Learning Through Interaction in Children With Autism: Preliminary Data From a Social-Communication-Based Intervention

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Learning through interaction in children with autism: Preliminary data from a social-communication-based intervention

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Abstract

The study evaluates a social-communication-based approach to autism intervention aimed at improving the social interaction skills of children with autism spectrum disorder. We report preliminary results from an ongoing randomized controlled trial of 51 children aged 2 years 0 months to 4 years 11 months. Participants were assigned to either a target treatment or community treatment group. Families in the target treatment group were given 2 hours of therapy and coaching each week in an intervention emphasizing social-interaction and the parent-child relationship. Children in the community treatment group received a variety of services averaging 3.9 hours per week. After 12 months, outcomes were measured to determine changes in the groups in social interaction and communication. In addition, a regression analysis was conducted to determine whether changes in social interaction skills were associated with language development. Results suggest that children in the treatment group made significantly greater gains in social interaction skills in comparison to the community treatment group, but no between-group differences were found for standard language assessments. Initiation of joint attention, involvement, and severity of language delay were found to be significantly associated with improvement of language skills in children with autism. Finally caregiver skills targeted by the intervention were found to be significantly associated with changes in children's interaction skills.

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Introduction

Among the core symptoms of autism spectrum disorder (ASD) are deficits in abilities related to social interaction and communication. Children with autism, for example, have been shown to display little enjoyment in interactions with others (Bieberich and Morgan, 2004; Scambler et al., 2007; Snow et al., 1987), in joint attention and shared attention with others (Aldred et al., 2004; Carpenter et al., 2000; Kasari et al., 2006; Kasari et al., 2010; Loveland and Landry, 1986; Mundy and Crowson, 1997; Mundy et al., 1994; Tomasello et al., 2005; Watson and Flippin, 2008), and in understanding and expressing verbal and non-verbal communication. Many interventions seek to improve such aspects of social interaction and communication by teaching specific behaviors known to be associated with or predictive of development in these areas. However, a second class of interventions, which might be classed as Developmental Social Pragmatic (DSP) interventions (Prizant and Wetherby, 1998), take a somewhat different approach. These interventions are designed around two concepts. First, they seek to teach children functional skills in a sequence that is generally consistent with typical child development. Second, they focus on helping children to develop various capacities related to social communication in a pragmatically appropriate social context rather than targeting the behaviors themselves. Here, we are making the distinction between the observable behaviors such as eye contact and pointing, which mark developmental capacities, and the developmental capacities themselves. The ability to engage in joint attention is a developmental capacity, but given that the capacity to engage in joint attention itself cannot be observed, researchers and clinicians observe markers of joint attention: eye contact, pointing, body positioning etc. To illustrate the difference in orientation of these two types of interventions, consider the importance of eye contact. Eye contact has been suggested to be an important skill for children because it is associated with greater joint attention skills (Arnold et al., 2000; Clifford and Dissanayake, 2009; e.g. Kasari et al., 2008; Tantam, 2009; Zwaigenbaum et al., 2005), and greater joint attention skills have in turn been associated with increased language abilities (e.g. Mundy et al., 1990; Tomasello and Farrar 1986). Given this research, many traditional intervention programs specifically teach children to make eye contact (e.g. through the use of fading procedures). However, from a DSP perspective, one might argue that it is not the behavior of looking in another person's eyes that is important; rather, it is the purpose for doing so (e.g. seeing where the person is looking or whether they are paying attention, or determining their emotional state). Theoretically, DSP models focus on the function of the developmental capacities rather than the behaviors (what Ingersoll and colleagues (2005) call 'specific forms'), and teach them in a pragmatically appropriate context to underscore their social and communicative functions. Moreover, many DSP models use stages or ordered sequences of skills that the children are taught with the understanding that some higher or more advanced skills depend on lower skills (e.g. the ability to engage in joint attentional frames is generally targeted before spoken language). Following Prizant and Wetherby (1998), Ingersoll and colleagues (2005) list several other common characteristics or strategies consistent with this general notion, including 1) the adult joins the child's focus of interest, 2) the adult arranges the environment to encourage initiations from the child, 3) communicative attempts are responded to as if they are purposeful, and 4) emotional expression and affect sharing are emphasized. For the purposes of characterizing the intervention under examination in this paper, we will use DSP to indicate interventions that follow in large part the tenets outlined above.

