132	0.035	-0.224	-0.046	0.100
Interaction attitude(robot)	0.119	-0.022	-0.103	0.071	-0.142	-0.054	0.157	0.126	0.090
Negative interaction attitude(robot)	0.082	0.052	0.059	0.178	-0.048	0.051	-0.137	0.026	0.150
Interaction experience (dog)	0.046	-0.178	0.043	-0.151	0.086	-0.007	-0.096	0.146	0.175
Interaction Frequency(dog)	-0.056	-0.183	-0.039	-0.217	0.037	-0.134	-0.153	0.050	0.107
Interaction attitude(dog)	-0.053	-0.209	-0.148	-0.023	-0.167	-0.121	0.096	-0.030	-0.053
Negative interaction attitude(dog)	0.011	0.131	-0.002	0.182	0.034	0.041	0.001	-0.005	0.040

* $P<0.05$

6 Discussions

The present study assumed that preschoolers show a higher level of anthropomorphism to the interacted robot relative to the non-interacted stuffed toy dog. The children ascribe more mental states to an interacted robot rather than a traditional toy dog because the robot can understand the orders from humans and behave accordingly, even if the appearance is not very close to a real dog. The results didn't show a significant difference in the empathy towards to robot dog and the toy dog, probably because even if the toy dog won't respond as the robot dog did but its furry appearance made the children think of real dogs and transferred the emotional from real dog to toy dog, and it has the same influence on empathy as the interaction did. However it indicates that the younger the children are the more likely they show a higher level of empathy towards non-living entities, this might be affiliated with their animism in thinking during early childhood.

Some deficiencies can be found on the present study. 1) There are different degrees on both interactivity and appearance stimulation, and have it's corresponding subjects reflecting different level. Such as the robot dog Aibo designed by SONY in a higher level of interactivity in relative to robot dog Ledie used in this study. The same issue applied to appearance stimulation. There is no available quantized scale to refer to the degree of

interactivity and appearance stimulation. Due to selecting available subjects (robots or toys) is not quantized, the comparison in this study is a general one (see Figure 8). 2) This article involved two factors: interactivity and appearance stimulation, it should have at least four different groups to be compared with: high level of interactivity and appearance stimulation, High level of interactivity but low level of appearance stimulation, low level of interactivity and high level of appearance stimulation, low level of interactivity and low level of appearance stimulation (see Figure 8). 3) Attachment, rearing style and children's temperament have close connection with empathy while they aren't reflected on the questionnaire. 4) Sympathy is a very important pattern of empathy, it comes from empathy but they are quite different, this study didn't distinguish them clearly.

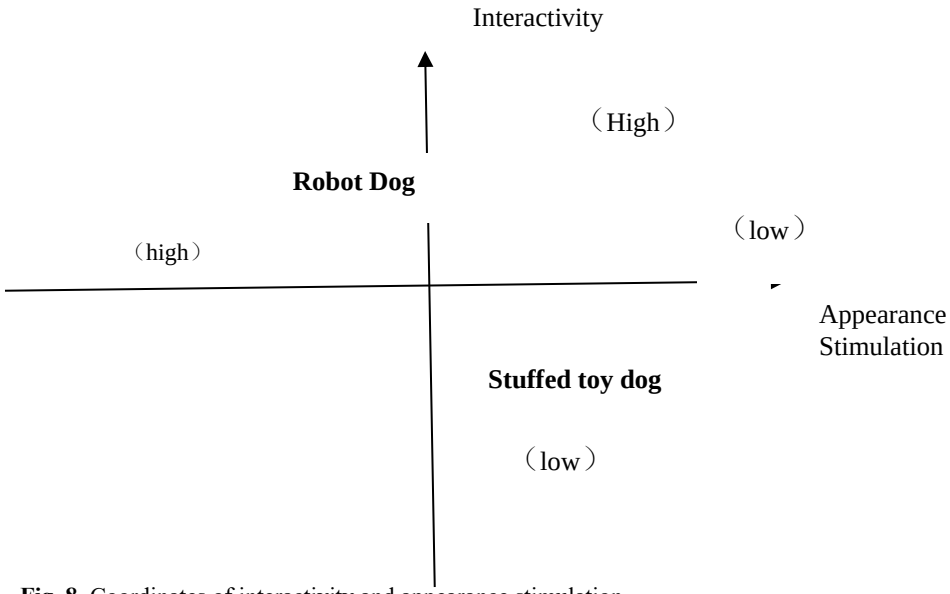

Fig. 8. Coordinates of interactivity and appearance stimulation.

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