# Support by Participatory Sense-Making in Robot Therapy for Children with Autism.

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**ABSTRACT**
People with Autism Spectrum Condition have issues navigating social situations. Typically, in therapy, robots teach people with ASC desirable social interaction according to traditional models which focus on the cognitive, rather than emotions or intuitions. Participatory sense-making could provide new insights in the theory of this area. To establish participatory sense-making, joint attention needs to be reached. We analyzed footage of a robot expressing emotions of therapy sessions in Serbia, during which a child with ASC has to guess the emotion. We used conversation analysis from the perspective of participatory sense-making with a focus on body language. Not speaking the language allowed us to focus on the body language without distraction. During the analysis 3 types of situations occurred: participatory sense-making, missed opportunity and non-compliance. The results showed that more elements of coordination lead to better participatory sense-making was established. We argue that a robot could provide support for a therapist when establishing participatory sense-making.

**Author Keywords**
Human robot interaction; autism; conversation analysis; robot design; interaction design

**INTRODUCTION**
Autism Spectrum Condition (ASC) is a condition where people have issues communicating and have trouble with social interactions [1]. Robots can be used in therapy for people with ASC to teach desirable social interaction and communication rules to use in social situations [2][3][4]. Usually this happens according to traditional models which focus on cognitive methods. For example by teaching people with ASC to pick up on signs to then analyse and interpret them. This can be very intensive and tiring for the person receiving therapy [1][5].
We are interested in the more subtle, but important aspects of communication: non-verbal, social signals that participants in a social interaction are exchanging. The participants adapt these signals based on their experience of the interaction with the others. They are in tune, which is important for successful social contact. If a social robot is to interact with a child socially, it could use these non-verbal signals to be easier to understand for the child.
We are using footage of a therapy session in which a therapist uses a robot to express different emotions to help teach a child on the autism spectrum how to recognize these emotions. Specifically, we looked at non-verbal interactions in this footage. By seeing how the therapist establishes participatory sense-making [6], a theory that will be explained further below, and joint attention, we can find interaction design implications for supportive robot behaviour during child therapy.

**Participatory Sense-Making**
Participatory sense-making is part of, or requires, social interaction as it can only happen with two or more people. De Jaegher and Paoli describe it as follows: “the regulated coupling between at least two autonomous agents, where the regulation is aimed at aspects of the coupling itself so that it constitutes an emergent autonomous organization in the domain of relational dynamics, without destroying in the process the autonomy of the agents involved (though the latter’s scope can be augmented or reduced) [6, pp.493].”

**Figure 1.Zeno (R35) by Robokind.**

| Timecode | Child | Therapist | Robot | Participatory Sense-Making | Elements of Coordination |
|---|---|---|---|---|---|
| 1 | Looks at robot | Points at robot | Idle | Joint attention | Anticipation |

**Table 1.Table for logging every participants actions and the level of participatory sense-making**

According to this definition coordination is an indication and important part of participatory sense-making. Coordination, according to de Jaegher and Paoli [6] exists out of different elements: mirroring, anticipation, imitation and synchronization. The perspective of participatory sense-making could provide new insight and help answer our question: How can we design robot behaviour to establish participatory sense-making in the context of therapy?

## METHOD

In this study we analyzed the recordings of 5 participants, aged 9-12 (M = 9.6). The participants have varying degrees of ASC.
The sessions involved a therapist, a child with autism and a robot, Zeno by Robokind, pictured in figure 1. All of which were considered participants when analysing the sessions. The children and the therapist are from Serbia.
We focus on conversation analysis as described by Dickerson, Robins and Dautenhahn [7], from the perspective of participatory sense making. Dickerson et al. discuss a similar situation where they analyze interaction between a child with ASC, a robot and a co-present adult through conversation analysis [7]. We implement conversation analysis by its main idea. We go in without predefined indicators, as we might miss important events. Dickerson et al. also state that it is important to put behavior in sequential context, to better understand and analyze the moment, the cause and the aftermath.
We, the researchers do not understand Serbian. Not understanding the spoken language was useful in this case, as it allowed us to focus on body language without the distraction of spoken language or implication of meaning and context.
Firstly we collected stills from significant moments in the footage, where participatory sense-making was or was not established. These stills were used for discussion and a decision on which moments to fully analyze. These moments were looked at frame by frame, while at the same time logging the actions of the therapist, the child, the robot and the status of participatory sense-making, as well as the different aspects of coordination in a table, see table 1.