Several recent studies have reported favorable results for DSP interventions. McConachie and colleagues (2005), for example, investigated the Hanen Method (Manolson, 1992), a parent teaching intervention aimed at improving language via social interactions. The quasi-experimental study found that parents learned the strategies taught to them by the method, and that children's vocabulary as measured by parent report increased. Ingersoll and colleagues (2005), in a single-subject multiple baseline study, demonstrated a significant increase in spontaneous language over baseline following the onset of a treatment program that combined some basic strategies from several developmental social-pragmatic approaches. Mahoney and Perales (2003, 2005) conducted a quasi-experimental study and a pre-post study in which they found that training parents in a relationships-based intervention resulted in significant improvements in children's social-emotional functioning. Wetherby and Woods' (2006) quasi-experimental study found marginally significant increases in social communication behaviors when parents were taught techniques as part of their Early Social Interaction Project. And in a small pre-post study of children receiving Relationship Development Intervention (RDI), Gutstein and colleagues (2007) found evidence of improvement in autism severity following 30+ months of treatment. Finally, Solomon and colleagues (2007), in a pre-post study, found that a Developmental Individualized Relationships-based (DIR) intervention significantly improved children's social-emotional functioning. Although these studies are beginning to build a convincing body of literature, we note that none of the studies mentioned above use randomized controlled designs. Consequently, each must be considered with the appropriate amount of caution.

There are, however, some recently published randomized controlled trials of treatments that have much in common with DSP approaches, and have found similar success in improving children's joint attention and communication abilities. Kasari and colleagues (2010), for example, were able to increase the frequency of children's joint attention behaviors and increase the frequency of functional play acts by teaching parents to focus on developing children's joint attention skills. Aldred and colleagues (2004) demonstrated that a parent-mediated social-communication intervention was effective in reducing the severity of autism symptoms as measured in the Autism Diagnostic Observation Schedule (ADOS). And Green and colleagues (2010), in a very well-controlled study of a social-communication-based intervention called PACT (Preschool Autism Communication Trial), were able to show both a small reduction in ADOS severity, as well as significant improvements in child initiations of joint attention and joint engagement. These randomized controlled trials taken together with the studies mentioned in the previous paragraph underscore the potential benefits of interventions targeting social interaction skills, and perhaps improvements in language skills as well. However, it is important to note that none of the interventions cited demonstrated improvements in standardized assessor rated measures of language – improvements were noted only for parent reports or non-standardized observations of language use.

To add to the general understanding of the effectiveness of DSP interventions, we have conducted a randomized controlled trial of a DIR-based intervention for autism at the Milton & Ethel Harris Research Initiative (henceforth the MEHRI treatment program, or simply MEHRIT). In this report, we present preliminary data from the ongoing study that specifically investigates improvements in children's social interaction and communication following 12 months of treatment in the MEHRI treatment program. Because MEHRIT may be classed as a DSP treatment model, this study adds to our understanding of the effectiveness of DSP and similar treatment models. In addition, it is only the second

peer-reviewed study to investigate the effectiveness of a DIR-based model, and the first to include a randomized control group. Because the DIR model, as well as other DSP and social-interaction based models, are gaining in popularity, research on their effectiveness is in demand, and this study makes a contribution towards filling that demand.

Given that the aim of DSP interventions is to improve social communication, we focus the investigation on four factors important to social interaction. First is the quality of social interaction. That is, how involved, engaged or interested is the child in play?; Research has suggested that the level of child engagement or involvement in social interaction is associated with cognitive and linguistic development in children with ASDs (Kim and Mahoney, 2004; de Kruif and McWilliam, 1999; Mahoney and Perales, 2005; Mahoney et al., 2007). Second is the child's ability to engage in and initiate joint attentional frames, an ability that, as noted above, predicts language development. Third is the degree to which the child seems to enjoy interacting with the caregiver, which may well reflect the child's intrinsic motivation to interact with the adult (see Deci and Ryan, 2000 for an overview of intrinsic motivation's affect on learning). Finally, as Hoff-Ginsberg and Shatz (1982) point out, social interaction is the primary means through which children typically learn language. On the assumption that this observation also holds for children with ASDs, we measure language ability using standard language assessments.

