Physical & Occupational Therapy In Pediatrics

ISSN: 0194-2638 (Print) 1541-3144 (Online) Journal homepage: www.tandfonline.com/journals/ipop20

Using Multitouch Collaboration Technology to Enhance Social Interaction of Children with High-Functioning Autism

Eynat Gal, Liron Lamash, Nirit Bauminger-Zviely, Massimo Zancanaro & Patrice L. (Tamar) Weiss

To cite this article: Eynat Gal, Liron Lamash, Nirit Bauminger-Zviely, Massimo Zancanaro & Patrice L. (Tamar) Weiss (2016) Using Multitouch Collaboration Technology to Enhance Social Interaction of Children with High-Functioning Autism, Physical & Occupational Therapy In Pediatrics, 36:1, 46-58, DOI: 10.3109/01942638.2015.1040572

To link to this article: https://doi.org/10.3109/01942638.2015.1040572

Published online: 30 Sep 2015.

Physical & Occupational Therapy in Pediatrics, 36(1):46–58, 2016

ISSN: 1541-3144 print / 1541-3144 online
DOI: 10.3109/01942638.2015.1040572

Using Multitouch Collaboration Technology to Enhance Social Interaction of Children with High-Functioning Autism

Eynat Gal[1,*], Liron Lamash[1], Nirit Bauminger-Zviely[2], Massimo Zancanaro[3], & Patrice L. (Tamar) Weiss[1]

[1]University of Haifa, Haifa, Israel, [2]Bar-Ilan University, Ramat Gan, Israel, [3]Fondazione Bruno Kessler (FBK), Trento, Italy

ABSTRACT. *Aims*. Children with high-functioning Autism Spectrum Disorder (HFASD) have major difficulties in social communication skills, which may impact their performance and participation in everyday life. The goal of this study was to examine whether the StoryTable, an intervention paradigm based on a collaborative narrative, multitouch tabletop interface, enhanced social interaction for children with HFASD, and to determine whether the acquired abilities were transferred to behaviors during other tasks. *Methods*. Fourteen boys with HFASD, aged 7–12 years, participated in a 3-week, 11-session intervention. Social interactions during two nonintervention tasks were videotaped at three points in time, one prior to the intervention (pre), a second immediately following the intervention (post) and a third three weeks after the intervention (follow-up). The video-recorded files were coded using the Friendship Observation Scale to ascertain the frequencies of positive and negative social interactions and collaborative play. Differences in these behaviors were tested for significance using nonparametric statistical tests. *Results*. There were significantly higher rates of positive social interactions and collaborative play, and lower rates of negative social interactions following the intervention suggesting generalization of the social skills learned during the intervention. Improvement was maintained when tested three weeks later. *Conclusion*. These findings provide support for the use of collaborative technology-based interventions within educational settings to enhance social interaction of children with HFASD.

KEYWORDS Children, high-functioning autism spectrum disorders, social interaction, social intervention, technology

INTRODUCTION

Autism spectrum disorder (ASD) is a complex neurobiological disorder with symptoms that seriously impair the child's social interaction–communication capabilities

Address correspondence to: Eynat Gal, Department of Occupational Therapy, University of Haifa, Mount Carmel, Haifa 31905, Israel (E-mail: egal@univ.haifa.ac.il).

(Received 28 May 2014; accepted 27 February 2015)

and repertoire of activities and interests (Diagnostic and Statistical Manual of Mental Disorders, DSM-V; American Psychiatric Association, 2013).

Social interaction is defined as a reciprocal process in which children effectively initiate and respond to social stimuli presented by their peers (Corbett et al., 2014 (Positive social interaction with peers comprises a major component of typically developing children's social competence (DeRosier, 2004). While they are cognitively and verbally capable, children with high-functioning autism spectrum disorder (HFASD) encounter problems initiating and maintaining interactions with peers during social activities or games (Beukelman and Miranda, 2013). They tend to show more parallel play rather than social or coordinated play (Gal et al., 2009) due to weak prosocial behaviors such as sharing, collaborating, and negotiating (Bauminger, 2002).

Children who have poor interaction skills with peers are considered to be at risk for loneliness and social adjustment difficulties (Hay et al., 2004). The deprivation in play associated with impaired social skills and reduced engagement in environmental contexts may result in secondary psychological disabilities (e.g., poor self-esteem, poor social adjustment) and other consequences (e.g., unemployment) that persist into adulthood (Law et al., 2005; Missiuna et al., 2012). Occupational therapists often focus intervention in the school system on coping skills in different social environments (e.g., classroom, recess) to facilitate the socialization of children with disabilities (Richardson, 2002).

