J Autism Dev Disord (2013) 43:1717–1724
DOI 10.1007/s10803-012-1705-7

BRIEF REPORT

Brief Report: Predictors of Outcomes in the Early Start Denver Model Delivered in a Group Setting

Giacomo Vivanti · Cheryl Dissanayake · Cynthia Zierhut · Sally J. Rogers · Victorian ASELCC Team

Published online: 3 November 2012

Abstract There is a paucity of studies that have looked at factors associated with responsiveness to interventions in preschoolers with autism spectrum disorder (ASD). We investigated learning profiles associated with response to the Early Start Denver Model delivered in a group setting. Our preliminary results from 21 preschool children with an ASD aged 2- to 5-years suggest that the children with more advanced skills in functional use of objects, goal understanding and imitation made the best developmental gains after 1 year of treatment. Cognitive abilities, social attention, intensity of the treatment and chronological age were not associated with treatment gains.

Keywords Autism · Intervention · Early Start Denver Model · Predictors of outcomes · Social learning

Recent research indicates that a number of Early Intensive Behavioural Intervention models (EIBI) are efficacious in improving cognitive and social-communicative outcomes in toddlers and young children with an autism spectrum disorder (ASD) (Rogers and Wallace 2011). However, response to the different evidence-based EIBI models varies considerably at the individual level (Howlin et al. 2009), indicating that no single treatment works for all children on the spectrum. Currently, we are unable to make a priori decisions about matching children with an ASD to appropriate programs as our knowledge about specific profiles of responders and non-responders to the different EIBI models remains limited (Stahmer et al. 2011). Available evidence indicates that a number of factors might be associated with differences in response to treatment across different intervention models, including pre-treatment I.Q, (Magiati et al. 2007; McEachin et al. 1993), symptom severity (Sallows and Graupner 2005a, b; Smith et al. 2000), adaptive skills (Flanagan et al. 2012; Makrygianni and Reed 2010), younger age (Harris and Handleman 2000; Perry et al. 2011), communication abilities (Eikeseth et al. 2007; Eldevik et al. 2006; Remington et al. 2007), play skills (Ingersoll 2010; Kasari et al. 2012a, b; 2008) interest in objects (Carter et al. 2011; Schreibman et al. 2009; Yoder and Stone 2006a, b), joint attention (Yoder and Stone 2006a, b; Kasari et al. 2008), and imitation (Sallows and Graupner 2005a, b). The mechanisms through which these factors moderate response to different treatments however are not clear, and more research is needed to determine how differences in specific learning processes mediate individual responses to specific teaching strategies.

The current study investigates factors associated with treatment response among pre-schoolers with ASD in a community program utilizing group delivery of the Early Start Denver Model (ESDM) (Rogers and Dawson 2010). This manualized, evidence- based intervention model, specifically designed for young children with an ASD, uses

The Victorian ASELCC Team in alphabetical order: K. Capes, E. Duncan, J. Feary, D. Pell, J. Reynolds, S. Upson.

G. Vivanti (✉) · C. Dissanayake
Olga Tennison Autism Research Centre, School of Psychological Science, La Trobe University, Bundoora Campus, Melbourne, VIC 3086, Australia
e-mail: g.vivanti@latrobe.edu.au

G. Vivanti · C. Zierhut · Victorian ASELCC Team
Victorian Autism Specific Early Learning and Care Centre, La Trobe University, Melbourne, VIC 3086, Australia

C. Zierhut · S. J. Rogers
The M.I.N.D. Institute, University of California, Davis, Sacramento, CA 95817, USA

an interdisciplinary team to teach skills that are foundational to social-cognitive development within the context of joint activity routines. Principles of the ESDM are informed by the literature on how children learn from others within the framework of rewarding social interactions (Kuhl 2007) and by developmental theory, with an emphasis on the impact of early social learning experiences on the developing brain (Johnson 2005). Based on these notions, the ESDM strategies involve embedding teaching episodes within the framework of intrinsically rewarding social interactions, with the idea that intensive participation in socially rewarding shared experiences lead children to become attuned to their social environment. A corollary of this idea is that by 'normalizing' the amount of meaningful and rewarding social interactions and, consequently, the frequency of social learning opportunities, the impact of autism on the developing child might be minimized. This should be particularly true in the case of younger children, as neural plasticity during early developmental stages might allow for a deeper impact of social learning experiences on the developing brain (Dawson and Bernier 2007). Effectiveness of this model was documented in a number of papers (Rogers et al. 2006; Vismara et al. 2009) including a recent randomized control trial (Dawson et al. 2010) indicating significant gains in cognitive and adaptive abilities (but no significant changes in ADOS scores) in a group of pre-schoolers with ASD receiving 25 h per week of ESDM for 2 years.