Overview of the MEHRI treatment program

MEHRIT fits well into the DSP model. It is aimed at improving children's social interaction and communication abilities, and includes each of the characteristics of DSP interventions described above. In addition to these common DSP features, MEHRIT includes several features that, although not inconsistent with DSP approaches, are also neither unique to nor required of DSP interventions, and are therefore worth mentioning. First, MEHRIT emphasizes caregiver involvement in the intervention process. Although this is not strictly a requirement of DSP interventions, it is fairly common. Of the studies mentioned above, only Ingersoll and colleagues (2005) did not include a parent-training component. There is, of course good reason to include parents in the interventions. Generally speaking, parents spend a great deal of time with their children, and therefore have many opportunities to implement the treatment throughout the child's day. Moreover, there is a good deal of research indicating both a close association between parent's behavior during social interaction with their child and children's cognitive and emotional development. For example, parenting behaviors are known to affect attachment (Bigelow et al., 2010; Cassidy and Shaver, 1999; Isabella and Belsky, 1991; McElwain and Booth-Laforce, 2006), emotional development (Bridgett et al., 2009; Pauli-Pott and Mertesacker, 2009; Pauli-Pott et al., 2004), regulation (Calkins and Hill, 2007; Conradt and Ablow, 2010; Gianino and Tronick, 1988; Haley and Stansbury, 2003; Spangler et al., 1994), and social communication (Akhtar et al., 1991; Carpenter et al., 1998; Tamis-LeMonda et al., 2001). Siller and Sigman 2002, 2008) have extended this research to children with autism in their longitudinal studies whose results suggest the importance of parental behaviors in facilitating social interaction among children with autism. And researchers have also shown that teaching parents simple behaviors, such as imitating the child's behavior, has a positive effect on autistic children's social communication skills (both verbal and non-verbal) (Dawson and Adams, 1984; Katagiri et al., 2009; Sanefuji et al., 2009; Tiegerman and Primavera, 1984).

Secondly, MEHRIT uses a set of developmental capacities derived from Greenspan and Wieder's (Greenspan and Wieder, 2006; Greenspan et al., 2007) DIR Floortime program as a general guide to treatment. They are: 1) the ability of a child to be regulated, 2) their ability to attend to social interaction, 3) their ability to engage in reciprocal interactions such as conversations or proto-conversations, 4) their ability to solve problems (as distinguished from learning solutions) in social interactions, and 5) their ability to use ideas and language functionally. The implication of the ordering (called 'stages' in DIR) is that there is an ordered dependency such that the degree of functioning of later capacities depends on the degree of functioning of earlier capacities.[1] Thus MEHRIT therapists will attempt to ensure that in any given moment a child is functioning adequately in lower capacities before targeting later capacities. A therapist working with a child who is at the time unable to engage in reciprocal interactions (stage 3) would not target the child's ability to use language (stage 5), for example. The phrases 'in any given moment' and 'at the time' are salient in MEHRIT because they underscore the fact that a child's level of functioning can change from moment to moment, and the therapist shifts the focus of therapy accordingly.

Finally, MEHRIT includes an emphasis on regulation through the use of co-regulation and sensory-motor supports. Co-regulation is the natural, perhaps instinctive, effect of one person's arousal level on another person's arousal level. It is the mechanism that accounts for the phenomenon that is observed in an interaction when one person's whispering causes the other person to also start whispering. It is the mechanism by which a mother soothes an upset child by speaking slowly and softly. In a sense, a person's arousal level can be thought of as contagious. In MEHRIT, the adult seeks to ensure that the child is at a level of arousal that is optimal for the task at hand, and optimal for that particular child. Sensory-motor supports include any modification or use of the environment to facilitate the child's optimal regulatory and attentive state. Although such supports may include swings or other equipment such as an occupational therapist might use, it can be as simple as dimming the lights in a room to help the child reduce his or her arousal level.

Methods

Participants

A sample of 51 children from an ongoing randomized controlled trial of the MEHRI intervention was selected for this paper. The sample selection includes all children who had completed 12 months of intervention (or 12 months in the community treatment group) and for whom a semi-structured parent-child interaction was videotaped both prior to intervention and following 12 months of intervention. Families were recruited through diagnosing physicians, public service agencies and newspaper advertisements in the Greater Toronto Area. All children were previously diagnosed with ASDs, and the diagnoses were confirmed using ADOS and Autism Diagnostic Interview (ADI) administered by individuals who have completed the research training requirements of the test developers. Children were between 2 years 0 months and 4 years 11 months at the start of treatment. Upon expressing interest in the study, families were pre-screened for eligibility requirements. Those with neurological or developmental diagnoses other than ASDs were excluded from the sample. Families who were not able to meet the time requirements of the study (2 hours per week of therapy and approximately 3 hours per day spent interacting with their child) were likewise excluded.