During the past decade, technology-based assessment and intervention have been increasing for people with ASD (Grynszpan et al., 2005). In particular, there are a growing number of applications that aim to improve social and communication skills, including learning activities based on multimodal computer interfaces (e.g., Bosseler and Massaro, 2003), video modeling (e.g., Dowrick, 2000), virtual reality (e.g., Parsons et al., 2006), robotics (e.g., Dautenhahn, 2003), and shared active surfaces (Bauminger-Zviely et al., 2013; Gal et al., 2005; Gal et al., 2009).

Multiuser "tabletops" are an example of a technology that can be programmed to enhance social interaction, use of vocabulary, and communication abilities of children and adults with ASD (Zancanaro, 2012). These devices allow simultaneous interaction by multiple users on the same large screen-like surface. They provide direct manipulation of digital objects through touch, thereby reducing the barrier between the user and the interface (Piper et al., 2006), and are large enough to allow multiple users to collaborate without crowding. Additionally, they can be programmed to require joint actions by pairs of users (Morris et al., 2006).

Using MERL's DiamondTouch (DT) Table (Dietz and Leigh, 2001) a multiuser tabletop distributed commercially by CircleTwelve (http://circletwelve.com/). Cappelletti et al. (2004) used "joint performance" (previously referred to as "enforced" collaboration) to create the StoryTable application which typically developing children used to perform a shared narrative activity (Zancanaro et al., 2007). The design rationale of StoryTable is based on a methodology known as Family Bears (Iandolo et al., 2012) where a child is invited to play with puppets representing a family of bears and their living environments (e.g., a house, a school) and then to invent stories about what happens to the family. The Family Bears methodology has been used in both educational and therapeutic settings to assess the linguistic capabilities of children. The StoryTable implements a similar methodology by providing a choice of virtual story backgrounds and characters which the children use to create a shared narrative activity (i.e., to tell a story). They first jointly select a story background and then select relevant story characters. A total of six story segments are recorded, with each child taking turns to tell three story segments. Each story segment is recorded with a microphone and then placed by the child in one of six story placeholders located on the DiamondTouch Table. In order to play back the entire story, the two children must simultaneously touch the first placeholder. The StoryTable offers a rich environment to negotiate key decisions about collaboratively creating, telling and listening to a story.

The results of a pilot study showed positive effects on social interaction, the level of shared play and reduction of autistic behaviors while using the StoryTable in comparison to a free construction game activity (Gal et al., 2005; 2009). A companion study explored the effect of the StoryTable on the children's language usage (Kupersmitt et al., 2010). The created stories were evaluated in terms of their form and content. Although the stories increase in length as the intervention progress, they showed poor local and global coherence, lacking either temporal or causal connections between subsequent propositions.

In the current paper, we present the results of a subsequent intervention study to determine the effectiveness of the joint performance during a shared narration (as implemented with the StoryTable) on enhancing social interaction for pairs of children with HFASD. The objectives were to (1) compare the children's social interaction skills prior to and following the intervention; (2) identify whether any observed changes in positive social interactions and collaborative play persisted beyond the intervention time; and (3) determine whether any improvements generalize to nonnarrative and/or nontechnology-based activities.

METHODS

Participants

The study sample included 14 boys, aged 8–12 years who met the criteria for ASD according to the DSM-IV-TR (American Psychiatric Association, DSM-IV., 2000) by a physician and with the Autism Diagnostic Observation Scale (ADOS) (Lord et al., 2000) by a psychologist, and were diagnosed with HFASD. All children were capable of verbal interaction (verbal IQ $\geq$ 80) according to the results of the Wechsler Intelligence Scale for Children–Revised (WISC-R, Wechsler, 1974).

Participants were pupils in one of three different special education classes in a mainstream public school. The sample did not include children with additional disabilities such as emotional disturbances, hearing or vision disabilities, and those who had motor difficulties that would prevent them from operating the multiuser tabletop. The allocation into pairs was carried out by the school's teaching staff in accordance with criteria based on grade level, chronological age, academic skills, and socio-communicative function as measured by the Social Responsiveness Scale (SRS: Constantino and Gruber, 2005) that was completed by the child's parent (Mean = 64.21, SD = 7.1). Socio-demographic characteristics are provided in Table 1.