No research so far has investigated the predictors of outcomes to the ESDM. In this study, we aim to address this issue by testing individual differences in the specific processes that, according to the theoretical principles upon which the model is built (developmental theory and social learning theory), should mediate response to treatment. Compared to other models that are based on different philosophies and theoretical backgrounds, the ESDM relies primarily on the notion that early learning is organized around socially rewarding activities and, therefore, rather than attempting to 'replace' socially-mediated learning with alternative forms of teaching (e.g., following instructions that are visually conveyed, so that the interaction with the adult is not required), emphasizes the need for social-affective engagement in all teaching episodes. This allows for the prediction that children who are more motivated and/or able to participate in and to learn from joint social activities will be particularly responsive to this treatment model. We tested this prediction in a cohort of 21 preschoolers with ASD enrolled in the Victorian Autism Specific Early Learning and Care Centre (Victorian ASELCC), who receive the ESDM in a group setting.

We used novel experimental tasks to characterize children in terms of the abilities that are thought to support the kind of socially-mediated learning that is involved in the ESDM. A behavioural task was used to measure children's tendency to act on the physical environment in a purposeful versus purposeless way. According to recent literature (Hernik and Csibra 2009; Sommerville and Woodward 2005; von Hofsten 2007), this ability reflects an early emerging cognitive bias (sometimes referred as 'goal-directedness') which provides the foundation for attributing meaning to and learning from others' actions. Given the importance of motivation/interest in others for cognitive development and social learning (Dawson and Bernier 2007), participants' social attention was also measured through an eye-tracking paradigm.

The ability to understand the goals behind others' actions, which is also considered to be a foundational skill for social learning (Bandura 1977; Csibra and Gergely 2007; Vivanti et al. 2011), was measured through a predictive gaze task. Finally, given the importance of imitation in social-cognitive development and learning (Tomasello 1999; Young et al. 2011), we measured participants' ability to imitate others' actions spontaneously through a behavioural task. In summary, based on the theoretical framework underlying the ESDM, we tested the hypothesis that children who show more advanced skills in four abilities that are foundational to early social learning (functional use of objects, social attention, goal understanding and imitation) will derive the most benefit from the ESDM program.

Methods

The study was approved by the La Trobe University Human Ethics Committee, and informed consent was obtained from all participants' parents.

Participants

Participants comprised 21 children (20 Male; 1 Female) aged 1 year 10 months to 4 years 10 months (average = 38 months, SD = 11.5) diagnosed with an ASD and enrolled at the Victorian ASELCC. Cognitive level was measured through the Mullen Scales of Early Learning (MSEL; Mullen 1995); the Composite Standard Scores at baseline was 57 (SD = 12; range = 49–94). ASD diagnoses were confirmed through administration of the Autism Diagnostic Observation Schedule (ADOS; Lord et al. 1999) by expert clinicians with 17 children meeting criteria for Autistic Disorder and 4 meeting criteria for ASD at baseline. All participants were free from any other medical conditions, and had no visual, hearing or motor impairments.

Measures: Predictors

The following tasks were administered to characterize children in terms of four basic abilities hypothesised to moderate response to treatment:

Functional Use of Objects Task

Children were provided with a set of 11 objects that afford specific opportunities for functional actions (i.e., actions that are directed to a goal and lead to a specific end-state) to ascertain their tendency to act in a goal-directed way in the environment. No specific instruction was given, and participants were video-recorded; their spontaneous use of objects was subsequently coded as functional (e.g., using a toy-hammer to push a peg) or purposeless (e.g., spinning the peg) by a trained research assistant (RA) who was blind to study hypotheses. Interrater reliability between the first author and the RA was calculated on 20 % of the data set; Cohen's kappa was .96.