Treatment groups

Children were accepted into the study in three cohorts to give therapists adequate time to accommodate new cases. In each cohort, children were stratified by age and baseline level of language function, and were randomly assigned to one of two groups using random.org's random number generator: 1) MEHRI treatment program (MEHRIT) or 2) Community Treatment (CT). The resulting dataset contained 25 children in the MEHRIT group and 26 in the CT group. Families in the CT group were encouraged to seek treatment for their child while awaiting treatment through the study. No families received more than 15 hours of treatment per week while awaiting treatment through our program. Various treatments solely or in combination were reported by parents, including traditional speech therapy (n = 18), ABA (n = 16), occupational therapy (n = 12), social skills group (n = 3), specialized part-time day care (n = 3), and other alternative treatments, such as hyperbaric oxygen therapy, specialized/holistic diets etc. (n = 8). On average, CT group families received 3.9 hours of treatment per week. Table 1 records pertinent demographic factors for the groups as well as pre-treatment scores on the ADOS (communication + social interaction scores), language age equivalents, and cognitive age equivalents as measured by either the Wechsler Preschool and Primary Scale of Intelligence-III (Wechsler, 2002), or, if under 2 years 6 months or unable to complete the Wechsler test, the Bayley Scales of Infant Development-III (Bayley, 2005 or see Table 1).

Treatment implementation

Therapists were licensed speech-language pathologists or occupational therapists. Therapists received approximately 3 weeks of intensive hands-on training from DIR faculty members

Table 1 Summary of group characteristics at intake

		MEHRIT	Community treatment
Child's age	t(49) = 1.619, p = .112	Mean = 42.52, SD = 8.76	Mean = 46.38, SD = 8.29
Mother's education level	Advanced degree	2	6
	Bachelor's degree	15	11
	Associates degree	1	3
	Some university/college	7	4
	High school	0	2
Income*	More than 100,000	12	11
	50,000–100,000	6	4
	Less than 50,000	4	8
Mother's native language	English	15	12
	Other	10	14
Language most often spoken at home	English	23	23
	Other	2	3
	Non-responders	0	0
Marital status	Married/partnered	24	22
	Single/divorced/separated	1	4

*Incomes are in Canadian dollars. Three families in each group elected not to provide information on their income. Statistics Canada reports the 2008 median gross income in Canada is approximately $76,000 (2010).

before the start of therapy. Thereafter, the therapists continued training by attending DIR Summer Institutes (required for DIR certification) and meeting weekly with DIR faculty members who oversaw therapy, provided continuing instruction in DIR, and consulted on cases. DIR Certification is offered only through the Interdisciplinary Council on Developmental and Learning Disorders (ICDL), and was directed by Serena Wieder, one of the founders of the DIR method, while the therapists were completing training.

Therapists met for 2 hours each week with children and caregivers. A 15–20 min break was given to children at the halfway point of a session, during which time therapists consulted with caregivers regarding the therapy. Therapists' primary goals were 1) to assess the individual strengths and challenges of the child from the perspective of speech and communication, sensory, cognitive and motor abilities, and 2) teach parents about their child's strengths and challenges and devise a set of strategies appropriate for the child and the family. In addition to weekly meetings, caregivers met approximately every 8 weeks with therapists to discuss progress and review videotaped play sessions of caregivers and their child to get a broad, off-line perspective of the therapeutic approach, and address any concerns or questions that could not be dealt with during the weekly sessions.

Experimental design

Assessments were conducted at the time children enrolled in the study and again 12 months later. During the 12 months, the MEHRIT group received 2 hours per week of treatment through the MEHRI treatment program. Children in the CT group received a variety of autism services available in the community.

Measures

A modified version of the Child Behavior Rating Scale (Kim and Mahoney, 2004; Mahoney and Perales, 2003) (henceforth mCBRS) was used to rate children's interactions with their parents at 0 and 12 months into treatment. The 5-point Likert-type scale is designed to track what Mahoney and colleagues call 'pivotal behaviors', which they define as core learning processes that mediate between parental responsiveness and developmental cognitive, linguistic and socio-emotional functioning (Kim and Mahoney, 2004; Mahoney et al., 2007). Their research has suggested that children with developmental disabilities show fewer pivotal behaviors than typically developing peers (Kim and Mahoney, 2004), and that increases in pivotal behaviors account for 9.5% of the variance in linguistic and cognitive gains (Mahoney and Perales, 2005).