TABLE 1. Socio-Demographic Characteristics

Characteristics		2nd Grade $N = 4$	3rd Grade $N = 8$	5th Grade $N = 2$	Total $N = 14$
Mean age (months)		101	113	131	112
%Taking medication (methyphenidate type)	Yes	75	50	0	21.4
	No	25	50	100	28.6
					50
Family status (%)	Parents married	75	50	100	50
	Parents divorced	25	50	0	50

Instruments

Screening Measures/Confirmation Of Diagnosis

Autism Diagnostic Observation Schedule (ADOS 1). This is a reliable and sensitive tool for assessing deficits within the autism spectrum for individuals aged 18 months to adulthood, and it correlates well with the diagnostic definitions as classified in the ICD-10/DSM-IV. ADOS include four modules, each addressing a specific expressive language level and chronological age. For this study, Module 3, which aims verbally fluent children and young adolescents was used (Lord et al., 2000).

Wechsler Intelligence Scale for Children–Revised (WISC-R) performance scale. The WISC-R is an individually administered intelligence test for children between the ages of 6 and 16 years. It generates an IQ score which represents the child's general cognitive ability (Wechsler, 1974).

Social Responsiveness Scale. The SRS is a 65-item questionnaire that assesses the severity of social impairments as well as repetitive behaviors of an individual who may have ASD. SRS T-scores between 60 and 75 indicate a level of autistic social impairment that is "mild to moderate," whereas scores above 75 indicate a "severe" level. The SRS has been extensively studied with evidence for high levels of internal reliability, $\alpha = 0.97$; test–retest reliability, $\alpha = 0.85$; and interrater reliability coefficients ranging from 0.75 to 0.91 across the different pairs of raters. SRS was used in this study to match pairs of children based on their social communicative skills (SRS: Constantino and Gruber, 2005).

Intervention Tool

The StoryTable application was implemented via the DT multitouch tabletop as described above.

Pre- and Postintervention Tasks

In order to assess whether the children's abilities in social interaction improved as a result of the intervention, and whether these skills transferred to other tasks that required social interaction skills, two assessment tasks were performed. These tasks were administered at each of the three different points of time (one prior to the intervention (pre), a second immediately following the intervention (post), and a third three weeks after the intervention (follow-up) by a qualified examiner who was not familiar with the study goals.

Collaborative Puzzle Game

The Collaborative Puzzle Game (CPG) provides positive and negative visual and auditory feedback in response to the placement of puzzle pieces that are jointly dragged on the DT tabletop surface (Battocchi et al., 2008; Ben-Sasson et al., 2013). This task assesses technology-supported collaboration via a non-narrative task (i.e., one that does not entail story telling) that uses the same tabletop technology as the ST intervention task.

Collaborative Collage (CC)

Shared art work such as creating a joint picture has been used in previous studies as an outcome measure to assess social interaction (Bauminger et al., 2008). In the current study the shared artwork task was a collaborative collage used to assess children's ability to generalize their cooperative behaviors (i.e., a task that required organization and collaboration but not narration nor technology). Pairs of children were asked to create the collage on a 29.7 × 42 cm sheet of white paper using colored markers, scissors, glue, stencils, and illustrated magazines.

Outcome Measure: Friendship Observation Scale

The Friendship Observation Scale (FOS) is an observational coding system that includes positive social interactions, negative social interactions, and collaborative play. It was originally developed to measure qualities of friendship in children on the autism spectrum (Bauminger et al., 2005). Previous research showed a mean interrater agreement level on the seven main sub categories of the original FOS positive scale of 93% (range: 84–100%) (Bauminger et al., 2008). These included (a) goal-directed behavior, including cooperative behaviors directly related to performance of task (construction, drawing); (b) sharing behaviors such as experiences or emotions; (c) prosocial behavior such as comforting and helping; (d) conversation, as in small talk and negotiation; (e) nonverbal interaction such as the combination of eye gaze and a smile; (f) affect, including shared laughter and positive affect; and (g) play. Using FOS friendship behaviors of individuals, dyadic interactions, and perceptions of friendship where shown to differ among children in the HFASD group in comparison to children with typical development (Bauminger et al., 2008). The negative social interactions category includes behaviors such as avoidance, verbal and nonverbal aggressive behavior, temper tantrums, and disassociation.

