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How Turn-Timing Can Inform about Becoming Familiar with a Task and Its Changes: A Study of Shy and Less Shy Four-Year-Old Children

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Abstract

In novel situations, the productive communicative behavior of shy children can require more time than that of their less shy peers. Investigating 14 preschoolers, we asked which situational demands and changes contribute to the individual processing. Whereas children's shyness was measured by a standardized questionnaire given to caregivers, their processing of situational demands was measured by their nonverbal turn-timing over two sessions with a social robot. We focused on how children respond to their partner when the situation changes in comparison to a familiar one. Our results, based on grouping children by shyness level, indicate that while differences in turn-timing were not significant, shy children's turn-timing was consistently characterized by higher latencies compared to the less shy children across sessions and tasks, particularly when introduced to a new task. Correlational analysis, accounting for the full shyness spectrum, confirmed this trend. Findings clarify how children perceive a situation and situational changes.

Keywords: multimodal turn-taking; turn-timing; shyness; child–robot interaction; task changes; action latency

Introduction

Turn-taking is a fundamental skill for studying the principles of successful communication in any context. It reflects the human skill to respond contingently to each other in a meaningful way. Much attention has been paid to study of both the phenomenon in general and its particular features (Casillas, Bobb, & Clark, 2016; Kaye, 1977; Levinson, 2015; Riest, Jorschick, & de Ruiter, 2015; Schegloff, 2020; Stivers et al., 2009). Previous research analyzing a turn-taking processes, has often emphasized its complexity, meaning that understanding of the seemingly simple idea of "whose turn it is and when it should start" involves numerous "subtasks". Examples of "subtasks" include the rapid comprehension of the received information, its processing, and decision on the appropriate response in the form of an utterance or action, asking for additional information for the effective turn, etc. (Riest et al., 2015; Wilson & Wilson, 2005).

It is natural that the turn-taking process is not always smooth, as it can be affected due to different reasons, resulting in variations of turn-timing. Longer processing of the received information may be one of the possible reasons for this. It may also reflect a particular processing that could be typical for a group of people who are dealing with specific situational demands. One such group may include people who can be characterized by a shy temperament.

Shyness and Its Effect on Turn-Taking

Shyness can be broadly defined as the presence of anxiety or inhibition in novel social situations, typically involving several components: global feelings of emotional arousal, acute public self-consciousness, and distress about being negatively evaluated by others, as well as observable behaviors such as quietness, gaze aversion, and social withdrawal (APA Dictionary of Psychology, 2018). The study of temperamental traits, such as shyness, is of particular interest because it is highly prevalent and informs us about individual differences. Typically concentrated on the (verbal or nonverbal) communicative behaviors of shy children, developmental research has extensively demonstrated that shyness can lead to a tendency for individuals to engage in reduced verbal interactions in unfamiliar social situations (Crozier & Badawood, 2009). In addition, children have been shown to express their shyness by using nonverbal signals such as coy smiles or by avoiding eye contact (Colonnesi et al., 2017; Reddy, 2005). What is apparent in these studies is that children's communicative behaviors are frequently studied in isolation from their partners' behaviors. Turn-taking, in contrast, appears to be a phenomenon that requires analysis in relation to the partner. How shy versus less shy children may differ in their fundamental turn-taking behavior has received little attention so far.

Turn-taking is based on responsivity to the partner and is also reflecting humans' ability to adapt to each other and to a situation (Van de Pol et al., 2023). Importantly, recently, multimodal turn-taking has been studied to do justice to the fact that nonverbal responses can follow upon verbal requests and vice versa (Rohlfing et al., 2019). With regard to how shy children respond to requests, recent research has emphasized a positive and socially adaptive function (Colonnesi, Nikolić, & Bögels, 2020; Reddy, 2005). For example, it has been suggested that in stressful social situations, shy children may exhibit high levels of attentional control, being able to appropriately regulate and shift their attentional focus in response to situational demands.

