Constraining Content in Mediated Unstructured Social Interactions: Studies in the Wild

James Kennedy, Paul Baxter and Tony Belpaeme
Centre for Robotics and Neural Systems
Cognition Institute
Plymouth University, U.K.
Email: james.kennedy@plymouth.ac.uk

***Abstract*—When studying social interactions, robust data collection protocols can come at the expense of allowing a natural interaction to take place because of a rigid structure in the experimental scenario. This work seeks to explore the use of an interaction mediator as a tool to constrain the content of a social interaction without imposing an interaction structure. Two studies were conducted in different interaction contexts using children: a peer-peer interaction, and a teacher-child interaction. Given that no interaction structure is imposed, objective metrics to characterise behaviour prove difficult to apply. Qualitative analysis techniques, namely Conversation Analysis, are therefore used to study the dyadic interactions. Results confirm the role of the mediating device in providing interaction content without imposing interaction structure. This illustrates the potential role of such devices in manipulating social interactions to facilitate empirical interrogation.**

I. Introduction

When studying social interactions, or phenomena related to social interactions, it is necessary to create a robust experimental protocol in order to gather metrics to use as evidence in the evaluation of hypotheses. Rigid constraints are typically applied to the interaction through the task context to ensure certain aspects of the interaction are fulfilled, to facilitate objective characterisation. However, it has been argued that the imposition of such constraints is detrimental to the degree to which the human interactants behave in a naturalistic manner [1]. This issue therefore seems to indicate a trade-off between rigid interaction and objective metrics on one side, and naturalistic interaction but subjective analyses on the other. It is not being suggested that either side of this balance is more worthy; merely that the methodologies applicable to one side do not necessarily apply completely to the other.

A methodology has been proposed that focuses on the study of naturalistic social interaction whilst mitigating the potential impact on objective metric acquisition: using a device to mediate the social interaction, but not impose a predefined interaction structure [2]. The proposal is that the mediating device enables the content of the interaction to be defined, but that the interactants determine how the social dyad emerges. This enables naturalistic interactions to occur whilst still providing the opportunity to gather objective data (through the mediating device) to measure aspects of the social engagement and experimental manipulations. The purpose of this paper is to provide an evaluation of this proposed methodology by examining human dyadic interactions in various interaction contexts, specifically involving children.

In such a scenario, there will however be an increased reliance on subjective and qualitative sources of information. There are a number of methodologies applicable to achieving this. For instance, video recordings of the interactions which are coded can be used to provide objective data regarding specific (relatively low-level) aspects of behaviour, such as gaze direction, or physical movement. However, these are typically insufficient to provide an account for the social interaction as a whole; a situation exacerbated when it is unstructured interaction that is the subject of study. An example of this includes the difficulty in objectively demonstrating turn-taking behaviour [3], or of the difficulty in assessing the effects of embodiment [4].

Another option is to make use of subjective self-report measurements, such as structured questionnaires or semi-structured interviews, and correlate these to the available objective metrics, e.g. [5]. However, it has been suggested that this means of evaluation results in misleading characterisations, particularly when conducting research with children as in the present case [6]. Indeed, we have previously experienced children's self-reported enjoyment of an activity to appear very disparate from the behaviour we observed.

A third option is to use the qualitative techniques provided by Conversation Analysis (CA) to characterise observed behaviours, and extract structure of behaviour, behavioural contingencies, etc [7]. This supports a drive towards objective, analytic observation of social robots in real-world environments [8]. The CA methodology provides an empirical means of analysing interaction, and has been applied not only to speech interaction [9], but also to interactions between humans and robots [10], demonstrating the general applicability of the approach; for this reason, CA is applied to the present study.

This paper will describe two studies: one conducted in a school and another in a university location designed for studies involving children. In both of these cases, the children involved were familiar and comfortable with the environments, thus moving the evaluations away from typically sterile research environments, and out *into the wild*. These studies provide supporting evidence for the claim that the mediator used does not impose an interaction structure, yet it can still provide the content of the social behaviour between participants. The remainder of the paper is structured as follows. Firstly, the

concept of mediating social interactions is summarised, and the mediator platform used in the present study described (section II). The two studies conducted are then introduced (section III), emphasising the different interaction contexts explored. Analysis of the video data captured using CA demonstrates the role of the mediating device in the various social interactions (section IV), supporting the application of this mediator methodology to wider studies in social interaction, based on the principle of providing interaction content, but not interaction structure (section V).