In the current study, the children's social interactions were video-recorded while they performed the pre-, post-, and follow-up intervention tasks. Two "blind" assessors were trained to code the positive and negative social interactions from videotapes of the ST intervention sessions (not analyzed here); an interobserver agreement level of 90% or higher was obtained for all FOS items. Using Corel VideoStudio 12 software, the frequency of each FOS item was coded over sixty 30-s intervals for each session, and then summed for each child. Thus, a higher score in a particular category indicated a higher frequency of behaviors in that category.

Procedures

A single group pretest-posttest design with repeated measures over a 3-week intervention period was used. Two tasks (CPG and CC) were conducted during the pretest, posttest, and follow-up.

The intervention phase included eleven 45-min structured intervention sessions administered by an occupational therapist over a period of 3 weeks, with 3–4 sessions per week. The intervention protocol for each meeting incorporated a concept clarification part and an experience part. The concept clarification part was formed of a teaching session of fundamental principles of social interaction and collaboration. Each session focused on teaching a different aspect of social interaction including key collaboration concepts such as sharing, negotiation, and receiving and providing help. Following the concept clarification part of each session, the pairs of children were asked to narrate a joint story using the ST functions. They had 20–30 min for this task. This part was conducted without any mediation from the therapist.

Data Analysis

Although the children performed the narrative task in pairs, the detailed analysis of the performance with the FOS Scale was conducted for each child separately. Pre-, post-, and follow-up test comparisons of changes in the social behaviors of the children were made using nonparametric statistical testing due to the small number of participants. The Friedman test was used to assess the overall significance of differences for each outcome measure and the Wilcoxon signed rank test was used to identify whether the differences between pre-, post-, and follow-up frequencies were significant.

RESULTS

Collaborative Puzzle Game

The Friedman test indicated significant differences in the positive social interaction at the three test times ($\chi^2_{(2)} = 8.53, p = .01$). The Wilcoxon signed rank tests showed a significant increase in the positive social interactions from pre- to posttest ($Z = -2.85, p = .004$), and from pre- to follow-up test ($Z = -2.49, p = .01$).

The Friedman test indicated significant differences in collaborative play at the three test times ($\chi^2_{(2)} = 11.87, p = .003$). The Wilcoxon signed rank tests showed a significant increase in collaborative play from the pre- to posttest ($Z = -2.67$, $p = .007$), and from pre- to follow-up test ($Z = -3.07, p = .002$).

The Friedman test indicated significant differences in negative social interactions at the three test times ($\chi^2_{(2)} = 5.72, p = .05$). The Wilcoxon signed rank test showed a significant decrease in the negative social interaction from pre- to posttest ($Z = -1.96$, $p = .05$), and from pre- to follow-up test (Z = -2.30, $p = .02$) (See table 2).

Collage Task

Although the means of the positive social interaction indicated progress from pre- to posttest, the Friedman test indicated no significant differences in the tests at the

TABLE 2. Collaborative Puzzle Game Task: Mean, Standard Deviations, Medians, Ranks Friedman, and Wilcoxon Tests Before and After the Intervention

	Mean (SD), Median, (Rank)			Friedman Chi Square	Wilcoxon Post hoc
	Pretest (A)	Post 1 (B)	Post 2 (C)		
Positive social interactions	16.33 (7.36) 15.00 (1.33)	23.25 (7.07) 25.00 (2.33)	24.50 (11.82) 23.00 (2.33)	8.53**	A < B,C
Collaborative play	3.00 (5.03) 1.50 (1.21)	13.42 (6.64) 15.50 (2.33)	14.33 (6.11) 14.50 (2.46)	11.87**	A < B,C
Negative social interactions	6.17 (6.68) 5.00 (2.46)	2.67 (3.34) 1.00 (1.92)	1.50 (1.73) 1.00 (1.63)	5.72*	A > B,C

*p < .05, **p< .001.

three test times ($\chi^2_{(2)} = 2.23$, $p = .327$). In contrast, the Wilcoxon signed rank tests indicated a significant increase in positive social interaction from the pre- to posttest ($Z = -1.98, p = .05$).

Collaborative play during the collage task improved significantly, with the Friedman tests indicating significant differences between the tests at the three test times ($\chi^2_{(2)} = 8.52, p = .014$), and the Wilcoxon signed rank tests indicating a significant difference between pre- and posttest ($Z = -2.45, p = .014$).