Goal Understanding

Goal understanding was assessed using a predictive gaze paradigm, which comprised measuring whether participants show anticipatory gaze to the target of observed actions. This measure is considered to be a reliable index of goal understanding (Cannon et al. 2012; Gredeback et al. 2009; Flanagan and Johansson 2003). A series of six video stimuli were shown on a 60-Hz Tobii 1750 binocular eye-tracker monitor with an imbedded camera (768 × 1,024 pixels resolution, average precision of 0.5° of visual angle). Data were analyzed using frame-by-frame defined areas of interest using Tobii Studio analysis software. Fixation criteria were set to ClearView defaults of a 30-pixel dispersion threshold for 100 ms. Participants were seated in a comfortable chair 60 cm from the monitor. No specific instruction was given. The video-stimuli featured an actor moving her hand toward one of four objects (target) in order to grasp it. The videos ended before the actor's hand actually touched the target objects. During observation of the video-clips, participants' eye movements were recorded to determine whether they predictively looked at the target of her action. The duration of attention (quantified in terms of number of fixations) to the target versus the other objects was used as a measure of goal understanding.

Social Attention

Social attention was measured using a similar eye-tracking paradigm. Video-stimuli for this task involved the same actor and the same set of objects; however, in these stimuli, the actor did not direct any actions towards the objects. Participants' gaze pattern was recorded to determine the amount of attention to the actor's face versus their attention to the objects.

Imitation

Spontaneous imitation was measured by showing participants a series of videos involving an actor performing 8 simple actions on objects. Materials necessary for the imitation of each trial were placed in front of the participant before the beginning of the trial. The materials and their arrangement were exactly the same as those displayed in the video. Participants' spontaneous behaviour with the objects in response to the demonstration was video-recorded for later scoring by the trained RA blind to the study hypotheses. A score of 1 was given when participants reproduced the observed action and summed to give an index of imitative performance. Interrater reliability was again calculated on 20 % of the data set; Cohen's kappa was .95.

Given the range of abilities in our sample, including many participants with minimal cognitive and communication abilities, all tasks where designed to capitalize on spontaneous behaviours, without the need to rely on verbal instructions.

Outcome Measures

The following standardized assessments were administered at baseline and at one-year post-treatment. Outcomes at 1 year post-treatment were ascertained via change scores on each of the measures below.

The MSEL is a standardized measure of early development, yielding standardized T Scores and age equivalent (AE) scores on the following subscales: Visual Reception, Fine Motor, Receptive Language, and Expressive Language. The rationale for using this scale as an outcome measure was based on the notion that the ESDM will support spontaneous learning from the social and non-social environment, thus resulting in gains across developmental domains (Rogers and Dawson 2010).

The ADOS is a standardized diagnostic observational instrument which quantifies autism symptoms in social reciprocity, communication, play and repetitive behaviours. To determine symptom severity across the entire sample, we used the ADOS severity score (Gotham et al. 2007), which allows for comparison of autism severity across participants tested with different ADOS modules.

Intervention

Participants received between 15 and 25 h of group-based ESDM intervention each week for a full calendar year.

Intervention was delivered at the Victorian ASELCC by trained therapists including a speech pathologist, psychologist, occupational therapist, as well as early education and childcare staff. The staff-child ratio was 1:3. Treatment was delivered according to the guidelines for group implementation of the ESDM detailed in Rogers and Dawson (2010). Similarly to the 1:1 implementation of the model, the group setting implementation involves the definition of individual goals based on the child's current skill level. Small circle group activities and 'play activity centres' are then planned in order to accomplish the individual learning objectives of children participating in each group. For example, small-group book or music activities provide opportunities for expressive and receptive language, gestural and vocal imitation, turn-taking, joint attention, cognitive goals (e.g., picture matching, counting), social (e.g., giving and sharing materials) and play skills. Moreover a number of 'activity centres' are created to target motor and cognitive abilities, together with the abovementioned communicative and social skills. These activities are implemented on a daily basis in addition to classroom routines that provide continuous opportunities for therapist-child teaching interaction based on the ESDM principles. Compared to the 1:1 model, the group-setting implementation model has the advantage of creating more opportunities to target developmental goals such as participation in cooperative activities, engagement in purposeful play with peers, and intentional communication with peers.