Two modifications were made to the CBRS reported in this study. First, all categories were coded in respect to interaction with the adult. That is, whereas the description of the category *Attention to Interactive Activity* states 'This scale assesses the extent to which the child attends to activities. While the child may or may not be actively involved in the activity, the child rated as demonstrating high attention remains in the activity for an extended duration,' our modification to the coding specified that the activity take place in the context of an interaction with the caregiver (parent): 'This scale assesses the extent to which the child attends to activities during joint interactions with the parent. Although the child may or may not be actively involved in the activity, the child rated as demonstrating high attention remains in the activity with the parent for an extended duration.' We made this modification to bring the analysis in line with the purpose of the research; namely, to investigate improvements in developmental capacities

related to social interaction. Without the modification, a child who repetitively lines up cars while ignoring the parent might ostensibly score high in *Attention to Interactive Activity* or *Involvement*. The second modification was to collapse the categories *Initiates Activity* and *Joint Attention*. This was made necessary by the fact that the first modification nullifies the difference between the descriptions of the two activities. That is, the original descriptions of *Initiates Activity* and *Joint Attention* are initially fairly close, as shown in (a) and (b):

(a) This scale measures the extent to which the child initiates activities.
(b) The extent to which the child initiates interaction with the adult is measured using this scale.

Following the changes imposed by the first modification, they become indistinguishable except for the use of the terms *Interactions* and *Activities*, which overlap considerably in terms of coding behaviors:

(a) This scale measures the extent to which the child initiates activities with the parent.
(b) The extent to which the child initiates interaction with the parent is measured using this scale.

To deal with this issue of redundancy, the codes from the two categories were averaged into a single category called *Joint Attention*, which encompassed behaviors coded under both descriptions. Finally, the category *Persistence* was omitted from analyses owing to the low frequency of occurrence of behaviors that qualified for a coding in that category (less than 5% of the videos). The final set of codes used in the study includes five items, *Attention, Involvement, Cooperation, Joint Attention,* and *Enjoyment of Activity*.

Following modifications, the internal consistency was calculated with the sample of 51 participants. Internal consistency for the entire scale was rated at $\alpha = .701$. Factor analysis shows that four of the five items factor closely together, with the fifth item, *Enjoyment of Activity*, having an item-scale correlation of only .2. Removing this item would increase internal consistency to $\alpha = .823$. However, doing so would make it impossible to calculate reliability for this item alone, and because an α of .7 is generally considered acceptable for psychometric scales, we elected to include all five items.

Preschool Language Scale IV (PLS) and Comprehensive Assessment of Spoken Language (CASL)

The Preschool Language Scale IV (Zimmerman et al., 2006) measures receptive and expressive language skills in children from birth to age 6 years. The measure was normed on a sample of 1500 children and is administered by a speech-language pathologist. Test-retest consistency for the PLS-IV total score ranges from .90 to .97. The standard deviation for the PLS-IV is 15 points with a mean of 100.

Although we are reporting outcomes from only the first 12 months of therapy in this report, therapy will last for a total of 2 years for each child. Adding to that the additional year during which the CT group is awaiting MEHRIT, many children would have aged out of the PLS (which is normed for children up to 6 years of age). As a result, when possible, we administered The Comprehensive Assessment of Spoken Language (Carrow-Woolfolk, 1999) to children because of its broader range of age norms. In all cases, children were administered the same

assessment pre- and post-treatment. The CASL measures receptive and expressive language skills in individuals 3 to 21 years of age. The measure was normed on a sample of 1700 individuals and was administered by a speech-language pathologist. The test-retest consistency for the CASL is .92 to .93 for the total composite score. The standard deviation for the CASL is 15 points with a mean of 100.