II. Mediating Social Interactions

Social interactions can be mediated by introducing a shared object between the participants. This shared object can take a variety of forms, for example tablet computers [11] and board games [12]. The shared object, or mediator, provides a collaborative space which both participants can interact with.

In the studies presented here, the aim is for the mediator to provide a context for the interaction, but not to impose a strict structure. The interactants should be free to interact as they see fit; eliciting natural and deep social behaviour. The mediator used in these studies is the Sandtray [2]: a large touchscreen embedded in a wooden frame, which is designed to be at a comfortable height for children to lean on. Figure 1 shows a schematic overview of the setup as used in the studies in section III.

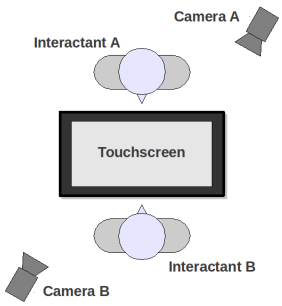

Fig. 1: Schematic overview of the mediation device-centred interactions under investigation in this paper. Two interactants (A and B) face one another over the touchscreen. Two video cameras record the interactants during the studies, each pointing at the person opposite. Figure not to scale.

The configuration of the mediator and participants as shown in figure 1 allows the dyad to interact in a multimodal and natural manner. The participants are free to move around the mediator and it is at a suitable height such that they can easily talk and gesture over it.

The Sandtray uses a sorting task; participants sort pictures on the screen into one of two categories. This is done by dragging screen items to an image signifying the category. When a screen item is correctly categorised, a large green tick is shown over the category image; when a screen item is incorrectly categorised, a big red cross is shown. When an item has been categorised, it vanishes from sight.

The items on screen are presented in sets, or libraries, such that most of the screen is filled at the start of each library. Two buttons can be found in the corners along one edge of the Sandtray; one to move to the next library, and one to start the current library again (place all previously categorised images back onto the screen). The remaining two corners display a score; this is calculated on a per-library basis. The score increments by one for every correct categorisation and decrements by one for each incorrect categorisation.

The Sandtray game is single touch; if multiple touches are detected then the screen item will move to an aggregate position. Participants can move items collaboratively, or pull items away from each other, allowing for very interesting interaction dynamics.

III. Two Studies in the Wild

Both studies were conducted in environments familiar and comfortable to the children. One participant was situated along each length of the Sandtray, as seen in figure 1. One camera was placed on each diagonal of the mediator so that gaze, movement and speech would all be possible to code from the recordings. Occasionally participants would move and obscure one of the cameras, but often the second camera would still provide enough information to code all of the events desired.

The main distinction between the two studies was in the roles of the participants. In the first study, the interaction took place between a child-child dyad, whereas the second study was between an adult teacher and a child. Roles can have a great impact on an interaction and come with specific social expectations [13]. Observing interactions in which contrasting roles are present, it is possible to evaluate whether the content is constrained in a similar manner across these differing interaction scenarios.

A. Child-Child Interactions

The first study was conducted in a primary school in the UK. The interaction took place in a classroom annex with which the children were familiar, and had easy access to and from the classroom. Figure 2 shows a still capture from one of the recorded interactions.

Fig. 2: Sandtray setup for Child-Child pilot study.

Two sorting tasks were used in this study; the children could move between them freely using the library buttons previously described. One task was to sort low and high carbohydrate foods, another was to sort mathematical equations into whether their result was even or odd. The category images were a ‘low’

or ‘high’ carbohydrate sign in the case of the foods, or a simple ‘Even’ or ‘Odd’ label for the maths task.

Ten pairs of children interacted with the Sandtray over the course of a morning at school. Written permission for participation in the study had been acquired from all of the children’s parents. However, some parents did not consent to their children being filmed; as a result, only seven of the ten interactions were filmed. The average length of a filmed interaction was 9 minutes 40 seconds (S.D.: 73 seconds). All of the children were from the same school class and were aged between 7 and 9 years old. Of the filmed interactions, there were 6 male participants and 8 females. The class teacher selected the pairings of children that would take part in each interaction; all pairs were same-sex.

