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Children's preference of appearance and parents' attitudes towards assistive robots*

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Abstract— **The paper aims to examine children's preference of visual appearance and parents' attitudes towards assistive robots. Results show that children do prefer visual appearances of robots with round and smooth edges, compact and stocky body and with feminine characteristics. Gender differences have been found in robot sketch preference, as well as in ascribing gender to robots – boys tend to be more gender-typed. The dominant colour preffered for the robot is blue, which is a colour associated with positive emotional states, trust, and stability. Based on the results, the paper provides general suggestions and guidelines for creating a robot that the children would find likable. Parents have shown more positive than negative attitudes towards robots in general, as well as towards robots in the children's therapy. Gender differences have been found in potentially negative aspects of child-robot interaction, with mothers more concerned about negative consequences. Also, differences in educational levels have been found, with parents of higher educational level showing more positive attitudes towards robots.**

I. Introduction

Considering the technological development and the fact that robots are going to become a part of people's everyday life, we may say that this development is not accompanied by adequate systematic research of both preference and attitude of the users of these technologies. In the field of psychology, it is well known that we would more readily and willingly engage in interaction with others if they are perceived as likable, benevolent, provoking positive attitudes. Cognitive bias in which an observer's overall impression of a person influences the observer's judgment of that person's personality traits is called Halo effect. It influences individuals' judgment, especially when they lack information about the specific trait they are interested in. If the first impression is positive, e.g. attractive person, we will probably perceive that person as positive in general, and be more prone to asses his/her behavior and other traits as positive. The halo effect has been studied beyond human-human interaction. Results of the study by Walters et al.[1] show that halo effect is seen in transferring liking for the particular robot appearance to ratings of robot's positive personality traits. Many studies have shown that people perceive, assess and treat robots with different appearances differently [2-5]. Goetz et al. [3] suggest that appearances should conform to the task context. Oyedele, Hong and Minor [6] have also shown that people show different concern for the extent of the humanness of the robotic appearance depending on the context of use (e.g. no concern in the context of touching the robot, and more concern in the context of communicating or living with the robot).

There are a relatively small number of studies about what a robot that would be a part of children's education or therapy should look like. The most extensive research has been done within the AuRoRa Project [7]. This Project studies the use of robots as tools that might serve an educational or therapeutic role for children with autism [8, 9]. The results of the studies of Robins et al. [10] with autistic children indicate that initially the children have shown preference for interaction with the robot with plain robotic appearance over the "pretty doll" human-like appearance robot. Working with healthy children, Woods et al. [11] have shown that certain combinations of robot's specific physical attributes of overall appearance are associated with specific personality traits and emotional conditions. This study demonstrated that robots with two legs, a rectangular body, human-like or machine-like appearance, facial features, and male gender were rated as having negative characteristics (aggressive, bossy, angry, sad). Robots with animal-like or human-machine appearance, facial features and more feminine characteristics were rated as friendly and happy. Pure animal robots were rated as the happiest, while pure machine-like robots rated as the most aggressive and angry. Animal-machine and human-machine robots were rated by children as being most friendly. Woods et al. [11] concluded that robots that aim to provoke positive emotional reactions should have cartoon like features, exaggerated facial features, a female gender, and bright coloured for positive behaviours. Robots with realistic features, less clear facial features, and being dully coloured depict negative behaviours. Robots for children should not be designed to look completely human-like, and a mixture of human-machine features is the most desirable. For a detailed survey about Child-Robot Interaction (CRI) refer to [12].

Andrew and Markus [13] state that their review of literature clearly shows that the colour can carry an important meaning and can have an important impact on people's affect, cognition, and behaviour. The research has

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shown that characteristics of colours (the color hue, brightness and saturation) can affect perception, but also physiological, emotional and behavior reactions [14]. Their research is based on the hypothesis that long-wavelength colours (e.g., red and yellow) are more arousing than short-wavelength colours (e.g., blue and green). Experimental studies that have used physiological measures show that red and yellow are indeed more arousing than blue and green [15, 16]. Wexner's [17] study examined associations between colours and words that describe feelings. Blue was associated with secure/comfortable and tender/soothing, and orange was associated with disturbing/ distressed/upset. One of the aims of this study is to answer the question which colours would children choose for the robots and whether 7-years-olds already adopted the usual meanings ascribed to certain colours? Considering the results of previous studies, if it was the case, it could be expected that the children chose colours generally associated with safety, trust, cofidence – various hues of colour blue.