The children engaged in very few negative social interactions during the collage task at any of the test times. Consequently, the Friedman tests showed no decreases in the negative social interactions ($\chi^2_{(2)} = 0.75, p = .687$). There were no significant differences in any of the measures between post and follow-up tests (see Table 3).

TABLE 3. Collage Task: Mean, Standard Deviations, Medians, Ranks and Friedman, and Wilcoxon Tests Before and After the Intervention

	Mean (SD), Median, (Rank)			Friedman chi square	Wilcoxon post hoc
	Pretest	Post 1	Post 2		
Positive social interactions	11.07 (6.66) 10.50 (1.75)	14.57 (6.17) 15.00 (2.29)	13.36 (4.58) 15.00 (1.96)	2.23	A < B
Collaborative play	1.28 (2.13) 0.00 (1.50)	2.71 (2.58) 2.00 (2.50)	1.71 (2.13) 1.00 (2.00)	8.52*	A < B
Negative social interactions	1.14 (2.41) 0.00 (2.00)	0.50 (0.94) 0.00 (1.89)	0.93 (1.59) 0.00 (2.11)	0.75	

*p <.05, **p <.001.

DISCUSSION

The current study examined the effectiveness of the StoryTable paradigm, a short term, directed intervention using a tabletop "joint performance" interface, to facilitate social interaction skills among children with HFASD, and to examine their ability to transfer these skills to other tasks. There was significant improvement in social interaction and collaborative play as well as lower rates of negative social interactions during the CPG in most of the postintervention tasks; these effects were maintained when tested three weeks later. The results suggest that the ST paradigm provides a technology-supported method for children with HFASD to enhance their social abilities. The ST paradigm entails four factors that may account for the significant improvements in the participants' social interaction behaviors. These factors are elaborated below.

Directed Intervention Based on Concept Clarification and Active Learning

The ST paradigm investigated in the current study was based on Bauminger's (2002) previous work which demonstrated the important role that a focused, problem-solving and affective knowledge intervention plays in supporting the development of positive social interactions with peers for children with ASD. We used a similar approach with the systematic clarification of collaboration concepts (e.g., sharing, negotiation, receiving, and providing help) and subsequent opportunities to experience these concepts during ST intervention task (without further explanation of terms or mediation by the therapist). A similar combination of concept clarification and opportunities to experience collaboration tasks has been recently shown to enhance social cooperation of children with high functioning ASD, resulting in improvement in the socio-cognitive area with children providing more active social solutions to social problems and revealing more genuine understanding of collaboration and social conversation after intervention (Bauminger-Zviely et al., 2013; Giusti et al., 2011).

Shared Creation of a Narrative

Shared narration, the primary task during the intervention, was selected since it is a key element in human interaction and critical to the development of communicative competence. The engagement of children in storytelling enables them to combine thought, action, and feeling into an organized verbal framework (Reilly et al., 2004), and to learn to share experiences with others and begin to understand the attitudes, emotions, knowledge, and motivations of others (Nelson, 2000). A key characteristic in Kupersmitt et al.'s (2010) study was the use of spontaneous, nondirected interactions during the ST narrations. This appeared to help the children to be attentive to ST task rules and constraints which may have served as a nonverbal scaffold, while practicing what they learned in the concept clarification part of the intervention (Kupersmitt et al., 2010).

Large Tabletop Display with Multimedia (Touch, Sound, Vision) Elements

In keeping with the findings of previous research, the results of the current study provide additional evidence that technology imparts added value to more traditional, nontechnological interventions. This value appears to be related to the observation that children with ASD are greatly motivated by computer-related activities (Goodwin, 2008; Hart, 2005). This motivation may be due to the technology's advantages for the core deficits of ASD, including (a) focusing on a computer screen, where only necessary information is provided, which may help people with ASD reduce distractions from extraneous sensory stimuli; (b) decrease of social demands; and (c) consistent and predictable responses (Murray, 1997). In addition, the technology-based activities provide an adaptable yet safe and secure environment where a child may repeat and practice everyday scenarios, and communication with a peer before attempting to participate in more risky real world interactions.