The experimenter would accompany each pair to the Sandtray and provide them with instructions on how it was possible to interact with the Sandtray. For example, what both of the buttons on the screen did and how to move images on the screen. The experimenter would then leave the room to wait outside, making a comment similar to “I’ll leave you to play”, or “we’ll just let you play”. This was done so that the children would not feel compelled to play the game; they were not explicitly told to play with the Sandtray or to complete the task that the Sandtray offered. Additionally, the children were told that they were free to stop or leave at any time, and that they could leave to ask the experimenter questions if they had any.

B. Teacher-Child Interactions

The second study took place in a University lab designed to be a pleasant and relaxing environment for children. The roles in this study are completely different to the first study, moving from peer-peer to teacher-student. The participants in this interaction were two children and one adult teacher. The children were aged 7 and 9. The children had not met the adult before, but had been informed that the adult was a teacher prior to the interaction. The children had been in the lab before and were comfortable with the environment, which should mean that they behaved in a natural manner.

The arrangement of this experiment was very similar to the one from the child-child pilot, but with one child replaced by the adult teacher, as seen in figure 3. The average time of interaction with the Sandtray was 12 minutes and 59 seconds, although the total interaction lasted slightly longer as the teacher also introduced themselves. Again, consent by a parent of each child had been given for both participation and filming in the study.

The sorting task was now focused on categorising ‘aliens’ into one of two planets; the children had to establish the common features of the aliens that would lead to a correct categorisation. This idea is based on work by Lupyan *et al.* to see whether learning is facilitated when people are given redundant labels, as described in [14]. Using aliens means that subjects can have no preconceptions about any given item; they are forced to create new theories for categorisation.

All aliens from the purple planet had yellow legs and a green arm; any other alien would be from the orange planet.

Fig. 3: Sandtray setup for Child-Teacher pilot study.

The teacher was made aware of this solution, but the child was not. The teacher was instructed to guide the child towards the solution by any means they desired, apart from simply stating the rule for the correct solution.

IV. Interaction Study Analysis

Conversation Analysis (CA) is an analytic tool used to transcribe the practices of people in social interaction; creating detailed transcripts of naturally occurring data [15]. There is an implicit assumption that talk-in-interaction is important in the social aspects of the interaction, as the analysis is mainly centred around the verbal communication between participants.

Analysing the interactions filmed as part of this study using CA provides clear examples of observed behaviour. This includes not just a characterisation of the behaviour seen by each member of the dyad, but also the emergent characteristics of the interaction as a whole. The structure of the interaction is often easily visible from the extracts provided.

The notation used for the Conversation Analysis conducted in this paper follows the Jefferson system, as described by Atkinson and Heritage [16]. For ease of reading, a short summary of the notation used in the subsequent analysis is included here in table I. Numbers along the left edge of the analysis extracts signify turns; the turn taker is noted as either C1 (child 1), C2 (child 2), Te (teacher) or Ch (child), depending on the interaction type. It is possible for one participant to take more than one turn consecutively and this can be used to help extract the interaction structure.

Symbol	**Meaning**	**Symbol**	**Meaning**
[ ]	Simultaneous events	(1.0)	Silence (time in secs)
>word<	Faster speech	<word>	Slower speech
UPPER	Louder speech	°word°	Quieter speech
↑	Rising intonation	↓	Falling intonation
underlined	Emphasis	=	Speech latching
,	Continued intonation	?	Intonation rise at end
::	Drawn out sounds	((word))	Analyst’s comment

TABLE I: Conversation Analysis notation symbols used and a brief description of their meaning.

When analysing the video recordings for both the child-child and teacher-child interactions, two main interaction structures emerged: one-sided interactions and turn-taking interactions. However, the content of the interaction always remained focused on the subject that the Sandtray displayed

(food, maths or aliens). These structures will now be considered in turn, with extracts of Conversation Analysis discussed in order to illustrate the behaviour observed.