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Along these lines, emerging interest has turned to the effects of shyness on children's unfolding interactional behavior as they become more familiar with contextual conditions to shed light on the adaptive processes connected to children's shyness. Tolksdorf and colleagues (2021a) examined the behavior of preschool children in relation to their temperamental shyness, looking at children's expressions of pleasure (e.g., smiling) and discomfort (e.g., frowning) over the course of four consecutive sessions involving multiple learning and testing situations of novel words. This was a child–robot interaction study to control for the effect of the partner. Interestingly, whereas the authors found that the shyer children generally remained less expressive in their positive reactions over time, analysis of the children's expressions of discomfort revealed that when the shy children had the opportunity to familiarize themselves with a particular contextual environment (e.g., the first learning or testing situation), their reactions of discomfort were significantly lower than those of the less shy children. The authors argued that this faster decrease in negative reactions may indicate a familiarization effect, which was particularly pronounced in the shy children and reflected that the children became accustomed to the associated demands within the specific situation. These findings suggest that, depending on contextual conditions, shy children may adapt differently to the demands of a particular task.

As mentioned above, one of the informative ways to assess the communicative behavior of partners in relation to each other is to analyze their turn-taking behavior, which has been barely studied so far in relation to children's shyness. To reveal how shy children might differ from their less shy peers in dynamically reacting to novel or changing situations, we analyzed data from an existing child–robot study. With this investigation, we aimed to shed more light on the question of how children perceive a situation and how their coping with situational changes affects their turn-taking processes.

Relevant Work on Becoming Familiar with a Task and Coping with Task Changes

The topic of how people become familiar with a task or cope with task changes and how this relates to their communicative behavior promises to provide insights into how situational models interplay with communicative abilities and behaviors. For children, this interplay may have important implications, as a novel task or changes in the task may impose a higher cognitive load, which may reduce children's communicative abilities in this context. One of the first studies demonstrating familiarization effects with a task was conducted by Farrar and colleagues (1993). In this study, familiarization with a toy set was used to expand children's action knowledge. It was assumed that action knowledge captures cognitive resources that are becoming available for language processing when children familiarize with a task. The results show that the children produced more event-specific verbs in familiar compared to unfamiliar event situations.

In addition, familiarization can affect not only children's but also caregivers' behaviors. As shown in a study by Marcos (1991), familiarization for caregivers allows them to start from a shared knowledge base and refer to shared experiences; they provide information in their reactions to the child's behavior, which in turn can lead to deepening and broadening of the child's knowledge. Moreover, Reder et al. (2015) highlight that less familiar stimuli are more difficult to combine to create new knowledge as they require more working memory resources. In general, familiarization can be considered in the context of learning or teaching something new and helping to understand and recognize it in future. Consequently, some new details added to the already familiar issues can interplay with recognition and adequate reaction to the already known situation. In other words, becoming familiar with something means being able to cope with the specific task quite successfully and not losing the understanding of the learned concept or task, even if the general setting undergoes certain changes.

In the context of our study, we understand a "task" as a set of actions that a child has to perform in order to complete the instructions proposed by the partner, in this case a social robot, and achieve the joint goal. However, a task can be solved in a very individual manner.

Considering shyness as a crucial dimension of individual differences that affects the way children engage in tasks and interactions, there is surprisingly little known about how turn-taking behavior in shy children interplays with small changes in the task and how it might differ from the behavior of their less shy peers. This question is important to clarify as it provides insights into the dynamics of how a situational model is updated individually.

For our investigation, driven by findings from the literature revealing the impact of temperamental characteristics on children's productive behavior, we hypothesized that shy children's nonverbal turn-taking will differ from their less shy peers. However, we found support in the literature for two possible differences that we aimed to explore: since shy children have been described as having a less reactive and more observant temperament, it may well be that they are more sensitive to the task changes (Mink, Henning, & Aschersleben, 2014). Therefore, on the one hand, it is possible that shy children will respond in a similar manner to novel settings, i.e., with longer latency when compared to their less shy peers. On the other hand, once shy children become familiar with the overall setting, small changes may be easier for them to cope with because they may benefit from their increased social understanding and abilities in observing others, which facilitate their social information processing. As a result, they may respond more quickly in comparison to their less shy peers.

Method

For the present work, we drew on data collected as part of a previous investigation examining how children learn a particular linguistic structure cross-situationally within recurrent and varying interactions with a social robot (Tolksdorf, 2024). All data were collected in accordance with university ethics procedures, with permission to use the data in further analyses. These longitudinal data include high-quality video recordings of four sessions over a two-week period capturing interactions between a preschool child and a social robot, each session lasting approximately 20–35 minutes, providing a solid foundation for our analysis.