Among various studies that focuse on attitudes towards robots, there are few research on perceptions and attitudes of parents whose children would be the robot users. This is an important issue, because parents with extremely negative attitudes will probably discourage child's interaction with the robot, no matter how much the child finds the robot likable or attractive. According to the social learning theory [18], observational learning is a process in which children learn new behaviour by observing the models (especially parents) in their social environment. This process is used to explain transmission not only of behaviour, but also of emotional reactions, attitudes, values etc. Therefore, if a parent is afraid or has negative attitudes towards the use of a robot in a therapy setting, the child will probably imitate parent's behaviour. Also, the parent will probably speak negatively about the robot, which will enforce the child's negative reaction. This is why it is important to examine parents' attitudes towards therapeutic robots.

The studies examining gender differences have shown that males tend to have more positive attitudes towards robots than females. In Nomura et al. [19] study, results showed that the female respondents had more pronounced negative attitudes toward situations of interaction with robots and lower negative attitudes toward emotions in interaction with robots, than the male respondents. Khan [20] investigated the influence of age, gender, and education on robotic preferences and also found gender differences in attitudes toward robotic assistance in household tasks, regardless of the fact that most people were generally positive toward the idea of service robots. Kuo et al. [21] showed men had significantly more positive attitudes towards healthcare robots than women. A large survey of public opinion examining attitudes towards robots showed that men and people with higher educational levels tend to have more positive attitudes [22]. We expect to find gender differences in fathers and mothers' attitudes towards therapeutic robot, which could be described by the following factors: 1) mothers are more involved in the child rearing, therefore they could be more skeptic towards the use of new methods and technologies; 2) it is possible that females are generally less interested in technological development and robotics, and therefore they might have more critical or less critical (due to lack of information) attitude towards robots. We also expect more positive attitudes in parents with higher educational level.

II. METHOD

This section describe the study objectives, sample and data collection procedure.

A. The Study Objectives

1. Study 1 – Children: Do children show preference to certain visual appearance of robots? Are there gender differences in these preferences and in ascribing gender to the robot? Is there a difference in the prevalence of different colours that children prefer when considering the visual appearance of the robot?
2. Study 2 - Parents: What are parents' general attitudes and attitudes towards the use of robots in the children's therapy? Are there gender differences between mothers and fathers, and between parents of different educational level?

B. Sample

The sample consists of children and one of their parents. Study 1 included 155 elementary school pupils of the first grade, age 7 years old, 75 boys and 80 girls. Study 2 included 130 parents, age 23-59 years, 37 fathers and 93 mothers.

C. Procedure

The study was conducted at schools. After a brief introduction and warm-up with the story about the creators of a robot that will help children, the instructions were given to choose the most likable among five black and white sketches of robots. The skeches were created as a combination of various characteristics suggested by previous studies (human-likeness/animal-likeness, round/sharp edges etc.). For this particular study, we used neutral black and white sketches in attempt to minimize interference of other factors that could influence selection of preferred model. After children chose one sketch, their further task was to colour it in order to make it the most attractive. While the children were colouring the sketches, the examiners asked them about the chosen sketch, its gender, traits etc., and about other four sketches. The five sketches are presented in Fig. 1-5.

The other part of the study focused on the parents. They were given two questionnaires created for the purpose of the study. The first questionnaire examined general attitudes towards robots, and it was created relaying on the questionnaire proposed by Heerink et al. [23]. Examples of the items: I would trust the robot if it gave me advice., I think it's a good idea to use the robot., I think I would find the robot intimidating., Robot could help me with my work assignments... The second questionnaire assesses attitudes

towards robots in therapeutic settings. Examples of the items: I am afraid that my child would damage or break the robot., I think it's a good idea to use the robot in children's therapy., My child would be afraid of interaction with the robot., Robot could further motivate my child to study, play, complete tasks... Both questionnaires have the same rating scale – from 1 (strongly disagree) to 5 (strongly agree). The subjects gave answers by choosing the degree of agreement with each statement (item).