A. One-Sided Interactions

A fairly common feature amongst the child-child interactions was that one child would interact directly with the mediator much more often than the other. The dyads all knew each other, so would have a pre-existing social hierarchy. Once the experimenter had left the room, one child would often become very vocal and possessive of the touchscreen space. This is not so surprising, as social dominance among children is the earliest dimension of peer group organisation [17]. This social dominance has also been correlated to the control of resources [18].

Figure 4 shows the analysis of a moment near the start of an interaction. One child is monopolising the touchscreen, preventing the other from completing any moves. Whenever Child 2 tries to make a move, Child 1 quickly makes a move which pulls the selected item away from Child 2.

```
1   C1: ah::, so what was it again? So that
        one was that. ((touchscreen move))
2   C2: ↑ye::ah. ((moves towards, then away
        from touchscreen))
3   C1: that one was that. ((touchscreen move))
4   C1: THAT one
5       (1.1)
6   C1: that one was that. ((touchscreen move))
7   C1: ((touchscreen move))
8   C2: °that one's ((move hand towards, then
        away from touchscreen))
9   C1: ((touchscreen move))
```

Fig. 4: One child monopolises both the dialogue and moves made.

Monopolisation by one child of the touchscreen space is seen in many other interactions. Figure 5 shows a child confronting their partner in the dyad when they try to make a move in the game, asking them to release the screen item. The child who relinquished control of the touchscreen space then tries to be involved vocally, by repeating what the other child says. This may have been an effort by the child to become more involved; mimicry has been related to increased social interest and pro-social behaviour [19] [20].

```
1  C1:  pizz↑a. ((touchscreen move))
2  C1:  def'nt'ly. ((touchscreen move))
3  C1:  that. ((touchscreen move))
4  C1:  SWE::ETS.
5  C2:  ((touches screen item))
6  C1:  OI can you let that go? I've got the sweets
7       (2.0) ((C2 releases item))
8  C1:  HIGH ((touchscreen move))
9  C2:  =HIgh, yep.
10 C1:  def'nt'ly
11 C2:  =↑def'nt'ly high
```

Fig. 5: One child tells the other to release an image on screen.

B. Turn-Taking

Many of the interactions had turn-taking whereby one child would make a series of moves and then allow their partner to make one move, as shown in section IV-A. This is similar behaviour to that which has been observed in other work [3]. Of the seven dyadic interactions recorded, two contradicted this pattern. One interaction had a very strict turn-taking policy; seemingly dictated by one child. This child would quite aggressively push their partner's hands away from the screen in order to maintain a one move per child turn-taking structure, as seen in figure 6.

```
1  C1:  heh heh °heh [((screen move))
2  C2:               [our score is three
3  C1:  >YES<
4  C2:  =↑Fo:ur
5  C1:  ↑ONE. heh heh [our score is ↓one
6  C2:                [((pushes C1's hands))
7  C2:  ((screen move))
8  C1:  our score is one. ((screen move))
9  C1:  two             [((moves towards screen))
10 C2:  >↑LET ME DO IT< [((pushes C1's hands away
        from screen))
11 C2:  =let me do it.
```

Fig. 6: One child enforces a turn-taking policy.

Another interaction had a more collaborative turn-taking policy. Both children appeared to be aware of whose turn it was, and it was only briefly mentioned once when one child attempted to take a turn out of sequence. This event is shown in figure 7 . The children had not previously discussed taking turns, but seem to have implicitly both agreed that they would each make one move before relinquishing control of the mediator screen to the other.

```
1  C1:  wha's that? ((points at item))
2  C2:  THat's:: (.) >no it's my go<
3  C1:  oh right, [the gre']
4  C2:            [LE::eks ] leeks
5  C1:  =>low carb'hydrate<
6  C2:  ((screen move))
```

Fig. 7: The children have an implicit turn-taking agreement.

Very different interaction structures emerged in the teacher-child pilot because of the turn-taking strategy the child adopted. The teacher was simply there to guide the child, so largely allowed the child to dictate the turn-taking strategy and adapted their feedback and screen moves to suit the child. One child (child A) adopted a strategy whereby they would aim to clear the screen of items (fourteen are presented) before receiving feedback from the teacher. However, another child (child B) would categorise just one screen item before seeking teacher feedback. These contrasting styles are reflected in the data collected about the interaction shown in table II.