## RESULTS

### Participatory Sense-Making

Figure 2 describes an almost perfect example of establishing participatory sense-making as found in the video. We see that all four elements of coordination, necessary to establish participatory sense-making as described by de Jaegher [6], are present: the therapist looks at the robot and points (anticipation), the child and therapist share an object of attention (synchronization), the takes its turn pointing (mirroring, imitation). The practice of establishing participatory sense-making is not something that works out perfectly often, or happens in this therapy context at all.

### Missed Opportunity

In figure 3 we see that even though the child responds to the therapist celebrating, there doesn't seem to be participatory sense-making or even joint attention.
In this situation participatory sense-making between the child and therapist isn't reached, partly because the child isn't looking at the therapist while interacting. If we look at the elements of coordination, anticipation towards the therapist seems to be missing on the child's side. The child was not paying attention to the body language of the therapist, but was paying attention to the robot. This makes it harder for the child to anticipate the therapists next action and imitate or mirror them. We could argue that the child's anticipation is directed at the robot and since the robot and child are both celebrating they are engaging in a form of participatory sense-making. The robot could help participatory sense-making between the child and therapist in this situation, by redirecting the child's attention to the therapist.

### Non-Compliance

Figure 4 shows a moment of non-compliance. It is unclear why pointing doesn't work here, where it did work before. In this case the child was in distress and not sitting at the table like the child in the other case, they seem to have different needs. This child needed to calm down first and therefore wasn't open to participate in the therapy.
The elements of coordination do not seem to build up in this situation. In order to build to participatory sense-making in this situation, the therapist needs to calm down the child and get it

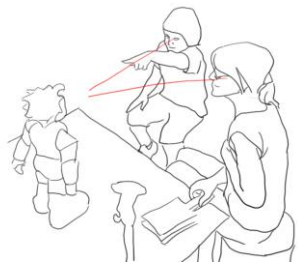

**Figure 2.Participatory sense-making The child and therapist engage in participatory sense-making.**

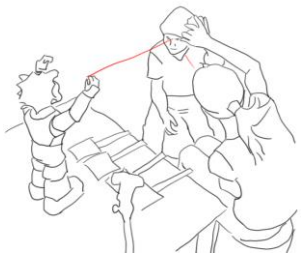

**Figure 3.A missed opportunity. The child joins in with the therapist, but the robot holds his attention.**

**Figure 4.Non-compliance during therapy. The child is annoyed and walks out of the frame**

interested in participating. The robot could help with the latter, by grabbing the child's attention with its movements. If the therapist were to recognize that the child's distress is caused by the robot, she would turn it off.
The three types of situations described above (participatory sense-making, missed opportunity and non-compliance) should give us more insight in what situation we'd have to tackle and how to design a robot for them that helps to establish participatory sense-making.

## DISCUSSION

The robot used in this study was designed as a conversational agent with the look of a puppet. Its design puts focus on verbal communication. It can show facial expressions, but these are used in the therapy as stimuli in an explicit emotion recognition task. Instead, we were interested in the implicit ways in which facial expression, gestures and posture influence the shared activity of making sense of the situation, called participatory sense-making. According to de Jaegher and Paoli [6] this is a kind of sense-making that does not draw on explicit recognition and interpretation of another person's behaviour, but rather on an ongoing dynamic process of interactive coupling, 'in action'. Participatory sense-making is happening in the current situation, but is quite rare. However, there are opportunities to support participatory sense-making.
We will now use our observations to discuss what would be the requirements for a robot to be able to effectively support such dynamic, ongoing, participatory sense-making.