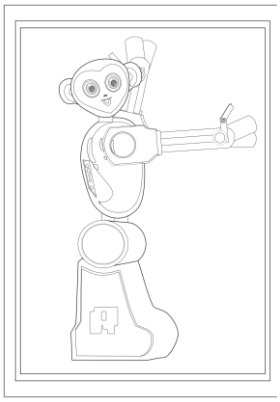

Fig. 1. Sketch A

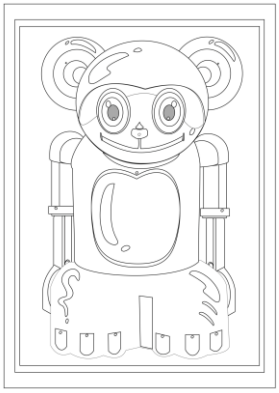

Fig. 2. Sketch B

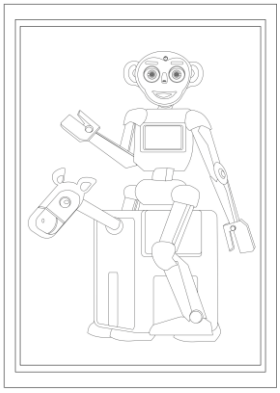

Fig. 3. Sketch C

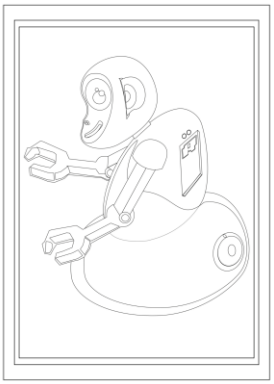

Fig. 4. Sketch D

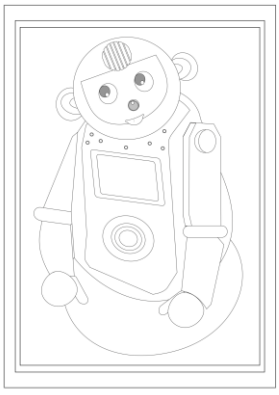

Fig. 5. Sketch E

III. Results and Discussion

Study 1 – Children's preferences of different visual appearances of robots

In order to examine if there are differences in preference of different sketches, we conducted chi-squared (χ^2) test [24]. This is a test that allows us to determine if there is a statistically significant difference in the observed frequencies (in this case frequences of children that choose different sketches), and theoretical frequencies (in this case, if there is no preference, all sketches would be chosen by the same number of children). The results show that the value of the chi-square is significant (χ^2 =30.327, $p \leq 0.001$). P value [24] is a probability that the result of a statistical test is obtained by chance. If p value is ≤ 0.05, we consider that the result is significant. Therefore, we conclude that children show preference towards certain sketches. By observing the frequences of children that chose each of the sketches, we see that the most popular are B (Fig. 2) and E (Fig. 5). The least selected sketch is D (Fig. 4). Sketches B and E have rounded edges, appear compact and stocky, and children probably interpret them as benevolent. Both models are animal-like, have a round head and resemble a mouse or a bear. Less frequently selected sketches depict robots with more hominid appearance, with long arms that resemble humans' arms by proportion, and sketch C (Fig. 3) also has legs. Sketch C is still relatively frequently chosen, possibly because it is more interesting in comparison to the others. In addition to the robot, it contains a horse. The qualitative data gathered during the examination confirm this conclusion. Most children freely expressed that they found interesting that the robot had its own horse. These results are consistent with the findings of the previous studies (e.g. [11]), according to which the robots that evoke positive emotional state (therefore being preferred by children) have exaggerated facial features like cartoon characters and are more animal-like. Based on the preferences, it can be concluded that the children like the models that have round, gentle lines with feminine characteristics, while the models that have the proportions more similar to the human body are less appealing.

Gender differences are also found in the preference of the sketches. Chi-squared test results (χ^2 =15.849, $p \leq 0.005$) show that these differences are statistically significant. The most notable differences are found for the sketches D (Fig. 4) and E (Fig. 5): girls select sketch E more than boys, while boys prefer sketch D more than girls (although this sketch is less frequently chosen in general). The results of the frequencies for the each sketch for the total sample, and separately for boys and girls are shown in the Table 1.

The most popular sketches in boys are B (Fig. 2) and C (Fig. 3). The popularity of model C could be explained due to its resemblance of a cowboy. Again, this interpretation has its confirmation in qualitative analysis of the verbal reactions of children while colouring the sketches.

TABLE I. FREQUENCES OF CHILDREN THAT CHOSE EACH OF THE SKETCHES

Preference of visual appearance	Chosen robot sketch – frequencies (percents)				
	A	***B***	***C***	***D***	***E***
Boys	13 (17.3%)	21 (28.0%)	18 (24.0%)	11 (14.7%)	12 (16.0%)
Girls	10 (12.5%)	28 (35.0%)	14 (17.5%)	1 (1.2%)	27 (33.8%)
Total sample	23 (14.8%)	49 (31.6%)	32 (20.6%)	12 (7.7%)	39 (25.2%)