Children with ASD have been shown to enjoy computer-based interventions, to benefit from them, and to be able to generalize acquired skills to other, nontechnology activities (Baron-Cohen et al., 2009). Large display surfaces with interactive multimedia elements such as the DT multiuser tabletop appear to be particularly successful for encouraging positive changes in social interaction abilities (Bauminger et al., 2013). Indeed, several studies suggest that for collaborative tasks a direct touch interface is more effective than the use of multiple pointing devices (such as a mouse), in particular for what concerns higher levels of awareness, fluidity of interactions, and spatial memory (e.g., Hornecker et al., 2008). Studies have shown tabletop applications to be engaging for group work (Hendrix et al., 2009; Piper et al., 2006) and to increase prosocial behaviors such as collaboration and coordination, to provide augmented appreciation for social activities, and novel forms of expression (Hourcade et al., 2012).

"Joint Performance" Interaction

In addition to its multimedia display characteristics, the DT tabletop device has a unique multiuser capability, i.e., "joint performance." The pairs of children were thus required to agree upon and perform key steps together during the storytelling task; the narration could not be completed if either child only responded individually. "Joint performance" encouraged them to communicate verbally, and to physically coordinate their movements for joint actions (Gal et al., 2009). It also required them to take turns and to negotiate, and to discuss changes to any part of the story. "Joint performance" is only one of several collaboration dimensions that are available with this technology (Giusti et al., 2011). Others include "object ownership" and "mutual planning," These collaborative dimensions appear to be motivating and engaging for children as well as provide an additional way for teachers and therapists to control the pace and the structure of the interaction (Zancanaro et al., 2011).

The combination of a short teaching phase of concept clarification in addition to a practicing phase using an enforced collaboration interface show a great potential in guiding children with HFASD to positively interact with one another in order to complete a mutual goal. It is recommended that such paradigm will be adopted in primary schools to enhance social interaction of children with ASD in an enjoyable yet educational way.

CONCLUSIONS

A simulation of participation in daily scenarios via the creation of a shared story has been shown to be an encouraging mechanism for change in social abilities for children with HFASD. Despite the small number of participants (the sample size was constrained by the need to pair up children with very similar functional levels) significant improvements were obtained. The results of the current study suggest that technologies that enhance collaboration may be used within school settings in order to improve the social interaction of children with ASD. Future studies should use a larger sample and include a comparison group of children with typical development, in order to further explore how the attributes of joint performance technologies can be used to improve the social, physical, emotional, and learning challenges that children and adults with ASD face. It is also very important to test mixed pairs (children with and without ASD) to understand whether social behavior changes following the ST intervention generalize to typically developing peers.

ACKNOWLEDGMENTS

The authors would like to thank Alessandro Cappelletti (FBK) for the programming of the interface, and the Tchernichovsky schools' stuff members, the children and their parents for participating in the study.

Declaration of Interest: The authors report no conflict of interest. The authors alone are responsible for the content and writing of this article.

FUNDING

The authors would like to thank Autism Speaks and the FBK-Haifa Agreement for funding.

ABOUT THE AUTHORS

Eynat Gal, BSc (OTR), MSc, PhD is a faculty member of Social Welfare and Health Studies in the Department of Occupational Therapy at the University of Haifa, Israel. Dr. Gal is the head of the pediatrics' studies in the department, and a co-director of the Autism Laboratory of University of Haifa. **Liron Lamash**, MSc, OT is a lecturer and a doctoral student in the Dept. of Occupational Therapy, Faculty of Social Welfare and Health Sciences, University of Haifa, Israel. She is also an ASD instructor in the Israeli Ministry of Education. **Nirit Bauminger-Zviely**, PhD is a full Professor at the School of Education, Bar-Ilan University. She serves as the Head of the school of education and of the Graduate Program in special education specializing in ASD. **Massimo Zancanaro**, MSc is the head of the i3—Intelligent Interfaces and Interaction—research unit at FBK. He is member of the Faculty of Doctoral School on Cognitive Science. At present, he serves as chair of the Italian Chapter of the ACM Special Interest Group in Computer–Human Interaction. **Patrice L. (Tamar) Weiss**, BSc (OT), MSc, PhD directs the Laboratory for Innovations in Rehabilitation Technology (LIRT) in the Dept. of Occupational Therapy, Faculty of Social Welfare and Health Sciences, at the University of Haifa (Haifa, Israel).

REFERENCES

American Psychiatric Association, & American Psychiatric Association. Task Force on DSM-IV. (2000). Diagnostic and statistical manual of mental disorders: DSM-IV-TR. American Psychiatric Publishing, Inc.