Each of the video recorded sessions contained several requests from the robotic partner to perform an action (e.g., to uncover an object), which were presented to the child in a consistent and controlled manner. This allowed us to precisely measure the time between the robot's request and the child's onset of action during the interaction.

Since the focus of our analysis was to examine the effect of shyness on children's turn-timing as a function of *changing interactional demands*, we deliberately chose the second and third sessions out of a total of four sessions for our analysis. The rationale for selecting these two sessions was that a subset of the total sample of children were presented with a change in task across these sessions, that is, whereas in the first two sessions, the demands remained the same, in the third session, these children encountered an altered setting. It was precisely this change in the task and its effects on the timing of the children's turns, in light of their shyness, that we were interested in.

Participants

The sample we included in our study comprised 14 preschoolers, typically developing and German-speaking children (6 female, 8 male) aged 4.25–5.83 years (M = 5.19, SD = 0.39). The children in the sample were recruited from the greater Paderborn area (North Rhine-Westphalia, Germany) through local kindergartens, libraries, and newspapers. A caregiver was present during all interactions but did not actively participate in the interaction. In accordance with university ethics procedures for research with children, caregivers provided written consent prior to their children's participation. Children verbally agreed to the participation in the interaction, and they were told that the interaction can be discontinued without any disadvantage to them.

Experimental Procedure and Operationalization of Task Changes

The design of the overall learning situation was guided by existing theoretical concepts of learning, emphasizing that communication is jointly organized by the interaction partners in a multimodal way and towards a goal (Rohlfing et al., 2019). Such a way of interaction is highlighted as we study the children's nonverbal responses (verbal reaction was not required from the participants, their nonverbal reaction is in focus, i.e., uncovering the items) to the robot's requests, expressed both verbally (explaining the task) and nonverbally (pointing at the item). Specifically, within the developed setting, the children were engaged in a storytelling activity with the robotic partner. The story told by the robot to the children included the plot of the robot's journey to the university and the things it saw along the way. This narrative plot served as an overarching contextual framing in which six novel color words were provided as input over the course of the long-term interaction over four consecutive sessions. Importantly, in these sessions, the children actively contributed to the goal of the interaction, and the robot asked them to perform specific actions in each session, such as uncovering or manipulating an object (the dialogue design developed for the child–robot interaction can be found on the OSF: https://osf.io/fc6uw/). As mentioned earlier, in the present study we focused only on the second and third sessions for our analysis, as children were confronted with changing interactional demands raised by the robot across these sessions. Table 1 and Figure 1 provide an overview of the characteristics of the settings that the children experienced during the long-term interaction and in which sessions they were implemented.

Table 1: Characteristics of the situational changes.

Term	Elaboration
General set-up	Children engaged with a robot in a joint storytelling activity in which they learned new color words; caregivers were present but were not actively involved.
Recurring setting (occurred in session 1 and recurred in session 2)	The target referents were objects in pictures. These were hanging on a wall (see Figure 1a). They were covered, and the robot asked the children to uncover them.
Alternating setting (implemented in session 3)	The target referents were objects in pictures, but there was a changed **spatial arrangement** of the target referents (s. Fig. 1b) as well as a changed **goal** of the joint interaction from purely sharing the new words and uncovering the object to the task of helping the robot to put the pictures to a different location (s. Fig. 1c).

In the *recurring setting*, which was presented to the children repeatedly in the first two sessions, the referents of six target words were presented as pictures hanging on the wall. They were covered by a small cloth, and the robot requested the child to uncover each one to reveal the target referent of the novel word. Thus, exactly 6 requests were presented to the child during this setting. In addition, the interactional characteristics of this setting involved establishing a specific dialogical role for the child and the robot with related tasks that involved specific actions. That is, whereas the robot acted as the narrator of the story and asked the child for help in uncovering the objects at certain stages of the story, the child fulfilled the role of a listener and helped the robot to uncover the objects.