Parent information sessions on the ESDM strategies were conducted on a regular basis, however parents were not required to demonstrate fidelity of implementation.

All families involved in this study complied with the requirement that the Victorian ASELCC would be their main intervention provider. We also required that any additional practitioner providing extra-hours of therapy outside the centre would be involved, together with the families, in regular meetings with the centre's staff to ensure consistency with the ESDM principles and strategies across intervention settings.

All staff were trained to fidelity by certified ESDM therapists according to the ESDM fidelity guidelines (Rogers and Dawson 2010).

Results

Deviations in kurtosis and skewness from the normal distribution curve were tested for all variables following guidelines set by Tabachnick and Fidell (1996), and no violation of normality was identified. Therefore, study hypotheses were tested via parametric analyses.

Developmental Gains

A series of paired-sample t-tests indicated significant differences at a group level between pre- and post-treatment age equivalent scores for all the MSEL subscales. Participants gained an average of 10 months in the Visual Reception domain ($t = -6.49$; $p < .001$; $d = -2.2$), 5.5 months in the Fine Motor domain ($t = -4.91$; $p < .001$; $d = -1.3$), and 8 months in each of the Receptive Language ($t = -4.94$; $p < .001$; $d = -1.2$), and Expressive Language ($t = 4.67$; $p < .001$; $d = -1.0$) domains. All differences were significant after a Bonferroni adjustment to control for the number of comparisons (alpha = .0125). There were, however, remarkable individual differences in the response to treatment, with gains in all domains ranging from 0 to 24 months across participants.

No significant decreases were found in ADOS severity scores when comparing post- treatment to pre-treatment scores ($p > .1$). However, there were widely varying individual differences, with scores ranging from −6 (reflecting reduction of autistic symptoms) to +8 (reflecting increased severity).

Predictors of Outcomes

The set of putative predictors used in the analyses included the four experimental measures described above (functional use of objects, goal understanding, social attention, and imitation), as well as measures of participants' chronological age, developmental age (MSEL Composite Score at baseline) and symptom severity (ADOS calibrated severity score at baseline). The possible role of treatment intensity (number of hours per week) was also assessed. The correlations between putative predictors and outcomes measures (as reflected in change scores between pre- and post-treatment in the MSEL and ADOS subscales) were examined first. Results are reported in Tables 1 and 2.

A linear regression was then run using only those predictors that showed a significant correlation with the outcome measures. The independent variables were entered according to the strength of bivariate correlation (Pallant 2010). Results of the regression analyses are illustrated in Tables 3, 4, 5 and 6.

As shown in the tables, the results of the regression indicated that Functional Use of Objects alone explained approximately 70 % of the variance in Visual Reception gains, with Imitation making a marginally significant contribution to the outcome once Functional Use of Objects was controlled for.

The regression on gains in Fine Motor ability showed that Imitation explained approximately 50 % of the

Table 1 Correlations between putative predictors and cognitive gains (change scores in MSEL domains)

	Visual reception	Fine motor	Rec. language	Expr. language
Functional use of objects	.82***	.45*	.38	.44*
Social attention	.10	−.17	.15	.23
Goal understanding	.29	.09	.57*	.23
Imitation	.73**	.70**	.53*	.30
Chronological age	−.16	−.17	−.27	−.43†
Baseline MSEL composite	.24	−.12	.18	.26
Baseline ADOS severity	−.13	−.26	−.47*	−.61**
Intensity	−.16	−.26	−.16	.15

† $p = .05$, * $p < .05$, ** $p < .005$, *** $p < .001$

Table 2 Correlations between putative predictors and change scores in ADOS subscales

	Social affect	RBB
Functional use of objects	.21	.03
Social attention	−.01	−.12
Goal understanding	.34	.24
Imitation	.17	.01
Chronological age	.25	.17
Baseline MSEL composite	−.06	.19
Baseline ADOS severity	.08	.09
Intensity	.25	.11

Table 3 Summary of hierarchical regression analysis for variables predicting gains in visual reception abilities

	Gains in visual reception					
Predictor variables	B	SE B	β	B	SE B	β
Objects use	2.54	0.44	.82***	−0.99	.56	.59**
Imitation				1.01	.56	.32†
R^2		.67			.73	
F change		33.23***			3.24†	

† = .09, ** $p < .01$, *** $p < .001$

variance, with Functional Use of Object not making a significant unique contribution to the model.