Event	Child A	Child B
Game time	803s	755s
Screen touches	180	69
Gazes at teacher	28	52
Teacher screen touches	53	96

TABLE II: Data from two Teacher-Child interactions

Child A plays for slightly longer than Child B, but touches the screen over twice as many times. Child B looks at the teacher more often and the teacher touches the screen more

```
1  Te:  which one d'yih wan'a go for next?
2  Ch:  that one ((points at item))
3  Te:  that one?
4  Te:  >where d'you think that one'll go?<
5  Ch:  go in that one ((points at category))
6  Te:  tr↑y
7       (1.8) ((Ch moves screen item))
8  Te:  mm:::m (.) >so that one< should have
        been in the or'n:ge one
```

Fig. 8: The child awaits feedback from the teacher after each move.

```
1  C1:  >put it in tha' one<
2  C2:  =e::r [yea
3  C1:        [>it's that<
4  C2:  ((screen move)) aw::
5  C1:  °sha' we swap places:?°
6  C2:  °yea
7  C1:  °swap places° ((children swap))
8  C1:  ↑umm::
9       ((continue playing))
```

Fig. 9: Children swap places part-way through an interaction.

when interacting with Child B. This is because the child would look to the teacher for feedback after each move and the teacher would often then highlight the next item for the child to categorise by moving it slightly on screen. An example of this behavioural pattern is seen in figure 8. In the interaction with Child A, the teacher would only touch the screen to rearrange some of the items at the start of each new set whilst they gave feedback to the child. This accounts for most of the disparity between child gazes at the teacher and teacher screen touches between the two interactions.

C. Unexpected Behaviour

Other noteworthy behaviour included one instance where two children spontaneously swapped places part-way through the interaction. This really emphasises how unstructured the interactions were; the participants were free to change any aspect of the interaction around the mediator. Analysis of this section of the interaction can be seen in figure 9. The children suddenly agree to swap places in the middle of a game and then continue to play as they were before.

D. Constrained Content

In all of these interactions, the children are clearly focused on the Sandtray task. The verbal and nonverbal behaviour from the children is centered around the subject on the Sandtray. The children are talking about and pointing to different images on screen with the aim of completing the task. This is true for both the teacher-student interactions and the child-child interactions. This shows that the content of the interactions is constrained between dyads across different roles.

Sometimes the children will directly reference screen items, for example in figure 5, child 1 often verbally states the food they are looking at or moving. Other times the child will use more referential gestures alongside vocalisations such as 'that', as seen in figure 4, so that their dyadic partner can share the same frame of reference. Even in child-child dyads where one child is not as verbal, or touches the screen less, they are still engaged in the interaction and with the content of the task.

In one of the most unstructured examples from the analysis, discussed in section IV-C, the content is still constrained to the Sandtray task. The children swap places, but they are discussing only the subject presented by the Sandtray both before and after the action of changing positions around the mediator. They subsequently continue to play for several more minutes, entirely focused on the Sandtray task and not mentioning their positions again.

V. Perspectives

From the analysis in section IV, it is apparent that the use of a mediator as implemented in these studies does not impose a strict interaction structure. The participants in each interaction were free to behave in the way that they desired resulting in an emergent interaction structure. Exploration of alternative relative positions around the mediator, the likes of which were observed in section IV-C, could warrant additional study. Some of the child-child dyads chose to impose a strict turn-taking structure (section IV-B), whilst other interactions were more one-sided (section IV-A). In no case did the children discuss the structure of the interaction; it emerged from the social behaviour between them. This provides evidence that a natural interaction structure will emerge from mediated interactions which have no structure defined *a priori*.

It is shown, however, that the mediator constrains the content of the interactions. The specific interaction snapshots examined (see figures 6 to 9), which are representative of all studied interactions, demonstrates how the interactants limit the subject of the interaction to that displayed on the mediating device. While this is perhaps to be expected in the case of the teacher-child interactions (given the guiding role of the teacher), there is no such bias or compulsion present in the child-child interaction case.