In the *alternating setting* implemented in the third session, we drew on work on introducing contextual changes in a learning task (Twomey, Ma, & Westermann, 2018) and changed the interactional characteristics and task demands that children encountered compared to the previously experienced setting. The purpose of the change was to introduce two novel tasks, while keeping the general set-up the same (see Table 1, Figure 1). Specifically, the first change in task involved a different spatial arrangement of the six target referents (see Figure 1b). This altered task was a slight modification of the task that the children had already performed in the two previous sessions, that is, the items were now placed on the floor, requiring a contrasting localization of the referents by the children. Then, the children were involved in a completely novel task, and the interactional demands changed clearly. In this case, after an object was uncovered and the robot told the child the appropriate target word for the referent, the child was now requested to put the picture into the robot's suitcase that was placed next to the robot in that session. Apart from this task framing, the other parameters of the interaction remained the same.

Stimuli

The robot employed in the present study was the NAO robot from Softbank Robotics. Being affordable and well-established, this humanoid robot has been widely used in child–robot interaction studies (e.g., Amirova et al., 2021). It is 58 cm tall and has 25 degrees of freedom. Teleoperation was used to allow the robot to act contingently. We implemented the behaviors in the NAO robot using Choregraphe and used the robot's integrated text-to-speech production, with German language. The referents of the six novel words (noun-adjective compounds such as "coral red [korallenrot]") were presented in pictures each measuring 14.8 × 21.0 cm.

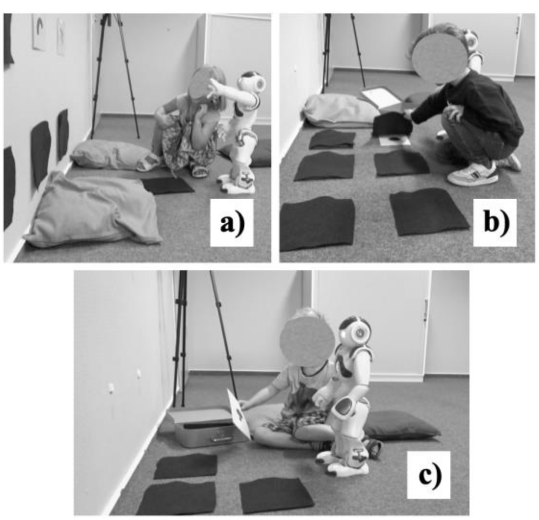

Figure 1: Characteristics of the recurring task of uncovering (a) and the alternating setting introduced in the third session with familiar task but in a changed spatial arrangement (b) and manipulating an object for a novel goal (c).

Coding of Children's Behavior

To analyze children's timing of all turns within the interaction with the robot, we used ELAN and imported the recorded videos. Specifically, the analysis required the development of a coding scheme to cover two key elements: the timing of robot's request and the action latencies of the children, i.e., the time they needed to act properly according to the formulated task. In our developed approach, coders blind to the hypotheses measured the time from the end of each request to the beginning of the child's action in milliseconds. The endings of the robot's requests were marked after the robot had finished its verbal utterance. The onset of the child's action was immediately marked by the child initiating the action, i.e., beginning to reach out to uncover the object. We considered the action only when it coincided with the robot's instruction, though there were very few cases when children were acting independently, uncovering the items without the robot's request. We did not take those cases into consideration. Therefore, the coding provided the latency of the child's action; the timing of the child's actions could have a negative latency if the child initiated the action before the robot had completed the request. Alternatively, there could be a positive latency if the child initiated the action after the robot had completed the request.

Assessment of Children's Shyness

To measure children's shyness, we utilized the Inventory on Integrative Assessment of Child Temperament (IKT, Zentner, 2011), a standardized questionnaire designed for 2- to 8-year-olds. It has been validated with over 4,400 children and aligns well with similar English-language temperament diagnostics, like the CBQ by Rothbart et al. (2001). Based on the integrative approach of Zentner and Bates (2008), the IKT assesses temperament across five dimensions, such as sensory sensitivity, frustration tolerance, or shyness. For each dimension of temperament, the IKT provides a unique score obtained from a questionnaire given to the child's caregiver, who evaluates their child's behavior related to everyday situations (e.g., behavior toward strangers) on a 6-point Likert scale. Since we are interested in the influence of shyness on children's turn-taking behavior, our analysis focuses on this score. Based on the raw scores obtained from the responses to the questions, the predefined scoring procedure of the IKT requires a conversion into percentile ranks in order to allow an adequate interpretation of the child's temperament according to age and gender in relation to the normative sample of the test. The higher the percentile rank value, the shyer the child, with the minimum and maximum values being 0 and 100, respectively. According to the IKT, children scoring above 75 were considered to be markedly shy. Based on these scores, we grouped our sample into less shy ($n = 8$, mean shyness score = 33.33, $SD = 20.14$) and shy ($n = 6$, mean shyness score = 91.67, $SD = 4.71$).