With regards to gains in Receptive Language, Goal Understanding alone explained approximately 30 % of the variance, while Imitation, symptom severity and Functional Use of Objects did not significantly contribute to the model.

The analysis of predictors of gains in Expressive Language indicated that symptoms severity alone explained approximately 40 % of the variance, while Functional Use of Objects, age and Imitation did not make a significant contribution to the model.

Table 4 Summary of hierarchical regression analysis for variables predicting gains in fine motor abilities

	Gains in fine motor					
Variable	B	SE B	β	B	SE B	β
Imitation	1.48	.38	.69***	1.53	.53	.72**
Objects use				−.07	.53	−.03
R^2		.48			.48	
F change		15.07***			0.20	

** $p = .01$, *** $p = .001$

None of the putative predictors was significantly associated with changes in the ADOS scores.

Discussion

The aim in this pilot study was to provide preliminary data on the characteristics of children who are more responsive to a specific EIBI model, the ESDM, being implemented in a community-based setting. Analyses of changes over 12-months of treatment suggest that participants, as a group, improved their cognitive and language abilities, although, consistent with previous literature, they did not show changes in ADOS scores (Dawson et al. 2010; Green et al. 2010). However individual differences in the gains were considerable.

Based on the ESDM theoretical framework, we predicted that children who are more able to learn from joint activities would be optimally "equipped" to benefit from the ESDM program. Our findings partially support our hypotheses. The ability to organize actions around goals (measured through the spontaneous functional use of objects), the ability to imitate others' goal-directed actions and the ability to understand other's goals appear to be related to gains in verbal and non-verbal cognitive abilities. This finding is consistent with the idea that goal-directedness is an important organizer of cognitive development and social learning (Csibra and Gergely 2006). Severity of symptoms at baseline also appears to play a role in expressive language gains. Conversely social attention, as measured through visual attention to the face in the eye-tracking paradigm, was not related to treatment response in this study. This is not consistent with our initial hypothesis, however it is possible that our task did not adequately capture differences in social attention/interest. Chronological and developmental age were not significant predictors of outcomes in this study, suggesting that in this age group significant improvements might be observed in both

Table 5 Summary of hierarchical regression analysis for variables predicting gains in receptive language abilities

	Gains in receptive language											
Predictor variables	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β
Goal understanding	.20	.08	.57*	.14	.9	.39	.11	.08	.33	.11	.09	.33
Imitation				.95	.79	.31	.93	.73	.31	.89	1.02	.29
ADOS total score							−1.3	−.37	−.37	−1.3	.80	−.37
Object use										.06	.90	.02
R^2		.32			.39			.53			.53	
F change		6.24*			1.44			3.26			.00	

* $p < .05$

Table 6 Summary of hierarchical regression analysis for variables predicting gains in expressive language abilities

	Gains in expressive language											
Predictor variables	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β
ADOS total score	−2.29	.73	−.61**	−2.04	0.59	−.54*	−1.71	.72	−.45*	−1.70	.75	−.45*
Object use				1.01	.58	.33	1.04	.56	.33	.86	.79	.28
Age							−.17	.12	-.26	−.18	.13	−.27
Imitation										.26	.79	.08
R^2		.38			.48			.54			.55	
F change		9.75**			3.02			1.94			.10	

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

younger and older children and across developmental levels. Moreover, unlike other studies (Granpeesheh 2009), we did not find any association between the number of treatment hours and outcome measures, which may be a result of all children receiving a minimum of at least 15 h of treatment per week.

These preliminary data suggest that the ESDM might be particularly beneficial to children whose cognition is more "organized" around goals, as reflected in the use objects in a goal-directed way, the understanding of goals behind others' actions and the imitation of others' goal-directed actions.