It is interesting that boys and girls have ascribed gender to the robot differently. The frequencies are shown in Table 2. Most boys marked the robot as a male, and girls showed a different pattern – 42.5% of them ascribed the male and 57.5% of them ascribed the female gender. This result could be explained by the theory of gender-typing. Gender-typing is a process by which individuals develop the attributes that are consistent with their gender roles. Our results confirm that gender-typing is stronger in boys than in girls, which is in line with a number of previous studies [25, 26]. Robots that were more frequently labeled as males were sketches A (Fig. 1) and C (Fig. 3). Sketch D (Fig. 4) is also more frequently labeled as male, but since it was generally less frequently chosen, this result should be taken with caution. Sketches B (Fig. 2) and E (Fig 5.) were equally often labeled as male and female. The frequencies are shown in Table 3. This result is also consistent with the findings of the previous studies (e.g. [11]), showing that robots assessed as the most pleasant were marked primarily as females, or as males and females equally, while robots primarily marked as males were robots perceived as potentially negative.

TABLE II. ASCRIBING THE GENDER TO THE ROBOT – GENDER DIFFERENCES IN CHILDREN

Gender differences in gender ascribing	The ascribed gender of the robot		
	Male	***Female***	***Total***
Boys	67 (89.3%)	8 (10.7%)	75
Girls	34 (42.5%)	46 (57.5%)	80
Total	101 (65.2%)	54 (34.8%)	155

TABLE III. ASCRIBING THE GENDER TO THE ROBOT FOR EACH SKETCH

Ascribed gender for each sketch	Chosen robot sketch					Total
	A	***B***	***C***	***D***	***E***	
Male	18 (17.8%)	29 (28.7%)	25 (24.7%)	9 (8.9%)	20 (19.8%)	101 (100%)
Female	5 (9.2 %)	20 (37.0%)	7 (13.0%)	3 (5.6%)	19 (35.2%)	54 (100%)
Total	23 (14.8%)	49 (31.6%)	32 (20.6%)	12 (7.7%)	39 (25.2%)	155 (100)

The most dominant colour that children chose was blue, including various combinations that include colour blue (this included colours like green and purple, but also situations in which children used several colours and the largest areas were coloured in blue). Approximately half of the children chose blue as the dominant colour. This is in accordance with the theory of the effects of colour on emotion, which considers blue as serene, dignified and serious (e.g. [17]). The colour blue is often associated with trust, safety and stability. It is interesting that children already at an early age associate colours in the similar way as adults.

Study 2: Parents' attitudes toward robots in general and robots in children's therapy

Results show that the parents' general attititudes towards robots, as well as the attitudes towards the use of robots in children's therapy, are more positive than negative. Most frequently chosen degree of agreement in both questionnaires is neutral and partial agreement. It means that the subjects tend to think of a robot as a potential helper, adviser, think that it can be of assistance, and that interaction with a robot is possible. This result is in line with previous studies (e.g. [20, 23, 27]) which show that people in general have positive attitudes towards the use of robots and that they are willing to interact with them.

When we compare means of the avarage scores on both questionnaires[1], we can see that the attitudes towards robot in children's therapy (mean 3.31, standard deviation .69) are more positive than the attitudes towards robots in general (mean 3.08, standard deviation .73). To test the significance of the difference beteween the two attitudes, we used t-test for dependent samples [24]. It is a test based on the paired differences between two measures. This method tests whether the two means are significantly different from each other by testing if the computed difference between two measures is significantly different from zero. The t and p values allow us to conclude if the differences are significant. The results reveal that this difference is statistically significant ($t=5.919$, $p \leq 0.001$), therefore we can concude that parents have a more positive attitude towards the use of robots in a specific setting, namely the children's therapy, than towards robots in general. Possible explanation for this result can be found in Technology Acceptance Model (TAM) [28]. TAM posits perceived usefulness and perceived ease of use as factors that determine technology acceptance. The research based on this model has proved that the perceived usefulness of certain technology has a strong effect on attitudes towards that technology. It is not easy to accept new concept or idea if it is too abstract, or if there is little prior information, especially if it not concretized in a specific setting. It is easier to accept novelty (in this case it is the use of robots) when we are able to anticipate potential benefits from it (e.g. more efficient children's therapy).

When we look at the answers to each of the items of the questionnaire separately and observe frequencies of the parents that rated the statement/item as "strongly agree" or "agree", we find that most parents think that using the robot in children's therapy is a good idea, they also think that their child would like to interact with the robot, and that the robot could further motivate their child to study, play and

[1] For this analysis, all items were recoded to be positively-keyed – so that the higher score means a more positive attitude

complete tasks. Table 4. shows median and mean scores on each item of the questionnaire. The items about potentially negative aspects of the child-robot interaction are given in italic.