Results

In the analysis of the data, we were interested in investigating how children's turn-taking behavior toward the robotic partner unfolded depending on children's level of shyness and changing tasks over the course of the sessions. Drawing on previous work, we assumed that shy children would either be very adaptive to the changing tasks in an overarching familiar environment and display comparable timing in their actions, or that they would display longer timing than their less shy peers owing to the novelty of the situational conditions. Due to the violation of the assumption of sphericity, we used a nonparametric equivalent to mixed ANOVA: the ANOVA type statistic (ATS) (Akritas, Arnold, & Brunner, 1997; Noguchi et al., 2012). The test statistic is similar to ANOVA's F-tests and exactly meets the α level while being conservative. A key advantage of this approach is that the ATS is robust to skewed, small, and even unequal sample sizes, while still being appropriate for longitudinal data. In addition, ATS provides a relative treatment effect (RTE) which is a measure of effect size based on the actual sample (Noguchi et al., 2012). The value of the relative effect RTE ranges between 0 and 1, whereby the occurrence of 0 and 1 means completely different conditions (e.g., for the shy and less shy children); 0.5 indicates that the conditions do not differ at all (Brunner, Bathke, & Konietschke, 2018; Noguchi et al., 2012). Moreover, the statistical approach of ATS has proven effective for application in developmental studies. (Tolksdorf, Crawshaw, & Rohlfing, 2021b; Viertel, 2019).

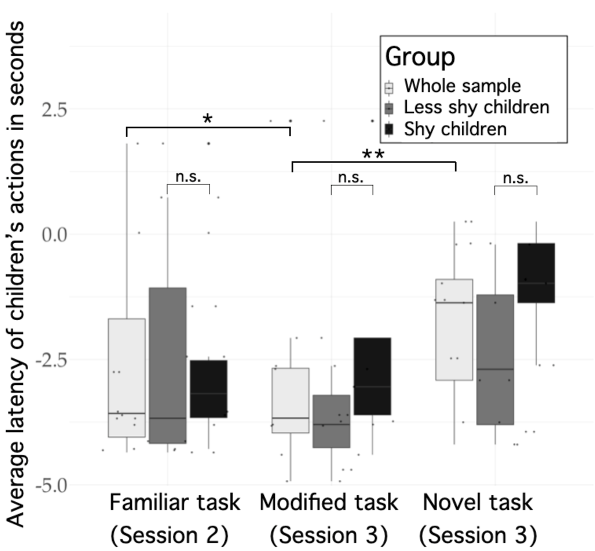

Figure 2: Average latency of the children's turn-taking in response to the robot's request depending on their shyness level, task type, and session. Note: negative values indicate an overlap of turns, while positive values indicate a gap between turns (*$p < 0.05$, **$p < 0.001$).

The ATS revealed a highly significant main effect of time, $F(1.84, \infty) = 15.58$, $p < .001$. The children's actions in response to the robot's request clearly overlapped with the robot's instruction during the already familiar task (Session 2, familiar action, *Mdn* = –3.574, IQR = 2.359, RTE = 0.49). In the third session, the overlap even increased with respect to the modified task, and children showed an increased negative latency when confronted with the slightly altered parameters within the previously known object uncovering task (Session 3, modified action: *Mdn* = –3.765, IQR = 1.845, RTE = 0.36). Multiple post-hoc comparisons showed that children's actions became significantly faster from Session 2 to Session 3, $F(1, \infty) = 9.34$, $p < .05$, even though a slight modification of the task required an adapted action.