This pilot study has a number of strengths, including the introduction of theory-driven experimental tasks that are suitable for children across functioning levels and that target specific processes involved in learning, as well as the focus on teaching procedures that are delivered according to manualized guidelines and subject to fidelity assessment. However, some relevant limitations must be noted. First, it is possible that factors other than the ones we tested moderated response to treatment. For example, it is possible that differences in the parents' use of ESDM strategies at home played a relevant role; however this was not measured in the present study. Moreover, the lack of a control group does not enable us to determine whether the factors that we found to be associated with positive outcomes are specific to responses to the ESDM. Interestingly, the ability to use play materials in a functional way, which was the strongest predictor in this study, emerges quite often as a predictor of outcome across studies focused on different treatment models (Kasari et al. 2012a, b; Schreibman et al. 2009; Carter et al. 2011; Yoder and Stone 2006a, b), suggesting that the ability to act in the physical environment in a goal-directed versus purposeless way might be a prerequisite for learning in general, regardless of the specific treatment received. Moreover, it is also possible that the factors that we identified, rather than mediating the response to specific teaching strategies, reflect abilities that are foundational to social-cognitive development, regardless of intervention. Indeed, individual differences in object play, imitation and joint attention have been found to be associated with language and cognitive development amongst both typically developing children and children with ASD (Poon et al. 2011; McEwen et al. 2007; Mundy et al. 2007).

In order to provide a rigorous investigation on the predictors of outcomes that are specific to the ESDM versus other models, it would be necessary to conduct a randomized control trial comparing different treatments and testing whether the hypothesised early predictors moderate response to the ESDM only. The findings from the present study provides the relevant information on the predictors that should be considered in future research.

Acknowledgments This Project was funded by the Commonwealth Department of Family, Housing, Community Services and Indigenous Affairs (FaHCSIA). The authors thank Carmela Germano for statistical assistance and Kristelle Hudry for her comments on a previous draft of the article. In addition, we extend our gratitude to the children and their families who participated so generously in this study.

References

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice Hall.

Cannon, E. N., Woodward, A. L., Gredeback, G., von Hofsten, C., & Turek, C. (2012). Action production influences 12-month-old infants' attention to others' actions. *Developmental Science, 15*(1), 35–42.

Carter, A. S., Messinger, D. S., Stone, W. L., Celimli, S., Nahmias, A. S., & Yoder, P. (2011). A randomized controlled trial of Hanen's 'More Than Words' in toddlers with early autism symptoms. *Journal of Child Psychology and Psychiatry, 52*(7), 741–752.

Csibra, G., & Gergely, G. (2006). Social learning and social cognition. The case for pedagogy. In Y. Munakata (Ed.), *Processes of change in brain and cognitive development* (pp. 249–274). Oxford: Oxford University Press.

Csibra, G., & Gergely, G. (2007). 'Obsessed with goals': Functions and mechanisms of teleological interpretation of actions in humans. *Acta Psychologica (Amst), 124*(1), 60–78.

Dawson, G., & Bernier, R. (2007). Social brain circuitry in autism. In D. Coch, G. Dawson, & K. Fischer (Eds.), *Human behavior and the developing brain*. New York: Guilford Press.

Dawson, G., Rogers, S., Munson, J., Smith, M., Winter, J., Greenson, J., et al. (2010). Randomized, controlled trial of an intervention for toddlers with autism: The early start Denver model. *Pediatrics, 125*(1), e17–e23.

Eikeseth, S., Smith, T., Jahr, E., & Eldevik, S. (2007). Outcome for children with autism who began intensive behavioral treatment between ages 4 and 7: A comparison controlled study. *Behavior Modification, 31*(3), 264–278.

Eldevik, S., Eikeseth, S., Jahr, E., & Smith, T. (2006). Effects of low-intensity behavioral treatment for children with autism and mental retardation. *Journal of Autism and Developmental Disorders, 36*(2), 211–224.

Flanagan, J. R., & Johansson, R. S. (2003). Action plans used in action observation. *Nature, 424*(6950), 769–771.

Flanagan, H. E., Perry, A., & Freeman, N. L. (2012). Effectiveness of large-scale community-based intensive behavioral Intervention: A waitlist comparison study exploring outcomes and predictors. *Research in Autism Spectrum Disorders, 6*(2), 673–682.

Gotham, K., Risi, S., Pickles, A., & Lord, C. (2007). The autism diagnostic observation schedule: Revised algorithms for improved diagnostic validity. *Journal of Autism and Developmental Disorders, 37*(4), 613–627.