Occasionally the children were aware of the cameras and their attention would shift to them briefly, but it would soon return to the Sandtray task. While more discrete camera placement may be desirable in future studies, practical constraints outside of laboratory settings often prevent this if the interaction is to be adequately captured for analysis. What is nevertheless seen in these interactions is that despite the recording equipment being noticed, this does not seem to adversely influence the observed interactions.

A. Benefits of Mediated Interactions "In the Wild"

There are a number of advantages to mediating interactions in the manner described in this paper. As raised in section I, the mediator acts as a virtual modality: while providing the context of the social interaction, it can also be used as a data collection device, enabling an objective characterisation to be made of the interactants behaviour (including, for example, speed of movement, classification accuracy, etc). This partially mitigates the shortfall in objective metrics available in unstructured interactions. This concept has also found application in the domain of Human-Robot Interaction (HRI) as a means for experimenters to focus their attention on the social aspects of robot behaviour, rather than the complex sensory and motor

processing required for real-world spacial interaction, e.g. [2], [21].

However, the use of a mediator can also have many benefits to any interaction studying human social behaviour. The mediator will dictate the task which takes place and the interaction events are likely to arise from this task; this is often seen in studies of people playing games, e.g. [22]. This paper has provided additional evidence for the idea of a mediator as a device to constrain interactions. This is particularly useful as experimental manipulations can then be made within this context, without changing the interaction structure, providing a better baseline for comparison.

One promising advantage of using such a mediator is the opportunity to intentionally manipulate aspects of the interaction in real time [2]. This could be between experimental conditions. For example, in the case of the sorting task presented here, the impact on the interaction and behaviour that arises if all images belonged to one category could be observed.

Alternatively, these manipulations could be made in an effort to draw a specific affective response from the human. This concept has been used in other work relating to human-computer interaction, as seen in [23]. This is a useful experimentation technique as it allows for repeatable conditions between subjects. In the context of the sorting task used in the present study, this could, for example, take the form of providing negative feedback to a correct classification by one of the interactants, thus facilitating the study of affective responses in a principled manner.

B. Summary

Mediating social interactions through the use of a touchscreen device affords a number of advantages and opportunities in terms of scientific investigation. In this paper, it has been shown that such devices do not impose an interaction structure, thus facilitating a more naturalistic social interaction than possible when such constraints are imposed.

However, what has been observed is that the content of the interaction is constrained to the task context provided by the interaction mediator, thus facilitating the application of objective metrics. With the potential for online experimental manipulations, this demonstrates the utility of such a mediating device in further empirical investigation, both in the exploration of human behaviour, and in HRI applications.

VI. Acknowledgment

This work is funded by the EU FP7 ALIZ-E project (grant 248116) and the Centre for Robotics and Neural Systems, Plymouth University. The authors would like to thank CAEN Community Primary School in Braunton, UK for hosting the child-child study.

References

[1] R. Ros, M. Nalin, R. Wood, P. Baxter, R. Looije, Y. Demiris, T. Belpaeme, A. Giusti, and C. Pozzi, "Child-robot interaction in the wild: advice to the aspiring experimenter," in *Proceedings of the 13th international conference on multimodal interfaces*. ACM, 2011, pp. 335–342.

[2] P. Baxter, R. Wood, and T. Belpaeme, "A touchscreen-based 'sandtray' to facilitate, mediate and contextualise human-robot social interaction," in *Proceedings of the 7th annual ACM/IEEE international conference on Human-Robot Interaction*. ACM, 2012, pp. 105–106.

[3] P. Baxter, R. Wood, I. Baroni, J. Kennedy, M. Nalin, and T. Belpaeme, "Emergence of turn-taking in unstructured child-robot social interactions," in *Proceedings of the 8th ACM/IEEE international conference on Human-robot interaction*. IEEE Press, 2013, pp. 77–78.

[4] B. P. Meier, S. Schnall, N. Schwarz, and J. a. Bargh, "Embodiment in Social Psychology." *Topics in cognitive science*, pp. 1–12, 2012.

[5] S. E. Lindley, J. Le Couteur, and N. L. Berthouze, "Stirring up experience through movement in game play: effects on engagement and social behaviour," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 2008, pp. 511–514.