### Physical requirements

The current robot is designed to 'look' like a person and the main mode of interaction is 'talk', but it has not really been optimized as a physical object to touch and explore physically. We have seen that the children seem to like to touch the robot and this could help gain and maintain their attention during the therapy. Therefore, the robot would have to be sturdy and pickup able. This would also be useful for initially establishing joint attention. The ability to touch the robot could also create a relation between the child and the robot, that doesn't exist between the therapist and the child. When they want to lock out the therapist they still might want play with the robot, as it is an object.

### Joint attention

During the therapy sessions, joint attention seems to be easily lost, but has to be regained or maintained to establish participatory sense-making. It would be useful if the robot could recognize when joint attention is lost. To reach joint attention, a minimum of one of the elements of coordination is necessary. Often this seems to be anticipation. We could use robot behaviour to create anticipation as a first step towards joint attention and participatory sense-making.
For example, robot movement re-establishes attention. In the current format this is done during the celebratory moment. This is probably a good moment as it re-establishes attention right before the next assignment.

### Participatory Sense-making

Once joint attention is established the robot could work on participatory sense-making. This seems to happen when the child and therapist engage in all four described elements of participatory sense-making. These elements seem to build up slowly. The exact triggers of some of the elements of coordination and therefore participatory sense-making are still unclear.

In order to establish and continue in participatory sense-making the robot will have to recognize when a child didn't understand or missed a cue and repeat an action. It will also have to be able to backtrack to a state of joint attention, in case participatory sense-making is lost.
A robot could invite a child to mirror it or mirror a therapist, for the latter the robot could copy the therapist. The same goes for imitation and synchronization.
For a robot to engage in participatory sense-making it would need a better understanding of what is going on. Lucy Suchman [8] analyzed two people who were having a conversation, they were engaging in participatory sense-making, while operating a copy machine. She observed that the copy machine has little knowledge about the interactions between the two people operating it. The copy machine has little part in the sense-making process. The same goes for the robot. If the robot gets a better view on what is going on between the two humans interacting with it, it can respond better to the participatory sense-making process.

## CONCLUSION

The results showed the more elements of coordination the better participatory sense-making was established. To establish participatory sense-making joint attention was necessary. This could be established through pointing or through robot movement. The element of coordination, anticipation, was often established when joint attention was happening. Once joint attention was established, participatory sense-making could be established in similar ways by mirroring or synchronization of the pointing and looking.
In order to improve participatory sense-making between the child and the robot, the robot could be adjusted in the following ways. First, the robot should support the therapist. Second, the robot will have to be sturdy as the children seem to like to touch it. Third, the robot should be capable of recognizing when either joint attention or participatory sense-making is established, as well as when a child is no longer paying attention. Lastly, the robot will have to be able to perform the actions to establish joint attention and participatory sense-making as well.

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## REFERENCES

1. Frith, U. (2008). *Autism: A very short introduction* (Vol. 195). Oxford University Press.
2. Robins, B., Dickerson, P., Stribling, P., & Dautenhahn, K. (2004). Robot-mediated joint attention in children with autism: A case study in robot-human interaction. *Interaction studies*, *5*(2), 161-198.
3. Robins, B., Dautenhahn, K., & Dickerson, P. (2009, February). From isolation to communication: a case study evaluation of robot assisted play for children with autism with a minimally expressive humanoid robot. In *Advances in Computer-Human Interactions, 2009. ACHI'09. Second International Conferences on* (pp. 205-211). IEEE.
4. Dautenhahn, K., & Werry, I. (2004). Towards interactive robots in autism therapy: Background, motivation and challenges. *Pragmatics & Cognition*, *12*(1), 1-35.
5. De Jaegher, H. (2013). Embodiment and sense-making in autism. *Frontiers in integrative neuroscience*, *7*, 15.
6. De Jaegher, H., & Di Paolo, E. (2007). Participatory sense-making.*Phenomenology and the cognitive sciences*, *6*(4), 485-507.
7. Dickerson, P., Robins, B., & Dautenhahn, K. (2013). Where the action is: A conversation analytic perspective on interaction between a humanoid robot, a co-present adult and a child with an ASD. *Interaction Studies*, *14*(2), 297-316.
8. Suchman, L. A. (1987). *Plans and situated actions: The problem of human-machine communication*. Cambridge university press.