Granpeesheh, D., et al. (2009). The effects of age and treatment intensity on behavioral intervention outcomes for children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, 1014–1022.

Gredeback, G., Stasiewicz, D., Falck-Ytter, T., von Hofsten, C., & Rosander, K. (2009). Action type and goal type modulate goal-directed gaze shifts in 14-month-old infants. *Developmental Psychology, 45*(4), 1190–1194.

Green, J., Charman, T., McConachie, H., Aldred, C., Slonims, V., Howlin, P., et al. (2010). Parent-mediated communication-focused treatment in children with autism (PACT): A randomised controlled trial. *The Lancet, 375*, 2152–2160.

Harris, S. L., & Handleman, J. S. (2000). Age and IQ at intake as predictors of placement for young children with autism: a four- to six-year follow-up. *Journal of Autism and Developmental Disorders, 30*(2), 137–142.

Hernik, M., & Csibra, G. (2009). Functional understanding facilitates learning about tools in human children. *Current Opinion in Neurobiology, 19*(1), 34–38.

Howlin, P., Magiati, I., & Charman, T. (2009). Systematic review of early intensive behavioral interventions for children with autism. *American Journal on Intellectual and Developmental Disabilities, 114*(1), 23–41.

Ingersoll, B. (2010). Pilot randomized controlled trial of reciprocal imitation training for teaching elicited and spontaneous imitation to children with autism. *Journal of Autism and Developmental Disorders, 40*(9), 1154–1160.

Johnson, M. H. (2005). *Developmental cognitive neuroscience*. Oxford: Blackwell.

Kasari, C., Gulsrud, A., Freeman, S., Paparella, T., & Hellemann, G. (2012a). Longitudinal follow-up of children with autism receiving targeted interventions on joint attention and play. *Journal of the American Academy of Child and Adolescent Psychiatry, 51*(5), 487–495.

Kasari, C., Gulsrud, A., Freeman, S., Paparella, T., & Hellemann, G. (2012b). Longitudinal follow-up of children with autism receiving targeted interventions on joint attention and play. *Journal of the American Academy of Child and Adolescent Psychiatry, 51*(5), 487–495.

Kasari, C., Paparella, T., Freeman, S., & Jahromi, L. B. (2008). Language outcome in autism: Randomized comparison of joint attention and play interventions. *Journal of Consulting and Clinical Psychology, 76*(1), 125–137.

Kuhl, P. K. (2007). Is speech learning "gated" by the social brain? *Development Science, 10*, 110–120.

Lord, C., Rutter, M., DiLavore, P. C., & Risi, S. (1999). *Autism diagnostic observation schedule*. Los Angeles, CA: Western Psychological Services.

Magiati, I., Charman, T., & Howlin, P. (2007). A two-year prospective follow-up study of community-based early intensive behavioural intervention and specialist nursery provision for children with autism spectrum disorders. *Journal of Child Psychology and Psychiatry, 48*(8), 803–812.

Makrygianni, M. K., & Reed, P. (2010). A meta-analytic review of the effectiveness of behavioural early intervention programs for children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 4*, 577–593.

McEachin, J. J., Smith, T., & Lovaas, O. I. (1993). Long-term outcome for children with autism who received early intensive behavioral treatment. *American Journal on Mental Retardation, 97*(4), 359–372 (discussion 373–391).

McEwen, F., Happe, F., Bolton, P., Rijsdijk, F., Ronald, A., Dworzynski, K., et al. (2007). Origins of individual difference in imitation: Links with language, pretend play, and socially insightful behavior in two-year-old twins. *Child Development, 78*, 474–492.

Mullen, E. (1995). *Infant Mullen scales of early learning*. Circle Pines, MN: American Guidance Service.

Mundy, P., Block, J., Delgado, C., Pomares, Y., van Hecke, A. V., & Parlade, M. V. (2007). Individual differences and the development of joint attention in infancy. *Child Development, 78*, 938–954.

Pallant, J. (2010). *A step by step guide to data analysis using the SPSS program* (4th ed.). Sydney, Australia: Allen & Unwin.