[6] J. H. Roth, M. R. Dadds, and J. McAloon, "Evaluation of a puppet interview to measure young children's self-reports of temperament," *Behaviour Change*, vol. 21, no. 1, pp. 37–56, 2004.

[7] E. A. Schegloff, "Analyzing single episodes of interaction: An exercise in conversation analysis," *Social Psychology Quarterly*, vol. 50, no. 2, pp. 101–114, 1987.

[8] S. Sabanovic, M. P. Michalowski, and R. Simmons, "Robots in the wild: Observing human-robot social interaction outside the lab," in *Proceedings of the 9th IEEE International Workshop on Advanced Motion Control*. IEEE, 2006, pp. 596–601.

[9] P. Drew, J. Chatwin, and S. Collins, "Conversation analysis: a method for research into interactions between patients and health-care professionals," *Health Expectations*, vol. 4, no. 1, pp. 58–70, 2001.

[10] A. Yamazaki, K. Yamazaki, M. Burdelski, Y. Kuno, and M. Fukushima, "Coordination of verbal and non-verbal actions in humanrobot interaction at museums and exhibitions," *Journal of Pragmatics*, vol. 42, no. 9, pp. 2398–2414, 2010.

[11] H. W. Park and A. Howard, "Providing tablets as collaborative-task workspace for human-robot interaction," in *Proceedings of the 8th ACM/IEEE international conference on Human-robot interaction*. IEEE Press, 2013, pp. 207–208.

[12] I. Leite, A. Pereira, C. Martinho, and A. Paiva, "Are emotional robots more fun to play with?" in *Proceedings of the 17th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*. IEEE, 2008, pp. 77–82.

[13] M. A. Eys, A. V. Carron, M. R. Beauchamp, and S. R. Brays, "Athletes perceptions of the sources of role ambiguity," *Small Group Research*, vol. 36, no. 4, pp. 383–403, 2005.

[14] G. Lupyan, D. H. Rakison, and J. L. McClelland, "Language is not just for talking: Redundant labels facilitate learning of novel categories," *Psychological Science*, vol. 18, no. 12, pp. 1077–1083, 2007.

[15] P. ten Have, *Doing conversation analysis: A Practical Guide*, 2nd ed. London, UK: SAGE Publications Limited, 2007.

[16] J. M. Atkinson and J. Heritage, "Transcript notation-structures of social action: studies in conversation analysis," *Aphasiology*, vol. 13, no. 4-5, pp. 243–249, 1999.

[17] F. Strayer and M. Trudel, "Developmental changes in the nature and function of social dominance among young children," *Ethology and Sociobiology*, vol. 5, no. 4, pp. 279–295, 1984.

[18] P. H. Hawley, "Social dominance and prosocial and coercive strategies of resource control in preschoolers," *International Journal of Behavioral Development*, vol. 26, no. 2, pp. 167–176, 2002.

[19] M. Heimann, K. E. Laberg, and B. Norden, "Imitative interaction increases social interest and elicited imitation in non-verbal children with autism," *Infant and Child Development*, vol. 15, no. 3, pp. 297–309, 2006.

[20] R. B. van Baaren, R. W. Holland, B. Steenaert, and A. van Knippenberg, "Mimicry for money: Behavioral consequences of imitation," *Journal of Experimental Social Psychology*, vol. 39, no. 4, pp. 393–398, 2003.

[21] A. Pereira, C. Martinho, I. Leite, and A. Paiva, "iCat, the chess player: the influence of embodiment in the enjoyment of a game," in *Proceedings of the 7th international conference on Autonomous agents and multiagent systems*, vol. 3. International Foundation for Autonomous Agents and Multiagent Systems, 2008, pp. 1253–1256.

[22] D. Machaj, C. Andrews, and C. North, "Co-located many-player gaming on large high-resolution displays," in *Proceedings of the International Conference on Computational Science and Engineering*, vol. 4, 2009, pp. 697–704.

[23] J. Scheirer, R. Fernandez, J. Klein, and R. W. Picard, "Frustrating the user on purpose: a step toward building an affective computer," *Interacting with computers*, vol. 14, no. 2, pp. 93–118, 2002.