TABLE IV. ASCRIBING THE GENDER TO THE ROBOT FOR EACH SKETCH

Items of the questionnaire	Median	Mean
I think my child would like to touch the robot.	5	4.14
I think my child would like to interact with the robot.	4	3.72
Robot could further motivate my child to study, play, complete tasks...	4	3.58
I think it's a good idea to use the robot in children's therapy	4	3.5
I would like for my child to have an opportunity to interact with the robot	4	3.45
I think the robot could improve my child's therapy	3	3.38
For certain aspects of therapy robot could be better than the human therapist	3	2.95
I am afraid that my child would damage or break the robot	3	3.22
My child would be afraid of interaction with the robot.	3	3.10
I am afraid that the robot could behave unpredictably	3	2.79
I would not trust the robot to work autonomously with my child.	3	2.59

For examining gender differences and differences between subjects with different educational levels in attitudes toward the robot in children's therapy, we used one-way analysis of variance (ANOVA) F-test [24]. This procedure provides a statistical test of whether or not the means of several groups are equal.

Gender differences in the average scores of mothers and fathers are found on assessment of potentially negative aspects of child-robot interaction – mothers are more afraid than fathers that their child could damage or break the robot ($F=4.725$, $p\leq0.05$), that their child would be afraid of the robot ($F=5.903$, $p\leq0.05$), and less than fathers trust the robot to do the therapy with their child autonomously ($F=13.732$, $p\leq0.001$) (Although it should be noted that the number of mothers is considerably larger than the number of fathers in our sample, and therefore the results should be interpreted with caution).

The results show that there are differences between parents with different educational levels, i.e. parents of higher education (university degree) have a more positive attitude towards the idea of using robots in the therapy of children ($F = 6.465$, $p\leq0.05$) and think their child would like to interact with the robot ($F = 4.225$, $p\leq0.05$) in comparison to parents of lower educational level (primary school and high school level).

Looking at the distribution of the scores of mothers and fathers, we can observe that the mothers are more prone to the extreme response style on both questionnaires. In the first questionnaire (the general attitude toward robots) 10,76% of women give extreme answers. After a detailed analysis of the outliers, we can conclude that these extreme responses are not the result of random answering, but truly reflect highly critical attitude toward robots (8.46% of mothers have a style of this type of answering), and an extremely positive attitude (2.30% of mothers). In the second questionnaire that examines attitudes towards the use of robots in the therapy of children, 2.30% of mothers give extreme answers that reflect extremely negative attitudes. More detailed review of the outliers showed that these are the mothers who also have extremely negative attitude in the questionnaire of general attitudes towards robots.

In summary, the results of the first part of the study enables formulation of some guidelines how to construct a robot that the children would find likable and appealing. Our results suggest that the robot should have rounded and gentle edges, appear compact and stocky and have feminine characteristics. It should be a combination of animal-like and human-like characteristics (animal with some anthropomorphic characteristics). The dominant colour should be blue. Based on these results (and results of other ongoing studies of children preferences), an assistive robot is being build [29-32]. Its aim is to assist in rehabilitation therapy of children with cerebral palsy, mainly to motivate them for further recovery, and to increase the effectiveness of therapy [33]. This is a work in progress, so for now we can show the head (Fig. 6). Once the robot is complete, we plan to fully explore acceptance and attitudes towards it, both by children and their parents.

Fig. 6. Head of the robot built on guidelines of this study

IV. CONCLUSION

The result of the study suggest that children prefer certain visual appearances of robots to others: animal-like, with exaggerated facial features like cartoon characters, compact and stocky. Children tend to prefer models of robots with rounded edges, feminine characteristics and benevolent appearance. Boys are more prone to ascribe male gender, and girls attribute both male and female gender to the robot, confirming stronger gender-typing in boys. The dominant colour that children chose for colouring the sketch of the robot is blue and the various combinations that include the colour blue – usually associated with pleasant emotions. Parents show more positive than negative attitudes towards both robots in general and robots in children's therapy. Observed gender differences between mothers and fathers

are obtained on potentially negative aspects of the child-robot interaction. Since mothers are more involved in the child rearing, it is somewhat expected for them to be more concerned about the negative outcomes of the interaction between their child and the robot. Previous research suggests that women are more likely to show distrust towards the use of robots in certain settings. It should be kept in mind that more than 70% of the subjects are women, and therefore these results should be taken with caution. Differences in attitudes in parents with different educational level is also in line with some previous research which shows that people with higher educational level have a more positive attitude towards robots. The results of this study are being incorporated in the development of an assistive robot whose aim is to participate in rehabilitation therapy of children with cerebral palsy.

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