Perry, A., Cummings, A., Geier, J. D., Freeman, N. L., Hughes, S., Managhan, T., et al. (2011). Predictors of outcome for children receiving intensive behavioral intervention in a large, community-based program. *Research in Autism Spectrum Disorders, 5*, 592–603.

Poon, K. K., Watson, L. R., Baranek, G. T., & Poe, M. D. (2011). To what extent do joint attention, imitation, and object play

behaviors in infancy predict later communication and intellectual functioning in ASD? *Journal of Autism and Developmental Disorders*, 1–11.

Remington, B., Hastings, R. P., Kovshoff, H., degli Espinosa, F., Jahr, E., Brown, T., et al. (2007). Early intensive behavioral intervention: outcomes for children with autism and their parents after two years. *American Journal of Mental Retardation, 112*(6), 418–438.

Rogers, S. J., & Dawson, G. (2010). *Early start Denver model for young children with autism : Promoting language, learning, and engagement*. New York: Guilford Press.

Rogers, S. J., Hayden, D., Hepburn, S., Charlifue-Smith, R., Hall, T., & Hayes, A. (2006). Teaching young nonverbal children with autism useful speech: a pilot study of the Denver model and PROMPT interventions. *Journal of Autism and Developmental Disorders, 36*(8), 1007–1024.

Rogers, S., & Wallace, K. (2011). Intervention for Infants and toddlers with autism spectrum disorders. In D. G. Amaral, G. Dawson, & D. H. Geschwind (Eds.), *Autism spectrum disorders* (pp. 1081–1094). New York: Oxford University Press.

Sallows, G. O., & Graupner, T. D. (2005a). Intensive behavioral treatment for children with autism: Four-year outcome and predictors. *American Journal on Mental Retardation, 110*(6), 417–438.

Sallows, G. O., & Graupner, T. D. (2005b). Intensive behavioral treatment for children with autism: Four-year outcome and predictors. *American Journal of Mental Retardation, 110*(6), 417–438.

Schreibman, L., Stahmer, A. C., Barlett, V. C., & Dufek, S. (2009). Brief report: Toward refinement of a predictive behavioral profile for treatment outcome in children with autism. *Research in Autism Spectrum Disorders, 3*(1), 163–172.

Smith, T., Groen, A. D., & Wynn, J. W. (2000). Randomized trial of intensive early intervention for children with pervasive developmental disorder. *American Journal of Mental Retardation, 105*(4), 269–285.

Sommerville, J. A., & Woodward, A. L. (2005). Pulling out the intentional structure of action: The relation between action processing and action production in infancy. *Cognition, 95*(1), 1–30.

Stahmer, A. C., Schreibman, L., & Cunningham, A. B. (2011). Toward a technology of treatment individualization for young children with autism spectrum disorders. *Brain Research, 1380*, 229–239.

Tabachnick, B. G., & Fidell, L. S. (1996). *Using multivariate statistics* (3rd ed.). New York: HarperCollins.

Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, Mass: Harvard University Press.

Vismara, L. A., Colombi, C., & Rogers, S. J. (2009). Can one hour per week of therapy lead to lasting changes in young children with autism? *Autism, 13*(1), 93–115.

Vivanti, G., McCormick, C., Young, G. S., Abucayan, F., Hatt, N., Nadig, A., et al. (2011). Intact and impaired mechanisms of action understanding in autism. *Developmental Psychology, 47*(3), 841–856.

von Hofsten, C. (2007). Action in development. *Developmental Science, 10*(1), 54–60.

Yoder, P., & Stone, W. L. (2006a). A randomized comparison of the effect of two prelinguistic communication interventions on the acquisition of spoken communication in preschoolers with ASD. *Journal of Speech, Language and Hearing Research, 49*(4), 698–711.

Yoder, P., & Stone, W. L. (2006b). A randomized comparison of the effect of two prelinguistic communication interventions on the acquisition of spoken communication in preschoolers with ASD. *Journal of Speech, Language and Hearing Research, 49*(4), 698–711.

Young, G. S., Rogers, S. J., Hutman, T., Rozga, A., Sigman, M., & Ozonoff, S. (2011). Imitation from 12 to 24 months in autism and typical development: A longitudinal Rasch analysis. *Developmental Psychology, 47*(6), 1565–1578.