Baron-Cohen S, Golan O, Ashwin E. (2009). Can emotion recognition be taught to children with autism spectrum conditions? Philosophical Transactions of the Royal Society of London.Series B, Biological Sciences, 364(1535): 3567–3574. doi:10.1098/rstb.2009.0191; 10.1098/rstb.2009.0191

Battocchi A, Gal E, Sasson AB, Pianesi F, Venuti P, Zancanaro M, *et al.* (2008). Collaborative puzzle game-an interface for studying collaboration and social interaction for children who are typically developed or who have autism spectrum disorder. The 7th International Conference Series on Disability, Virtual Reality and Associated Technologies (ICDVRAT), 127–134.

Bauminger N, Rogers S, Aviezer A, Solomon M. (2005). The friendship observation scale (FOS). Unpublished Manual, Bar Ilan University, Israel and University of California, Davis, CA,

Bauminger N. (2002). The facilitation of social-emotional understanding and social interaction in high-functioning children with autism: Intervention outcomes. Journal of Autism and Developmental Disorders, 32(4), 283–298.

Bauminger N, Solomon M, Aviezer A, Heung K, Gazit L, Brown J, *et al.* (2008). Children with autism and their friends: A multidimensional study of friendship in high-functioning autism spectrum disorder. Journal of Abnormal Child Psychology, 36(2), 135–150.

Bauminger-Zviely N, Eden S, Zancanaro M, Weiss PL, Gal E. (2013a). Increasing social engagement in children with high-functioning autism spectrum disorder using collaborative technologies in the school environment. Autism : The International Journal of Research and Practice, 17(3), 317–339. doi:10.1177/1362361312472989; 10.1177/1362361312472989

Ben-Sasson A, Lamash L, Gal E. (2013). To enforce or not to enforce? the use of collaborative interfaces to promote social skills in children with high functioning autism spectrum disorder. Autism : The International Journal of Research and Practice, 17(5), 608–622. doi:10.1177/1362361312451526; 10.1177/1362361312451526

Beukelman D. and Miranda P. (2013). Augmentative and Alternative Communication: Supporting Children and Adults with Complex Communication Needs (4th edn). Baltimore, MD: Paul H. Brookes.

Bosseler A, Massaro DW. (2003). Development and evaluation of a computer-animated tutor for vocabulary and language learning in children with autism. Journal of Autism and Developmental Disorders, 33(6), 653–672.

Cappelletti A, Gelmini G, Pianesi F, Rossi F, Zancanaro M. (2004). Enforcing cooperative storytelling: First studies. Advanced Learning Technologies, 2004. Proceedings. IEEE International Conference On, 281–285.

Constantino, JN, Gruber, CP. (2005). The Social Responsiveness Scale Manual. Western Psychological Services, Los Angeles.

Corbett BA, Qualls LR, Valencia B, Fecteau S, Swain DM. (2014). Peer-mediated theatrical engagement for improving reciprocal social interaction in autism spectrum disorder. Frontiers in Pediatrics, 2,(110): doi: 10.3389/fped.2014.00110.

Dautenhahn K. (2003). Roles and functions of robots in human society: Implications from research in autism therapy. Robotica, 21(4):443–452.

DeRosier ME. (2004). Building relationships and combating bullying: Effectiveness of a school-based social skills group intervention. Journal of Clinical Child and Adolescent Psychology, 33(1):196–201.

Dietz P, Leigh D. (2001). DiamondTouch: A multi-user touch technology. Proceedings of the 14th Annual ACM Symposium on User Interface Software and Technology, 219–226.

Dowrick PW. (2000). A review of self modeling and related interventions. Applied and Preventive Psychology, 8(1):23–39.

Gal E, Bauminger N, Goren-Bar D, Pianesi F, Stock O, Zancanaro M, *et al.* (2009). Enhancing social communication of children with high-functioning autism through a co-located interface. Ai & Society, 24(1), 75–84.

Gal E, Goren-Bar D, Gazit E, Bauminger N, Cappelletti A, Pianesi F, *et al.* (2005). Enhancing social communication through story-telling among high-functioning children with autism. Intelligent technologies for interactive entertainment (pp. 320–323) Springer.

Giusti L, Zancanaro M, Gal E, Weiss PLT. (2011). Dimensions of collaboration on a tabletop interface for children with autism spectrum disorder. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 3295–3304.

Goodwin MS. (2008). Enhancing and accelerating the pace of autism research and treatment. Focus on Autism and Other Developmental Disabilities, 23(2):125–128.