Interestingly, we found no significant effect for the shyness group, $F(1, 11.25) = 1.60$, $p = .20$, suggesting that subjects did not differ in the temporal coordination of their actions in response to the robot's turn in terms of their shyness. In particular, the shy children showed a relatively stable level of overlap in their actions during the familiar task in the second session, *Mdn* = -3.179, IQR = 1.139, RTE = 0.51, and the slightly modified task in the third session, *Mdn* = -3.324, IQR = 1.888, RTE = 0.45 (s. Fig. 2). With the new task in the third session, *Mdn* = -0.582, IQR = 1.413, RTE = 0.80, the action latencies of shy children were longer on average by more than 2.7 seconds compared to the previous action, whereas the less shy children demonstrated clearly overlapping actions in response to the robot's requests in the second session during the familiar task, *Mdn* = –3.671, IQR = 3.103, RTE = 0.47, and also in the third session during the modified task, *Mdn* = –3.808, IQR = 1.282, RTE = 0.28. In addition, there was also a reduction in overlap in the group of less shy children in relation to the new task in the third session, *Mdn* = –2.694, IQR = 2.590, RTE = 0.53, although the overlap of actions remained at a higher level than for the shy children.

Overall, summarizing the children's action latencies over the course of the sessions and considering the changing tasks, we found that on the one hand, independent of the shyness groups, there was an increase in overlap when an already familiar task was slightly modified. However, when a novel task was presented to the children, this had a significant effect on children's turn-timing, making it longer. On the other hand, although the difference between the shyness groups did not reach significance, shy children were consistently slower to perform the requested actions compared to the less shy group across all sessions and tasks. This was particularly pronounced when the shy children were confronted with a novel task and performed their action on average more than two seconds later than their less shy counterparts.

In a second step, we aimed to go beyond the dichotomous group comparison and explore how the full range of the shyness spectrum influences children's turn-timing with regard to their action latencies. Informed by theory (Coplan & Weeks, 2009; Farrar, Friend, & Forbes, 1993) and in light of our group comparison findings, we were particularly interested in the relationship between children's degree of shyness and the temporal coordination of their turns when the demands of the interaction were changed in a way that involved introduction of a novel task. We therefore focused on children's action latencies during the third session, when children were confronted with the novel task presented by the robotic partner. The relationship between children's action latencies and their shyness scores (as measured by the IKT) was examined using Pearson product-moment correlation coefficients. This analysis revealed that children's shyness was positively correlated with the time they needed to perform the requested action, $r = .41$, $p = .07$. This positive relationship indicates that the higher the level of children's shyness, the longer the action latencies; conversely, children with lower levels of shyness demonstrated shorter action latencies. In addition, this finding provides support that children with higher levels of shyness adapt differently to changing interactional demands, such as when confronted with a novel task, as reflected in their turn-timing.

Discussion

The advantage of using a robot as an interaction partner is that it provides controlled behavior (Fischer, 2016). In this way, we were able to analyze the effects of changes (alternating setting) that were made to the setting and how they influenced shy versus less shy children's multimodal turn-timing. Our study contributes to the investigation of children's turn-taking in the context of its multimodal nature. In particular, although multimodal turn-taking behavior has been studied in previous works (Kendrick, Holler, & Levinson, 2023; Rohlfing et al., 2019), children's turn-taking with artificial interaction partners have remained relatively unexplored—even less is known about their individual differences influencing the temporal coordination. In this respect, our analysis revealed that during the repeated session with a familiar task, for both shy and less shy children a similar turn-timing in response to the robot's request could be observed. The action time latency was mostly negative, indicating substantial overlap, meaning that the children started their actions before the robot finished its utterance.

In a consecutive session, the setting was altered by introducing a change in the spatial arrangement of the objects (Fig. 2b). Interestingly, children's turn-timing appeared to maintain a similar level of action latencies, independent of the children's temperamental shyness. In fact, we found that participants' overall mean action latency was significantly faster when performing the familiar task, even when some changes in the task occurred. In contrast, the turn-timing changed and was slower when children were presented with a novel task, as it was the case for the last part (Fig. 2c) of the third session. Here, it was not only a different spatial arrangement of the objects encountered, but also the modified request of the robot for a new goal. While there was still an overall overlap between request and action in the novel task, the responses of the shy children in particular had on average 2.7 seconds higher latency compared to the previous task. In contrast, the actions of the less shy children were considerably faster, although the difference between the groups did not reach statistical significance. Further analysis of this trend revealed a positive correlation between children's levels of shyness and their action latencies when considering the entire spectrum of shyness in our sample. This correlation supports previous findings suggesting that shy children can be more inhibited in their productive behavior than less shy children (Cameron, 2009) when facing a novel situation.

