Children Comply with a Robot's Indirect Requests

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ABSTRACT

Compliance studies in human-robot interaction (HRI) tend to consist of direct requests from the robot to the human. It is suggested that indirect requests are considered more polite, which has been positively correlated with learning gains. An experiment is conducted to explore compliance with indirect robot requests in teaching interactions. A comparison is made across embodiment conditions, but no significant differences are found. Overall, children comply with the robot's requests, which is used to support the hypothesis that given a well-defined context, children will infer the indirect meaning of a suggestion from a robot.

Categories and Subject Descriptors

H.1.2 [**Models and Principles**]: User/Machine Systems

General Terms

Experimentation, Human Factors, Theory

Keywords

Social HRI; compliance; educational interactions; Sandtray

1. INTRODUCTION

Many studies have considered compliance in human-robot interaction (HRI). It is commonly found that humans will comply with a robot's request or instruction; this compliance can even be stretched to carrying out unusual, possibly 'incorrect', tasks when a physical robot is present [1].

However, these studies often use very direct phrasing; the participants are directly told what to do by the robot as in [4]. It has been suggested that humans tend to make requests indirectly as this is considered to be more polite [3]. In turn, increased politeness has been positively correlated to learning gains in teaching interactions [6].

Therefore, using indirect requests with a robot can be seen as desirable in an educational setting. One of the challenges here is that an indirect approach often requires the respondent to process the request into multiple meanings: the literal understanding of the questions being asked and the inference of the request for action [3]. This relies not only on the social understanding between the interaction partners, but also on the context in which requests are made. It is hypothesised that when provided with a suitable context, children will complete this process and comply with a robot's indirect suggestion.

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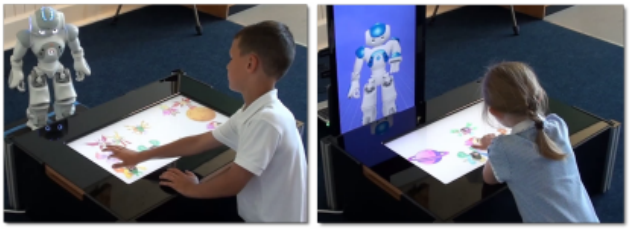

Figure 1: Experimental setup - the child and robot sit opposite to each other around the Sandtray. Both the real robot (left) and virtual robot (right) conditions are shown.

2. METHODOLOGY

Dyadic interactions between a child and a robot took place around a large touchscreen called the 'Sandtray' (figure 1), which has previously been used to contextualise interactions [5]. A total of 28 interactions took place (11M, 17F, age=7.9, SD=0.31). The age range of 7-8 year old children was used as part of a larger research project [2].

The children were introduced to the robot by the experimenters, before the robot informed the children of the task to be completed: sorting aliens into one of two planets (with a predefined membership rule). The robot then explained to the child that categorisations could be made by dragging an alien over one of the planets and releasing it. The child is then asked to 'have a go' without the help of the robot. Once a full set of 12 aliens had been completed, the robot started the teaching phase of the interaction.

One of the study aims was for the children to learn the pattern which led to correct alien categorisations. In order to achieve this, the robot acted as a teacher and would try to guide the child towards the correct pattern for categorisation by making suggestions and providing feedback on child categorisations. The robot would suggest an alien to move by selecting it and moving it to the centre of the screen, ac-

companying the move with an indirect suggestion. Example suggestions include "How about this one with green arms?" and "Where will orange wings go?".

The average length of the entire interaction was 533 seconds (SD=58s), with the teaching phase lasting an average of 309s (SD=45s). Previous studies have revealed differences in compliance between different robot embodiments [1], so children were split across two embodiment conditions; 15 interacted with the real robot and 13 with the virtual robot.

3. ANALYSIS

The robot made a total of 363 moves across all of the interactions (M=13.0, SD=6.2). Some of the moves by either the child or robot were occluded, so cannot be counted in the statistical analysis. 'Taken immediately' means that the child categorised the suggested image as their next move after the suggestion. 'After completing move' means that if the suggestion was made whilst the child already had an image selected, they categorised their selected image and then the suggested one. 'Not taken' means that the child did not categorise the image in their move immediately succeeding the suggestion.

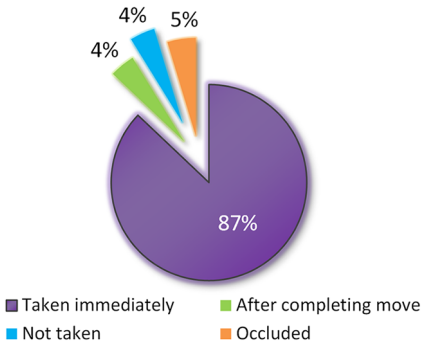

Figure 2: Pie chart of the reactions to suggestions made by the robot. Some are occluded as it is unclear which image the robot or child moved.

Of the moves which were not occluded (figure 2), significantly more were taken immediately (M=11.3, SD=6.2) than after the completion of a current move or not taken at all (M=1.1, SD=1.2), $t(27)=8.308$, $p<0.001$. No significant differences were found between different embodiment conditions for overall compliance with the robot's suggestions. In the task and context used here, the robot's behaviour has a stronger effect than its embodiment; further work could explore whether this holds true for different contexts.

These results demonstrate that the children inferred from the context that a suggestion did not simply mean to answer the question, but also to carry out the action of categorising the item the robot had suggested. Additionally, it shows that the children are willing to comply with the request. This may not be so surprising, as the only thing that they can do is categorise images; the choice they make is whether to categorise the image the robot has highlighted or a different one.

A further characterisation can be made by considering the instances in which the robot made a suggestion while the child was part-way through another move; an 'interrupting' suggestion. A total of 82 interrupting suggestions occurred across all of the interactions (M=2.9, SD=2.6), but there were none in 5 of the interactions. In interactions where these suggestions occurred, significantly more were taken immediately (M=2.4, SD=2.1) than not (M=1.0, SD=1.1), $t(22)=2.709$, $p=0.013$. Again, no significant differences were found between embodiment conditions.

4. DISCUSSION

The results show that children are significantly more likely to immediately comply with the robot's suggestion than not, regardless of embodiment condition and whether they already have an image which they are moving. These interrupting suggestions provide the most compelling evidence that the children want to comply with the robot's requests, as it requires them to stop and change their current plan.

As described in section 1, the suggestions are indirect and require the children to process both the literal and indirect meanings. The results provide support for the hypothesis, that children do indeed go through this process and come to the correct conclusion: 'the robot wants me to move that image'. The context provided by the Sandtray enables this kind of suggestion because the content is so constrained that the suggestion, despite being indirect, is unambiguous.

Although not measured here, it is possible that humans would see robots as more polite when they use indirect suggestions. This potentially increased politeness and its link to knowledge gain [6] would certainly make for an interesting future study.

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