Grynszpan O, Martin JC, Nadel J. (2005). Designing educational software dedicated to people with autism. Assistive Technology: From Virtuality to Reality, Proceedings of AAATE, 456–460.

Hart M. (2005). Autism/excel study. Proceedings of the 7th International ACM SIGACCESS Conference on Computers and Accessibility, 136–141.

Hay DF, Payne A, Chadwick A. (2004). Peer relations in childhood. Journal of Child Psychology and Psychiatry, 45(1):84–108.

Hendrix K, van Herk R, Verhaegh J, Markopoulos P. (2009). Increasing children's social competence through games, an exploratory study. Proceedings of the 8th International Conference on Interaction Design and Children, 182–185.

Hornecker E, Marshall P, Dalton NS, Rogers Y. (2008). Collaboration and interference: Awareness with mice or touch input. Proceedings of the 2008 ACM Conference on Computer Supported Cooperative Work, 167–176.

Hourcade JP, Bullock-Rest NE, Hansen TE. (2012). Multitouch tablet applications and activities to enhance the social skills of children with autism spectrum disorders. Personal and Ubiquitous Computing, 16(2):157–168.

Iandolo G, Esposito G, Venuti P. (2012). The Bears Family Projective Test: evaluating stories of children with emotional difficulties. Perceptual and Motor Skills, 114(3):883–902

Kupersmitt J, Yifat R, Gal E, Bauminger N, Stock O, Zancanaro M, *et al.* (2010). Joint construction of stories by high functioning children with autism: Using a technological setting. Int. J. Child Adol. Health 2:97–112.

Law M, Baum C, Dunn W. (2005). Measuring occupational performance: Supporting best practice in occupational therapy. Thorofare, NJ: Slack Incorporated.

Lord C, Risi S, Lambrecht L, Cook EH, Leventhal BL, DiLavore PC, *et al.* (2000). The autism diagnostic observation Schedule—Generic: A standard measure of social and communication deficits associated with the spectrum of autism. Journal of Autism and Developmental Disorders, 30(3):205–223.

Missiuna CA, Pollock NA, Levac DE, Campbell WN, Whalen SDS, Bennett SM, *et al.* (2012). Partnering for change: An innovative school-based occupational therapy service delivery model for children with developmental coordination disorder. Canadian Journal of Occupational Therapy, 79(1):41–50.

Morris MR, Huang A, Paepcke A, Winograd T. (2006). Cooperative gestures: Multi-user gestural interactions for co-located groupware. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 1201–1210.

Murray D. (1997). Autism and information technology: Therapy with computers. Autism and Learning: A Guide to Good Practice, 100–117.

Nelson K. (2000). Narrative, time and the emergence of the encultured self. Culture & Psychology, 6(2), 183–196.

Parsons S, Leonard A, Mitchell P. (2006). Virtual environments for social skills training: Comments from two adolescents with autistic spectrum disorder. Computers & Education, 47(2):186–206.

Piper AM, O'Brien E, Morris MR, Winograd T. (2006). SIDES: A cooperative tabletop computer game for social skills development. Proceedings of the 2006 20th Anniversary Conference on Computer Supported Cooperative Work 1–10.

Reilly J, Losh M, Bellugi U, Wulfeck B. (2004). "Frog, where are you?" narratives in children with specific language impairment, early focal brain injury, and williams syndrome. Brain and Language, 88(2), 229–247.

Richardson PK. (2002). The school as social context: Social interaction patterns of children with physical disabilities. The American Journal of Occupational Therapy: Official Publication of the American Occupational Therapy Association, 56(3):296–304.

Wechsler D. (1974). Manual for the wechsler intelligence scale for children, revised Psychological Corporation.

Zancanaro M. (2012). Shared interfaces for co-located interaction. Ubiquitous display environments (pp. 71–88) Springer.

Zancanaro M, Giusti L, Gal E, Weiss PL. (2011). Three around a table: The facilitator role in a co-located interface for social competence training of children with Autism Spectrum Disorder. In: Proceedings of 13th IFIP TC13 Conference on Human-Computer Interaction – INTERACT 2011. Lisbon, Portugal.

Zancanaro M, Pianesi F, Stock O, Venuti P, Cappelletti A, Iandolo G, *et al*. (2007). Children in the museum: An environment for collaborative storytelling. PEACH-intelligent interfaces for museum visits (pp. 165–184) Springer.