Overall, although the findings did not reach significance, our results indicate the possibility that shy children might make use of their finely developed observational skills (Wellman et al., 2011), which allow them to be more sensitive to changes in the situation. Following this line of research, shy children may have a richer analysis of an ongoing situation and more nuanced awareness of its changes. Since in our study, shy children reacted differently to changes in the spatial arrangement of the objects than to changes that also included robot's request and thus changed the task's goal, we suggest that future studies differentiate between situational aspects that are critical to the task and vary them more systematically.

There are some limitations to our approach: Whereas we decided to measure the *action* of the child as a response / turn, another possibility is to consider the *reaction* to the robot's request in form of children's eye/head movements toward a speaker, change in body position, as a preparation for the requested action and to relate the subsequent action to it. This would allow us to address individual differences in performing an action in a faster or slower way. Another limitation concerns control of the child's physical location: Children's position was set by the cushions, on which children sit to be close enough to the items (for equal conditions for all the participants), and in the second half of the experiment NAO asked the children to move to the two items that were located farther. However, there were cases when (some active) children were sitting closer/farther to the items they were asked to uncover.

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References

Amirova, A., Rakhymbayeva, N., Yadollahi, E., Sandygulova, A., & Johal, W. (2021). 10 Years of Human-NAO Interaction Research: A Scoping review. *Frontiers in Robotics and AI, 8*.

American Psychological Association. (n.d.). Shyness. In *APA dictionary of psychology*. Retrieved January 28, 2024, from https://dictionary.apa.org/shyness

Akritas, M. G., Arnold, S. F., & Brunner, E. (1997). Nonparametric hypotheses and rank statistics for unbalanced factorial designs. *Journal of the American Statistical Association, 92*(437), 258–265.

Brunner, E., Bathke, A. C., & Konietschke, F. (2018). *Rank and pseudo-rank procedures for independent observations in factorial designs: Using R and SAS*. Springer International Publishing.

Cameron, C.A. (2009). Associations between shyness, reluctance to engage, and academic performance. *Infant and Child Development, 18*. 299–305.

Casillas, M., Bobb, S. C., & Clark, E. V. (2016). Turn-taking, timing, and planning in early language acquisition. *Journal of Child Language, 43*(6), 1310–37.

Colonnesi, C., Nikolić, M., & Bögels, S. M. (2020). Development and psychophysiological correlates of positive shyness from infancy to childhood. In L. A. Schmidt & K. L. Poole (Eds.), *Adaptive Shyness: Multiple Perspectives on Behavior and Development*. Springer International Publishing.

Colonnesi, C., Nikolić, M., de Vente, W., & Bögels, S. M. (2017). Social anxiety symptoms in young children: Investigating the interplay of theory of mind and expressions of shyness. *Journal of Abnormal Child Psychology*, *45*(5), 997–1011.

Coplan, R. J., & Weeks, M. (2009). Shy and soft-spoken: Shyness, pragmatic language, and socio-emotional adjustment in early childhood. *Infant and Child Development*, *18*(3), 238–254.

Crozier, W. R., & Badawood, A. (2009). Shyness, vocabulary and children's reticence in Saudi Arabian preschools. *Infant and Child Development*, *18*(3), 255–270.

Farrar, M. J., Friend, M. J., & Forbes, J. N. (1993). Event knowledge and early language acquisition. *Journal of Child Language*, *20*(3), 591–606.

Fischer, K. (2016). Robots as confederates: How robots can and should support research in the humanities. In J. Seibt, M. Norskov, & S. S. Andersen (Eds.), *What social robots can and should do: Proceedings of robophilosophy 2016 / transor 2016*. IOS Press.

Kaye, K. (1977). Toward the origin of dialogue. In H. R. Schaffer (Ed.), *Studies in mother-infant interaction*. London: Academic Press.

Kendrick, K. H., Holler, J., & Levinson, S. C. (2023). Turn-taking in human face-to-face interaction is multimodal: gaze direction and manual gestures aid the coordination of turn transitions. *Philological Transactions of the Royal Society B: Biological Sciences, 378*, 1875.

Levinson, S. C. (2015). Turn-taking in human communication – Origins and implications for language processing. *Trends in Cognitive Science*, *20*(1), 6–14.

Marcos, H. (1991). How adults contribute to the development of early referential communication? *European Journal of Psychology of Education, 6*(3), 271–282.

