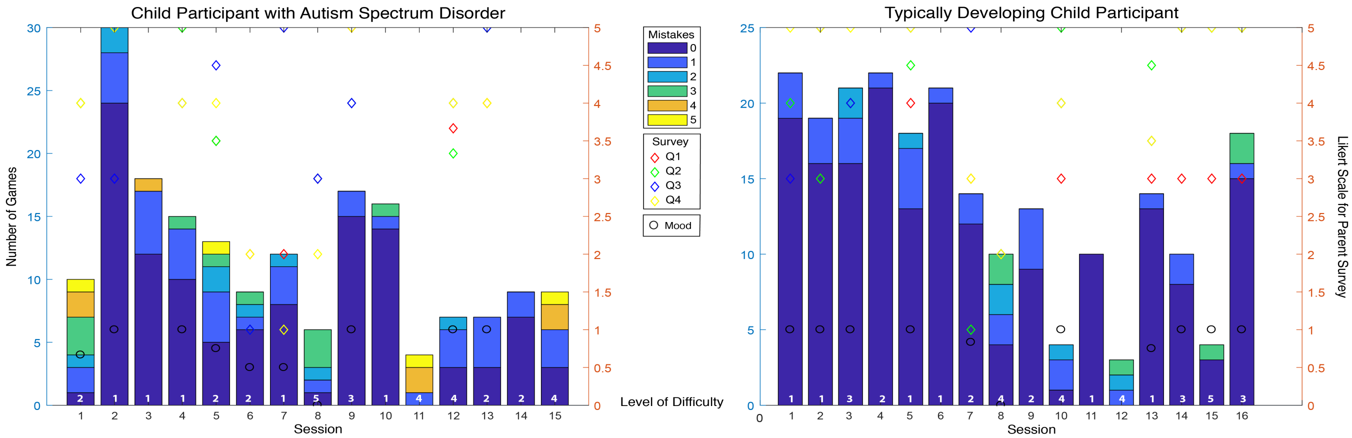


**Figure 1:** The bar graph shows the mistakes made for each sibling per interaction session as well as the total number of games and difficulty level played in that session. Overlaid are the results from the five-point Likert Scale parent surveys and the child's computed mood.

child with ASD interacted with the SAR system 15 times for $9.904 \pm 4.002$ minutes and the sibling interacted 16 times for $10.142 \pm 4.403$ minutes. The study produced over five hours of recorded interaction, a comprehensive analysis of which would extend far beyond the scope of this report. Thus, we focus our analysis on the child participants' longitudinal performance and survey data; namely, we discuss the need for personalization and the value of long-term, situated interaction.

Though the child participants were in the same school year, Figure 1 shows that there were clear differences in their aptitude with respect to the games. Overall, both children completed a similar number of games at similar difficulty levels with a generally positive mood. However, the child with ASD made three or more mistakes more frequently than the TD sibling ($p < 0.05$). Additionally, for both children, we found the number of games completed to be negatively correlated with the difficulty level ($p < 0.01$) and positively correlated to games completed with no mistakes ($p < 0.001$). While this result is intuitive, as it takes less time to complete easier games, it is important to note that difficulty level was the only significant factor found. Over the course of the intervention, both children completed fewer games ($p < 0.05$) and with fewer than two mistakes ($p < 0.05$). This may indicate increased aptitude as well as decreased interest in the games over time.

Through our weekly interviews, we found that the parent felt increasingly more comfortable leaving the children to interact independently with the SAR system. The parent also reported that the SAR system afforded time to focus on other tasks while the child remained socially and educationally engaged with the SAR system. However, only 51.79 percent of the intervention was annotated as purely dyadic ($k > 0.9$); the child participant and SAR system were in frequent presence of other people. This argues for conducting SAR research in realistic environments, outside the context of dyadic interaction and laboratory settings.

In our post-intervention interview, both child participants reported that they would like the SAR system to stay in their home for longer, even after a month of interacting with educational games. Such positive feedback from participants supports the promise of long-term engagement through SAR.

## 5 CONCLUSION

In this report, we presented some preliminary results of a month-long, in-home case study of a fully autonomous SAR system designed for children with ASD. Specifically, this case study demonstrates the importance of personalization for children with varying needs and illuminates some effects of long-term, family-situated interventions on user acceptance. The deployment of a fully autonomous SAR system in a home for 30 days pushes the boundaries of SAR, HRI, and broader robotics research. We are continuing to deploy long-term, in-home case studies with this system to gain further insights into the potential of SAR for children with ASD.

## REFERENCES


[1] Timothy W Bickmore and Rosalind W Picard. 2005. Establishing and maintaining long-term human-computer relationships. *ACM Transactions on Computer-Human Interaction (TOCHI)* 12, 2 (2005), 293–327.

[2] Deborah L Christensen, Deborah A Bilder, Walter Zahorodny, Sydney Pettygrove, Maureen S Durkin, Robert T Fitzgerald, Catherine Rice, Margaret Kurzius-Spencer, Jon Baio, and Marshalyn Yeargin-Allsopp. 2016. Prevalence and characteristics of autism spectrum disorder among 4-year-old children in the autism and developmental disabilities monitoring network. *Journal of Developmental & Behavioral Pediatrics* 37, 1 (2016), 1–8.

[3] Caitlyn Clabaugh, Gisele Ragusa, Fei Sha, and Maja Matarić. 2015. Designing a socially assistive robot for personalized number concepts learning in preschool children. In *Development and Learning and Epigenetic Robotics (ICDL-EpiRob), 2015 Joint IEEE International Conference on.* IEEE, 314–319.

[4] David Feil-Seifer and Maja J Mataric. 2005. Defining socially assistive robotics. In *Rehabilitation Robotics, 2005. ICORR 2005. 9th International Conference on.* IEEE, 465–468.

[5] David Feil-Seifer and Maja J Matarić. 2009. Toward socially assistive robotics for augmenting interventions for children with autism spectrum disorders. In *Experimental robotics.* Springer.

[6] Carole A Kubota and Roger G Olstad. 1991. Effects of novelty-reducing preparation on exploratory behavior and cognitive learning in a science museum setting. *Journal of research in Science Teaching* 28, 3 (1991), 225–234.

[7] Tara A Lavelle, Milton C Weinstein, Joseph P Newhouse, Kerim Munir, Karen A Kuhlthau, and Lisa A Prosser. 2014. Economic burden of childhood autism spectrum disorders. *Pediatrics* 133, 3 (2014), e520–e529.

[8] Y. F. E. Short, Dale Short, and Maja J Matari', 2017. Sprite: Stewart platform robot for interactive tabletop engagement. *Department of Computer Science, University of Southern California,âĂİ Tech Report* (2017).