Mink, D., Henning, A., & Aschersleben, G. (2014). Infant shy temperament predicts preschoolers Theory of Mind. *Infant Behavior and Development, 37*(1), 66–75.

Noguchi, K., Gel, Y. R., Brunner, E., & Konietschke, F. (2012). nparLD: An R software package for the nonparametric analysis of longitudinal data in factorial experiments. *Journal of Statistical Software*, *50*(12), 1–23.

Reddy, V. (2005). Feeling shy and showing-off: Self-conscious emotions must regulate self-awareness. In J. Nadel & D. Muir (Eds.), *Emotional development: Recent research advances*. Oxford Univ. Press.

Reder, L. M., Liu, X. L., Keinath, A., & Popov, V. (2015). Building knowledge requires bricks, not sand: The critical role of familiar constituents in learning. *Psychonomic Bulletin and Review*, *23*(1), 271–277.

Riest, C., Jorschick, A. B., & de Ruiter, J. P. (2015). Anticipation in turn-taking: mechanisms and information sources. *Frontiers in Psychology, 6*, 89.

Rohlfing, K. J., Leonardi, G., Nomikou, I., Rączaszek-Leonardi, J., & Hüllermeier, E. (2019). Multimodal turn-taking: Motivations, methodological challenges, and novel approaches. *IEEE Transactions on Cognitive and Developmental Systems*, *12*(2), 260–271.

Rothbart, M. K., Ahadi, S. A., Hershey, K. L., & Fisher, P. (2001). Investigations of temperament at three to seven years: The children's behavior questionnaire. *Child Development*, *72*(5), 1394–1408.

Schegloff, E. A. J. (2000). Overlapping talk and the organization of turn-taking for conversation. *Language in Society, 29* (1), 1–63.

Stivers, T., Enfield, N. J., Brown, P., Englert, C., Hayashi, M., Heinemann, T., Hoymann, G., Rossano, F., de Ruiter, J. P., Yoon, K.-E., & Levinson, S. C. (2009). Universals and cultural variation in turn-taking in conversation. *Proceedings of the National Academy of Sciences of the United States of America, 106*(26), 10587–10592.

Tolksdorf, N. F., Viertel, F., & Rohlfing, K. J. (2021a). Do shy children interact differently when learning language with a social robot? An analysis of preschool children's interactional behavior and word learning. *Frontiers in Robotics and AI, 8*, 676123, 1–14.

Tolksdorf, N. F., Crawshaw, C. E., & Rohlfing, K. J. (2021b). Comparing the effects of a different social partner (social robot vs. Human) on children's social referencing in interaction. *Frontiers in Education, 5*, 569–615.

Tolksdorf, N. F. (2024). *Word learning with social robots: The influence of a systematic variation of the pragmatic frame on the long-term learning of morphologically complex words in preschool children*. Narr Francke Attempto.

Twomey, K. E., Ma, L., & Westermann, G. (2018). All the right noises: Background variability helps early word learning. *Cognitive Science*, *42*(2), 413–438.

Van de Pol, J., Van Braak, M., Pennings, H. J. M., Van Vondel, S., Steenbeek, H., & Akkerman, S. (2023). Towards a conceptual framework of adaptivity in face-to-face-interaction: An interdisciplinary review of adaptivity concepts. *Annals of the International Communication Association*, *47*(1), 1–19.

Viertel, F. E. (2019). *Training of visual perspective-taking (level 1) by means of role reversal imitation in 18-20-month-olds with particular regard to the temperamental trait shyness*. Doctoral dissertation, Paderborn University.

Wellman, H. M., Lane, J. D., LaBounty, J., & Olson, S. L. (2011). Observant, nonaggressive temperament predicts theory-of-mind development. *Developmental Science, 14*(2), 319–326.

Wilson, M. & Wilson, T. P. (2005). An oscillator model of the timing of turn-taking. *Psychonomic Bulletin and Review*, *12*(6), 957–968.

Zentner, M. (2011). *Inventar zur integrativen Erfassung des Kind-Temperaments*. Huber Verlag.

Zentner, M., & Bates, J. E. (2008). Child temperament: An integrative review of concepts, research programs, and measures. *International Journal of Developmental Science*, *2*(1-2), 7–37.