Parent fidelity to treatment

Caregiver behaviors were measured using a subset of items from the MEHRIT Fidelity Scale (Casenhiser et al., 2010). Because the scale is intended to measure fidelity of professional clinicians, items from the full scale that are specific to a particular therapist's discipline (e.g. speech-language pathologist, occupational therapist), or that could not be coded from the videotaped interactions (e.g. items referring to 'room set-up' were excluded because all parents had the same room set-up) were not coded. A brief description of the remaining seven items is provided below:

(1) *Co-regulation*: How well does the adult use his or her own arousal level (as expressed through movement, voice, facial expressions etc.) to counterbalance and/or complement that of the child?
(2) *Expression of Enjoyment of the Child:* Does the adult express enjoyment in being with the child through displays of affect (excited/happy tone of voice, facial expressions, gestures etc.)?
(3) *Sensory-Motor Support*: How well does the adult support the child's regulation through the use of objects at hand, physical support to the body, such as postural support, deep pressure, vestibular support, etc.?
(4) *Joining*: How well does the adult join the child's focus of attention rather than directing the child to the adult's focus of attention?
(5) *Use of Affect*: How well does the adult use affect (tone of voice, facial expressions, actions and gestures) to support the child's interest in and attention to the interaction?
(6) *Support of Reciprocity:*How well is the adult able to encourage the child to engage in balanced and extended interactions through the use of matching the child's level of functioning in the moment, building rhythm, use of anticipatory facial expressions or gestures, and other scaffolding techniques?
(7) *Support of Independent Thinking*: How well does the adult support the child's efforts to engage in independent cognitive processes, ideation and/or problem solving that is just beyond the child's current cognitive ability through the use of various supports and scaffolds (visual supports, waiting, use of affect, offering hints etc.)?

Items are coded with a 6-point scale: 0 = No evidence of interactions appropriate to MEHRIT, 1 = Interactions appropriate to MEHRIT are rarely observed, 2 = Interactions appropriate to MEHRIT are sometimes observed, 3 = Interactions appropriate to MEHRIT are frequently observed, 4 = Full competence (errors are rare), 5 = Mastery (no obvious errors). Because the scale was intended for fidelity rating of professional clinicians with extensive experience and training, parents are not expected to gain full competence in the model. The scale should nonetheless serve as a process measure of change in the behaviors that MEHRIT considers important for development.

Psychometric properties of the scale

Cronbach's α is in the good range at.841 (n = 96). Factor analysis indicates two factor clusters that are characterized as items that support the child's regulation (*Co-regulation*, *Use of Affect*, and *Sensory-Motor Support*), and items affecting the quality of the interaction itself (*Expression of Enjoyment of the Child*, *Joining*, *Support of Reciprocity*, and *Support of Independent Thinking*).

Data analysis and results

mCBRS data preparation and analysis

All interactions were videotaped and later scored by a team of four coders who were blind to group assignment. Each video was coded independently by two coders. Before discussion, the average intra-class correlation coefficient was 0.92. Following the initial coding, the two coders met to discuss disagreements and review videotapes until a consensus was reached bringing the final agreement between the coders to 100%.

No significant differences were observed between groups on any of the items before treatment (α is $p < .05$ throughout) (Table 2). Difference scores were calculated for each item in the scale. In preparation for the initial MANOVA analysis, preliminary tests were conducted to confirm that data meet the assumptions of normality ($z < \pm 1.96$ for skew and kurtosis) and homogeneity of covariance matrices ($p > .05$). A repeated measures MANOVA was conducted with pre and post scores of the 5 scale items as dependent measures and group as the independent measure. Results indicate that overall, significant improvements were made in scores pre- to post-treatment ($\Lambda = .418$, $F(5, 45) = 12.532$, $p < .001$, $\eta^2 = .582$), and that these changes differed marginally significantly by group ($\Lambda = .792$, $F(5, 45) = 2.300$, $p = .061$, $\eta^2 = .204$). There was also a significant pre-post-treatment by group interaction observed ($\Lambda = .671$, $F(5, 45) = 4.408$, $p = .002$, $\eta^2 = .329$). Univariate tests were examined for the details of the interaction. The improvements made by the MEHRIT group were

Table 2 Summary of group differences on the mCBRS (Statistics Canada, 2010)

		Pre-treatment between-group comparison			Pre-post between-group comparison			
Scale item	Group	Time 1 Mean	SD1	*t(49)*	post-treatment mean	SD2	F(1,49)	Cohen's *d*
Attention to Activity	MEHRIT	2.96	.735	0.544	3.72	.614	5.78**	0.69
	CT	3.08	.796		3.38	.752		
Involvement	MEHRIT	2.56	.583	0.307	3.20	.866	7.73***	0.87
	CT	2.62	.697		2.69	.788		
Compliance	MEHRIT	2.68	.748	0.773	3.48	.963	2.121	0.51
	CT	2.85	.784		3.35	.797		
Initiation of Joint Attention	MEHRIT	1.28	.542	0.488	1.84	.549	15.83****	1.02
	CT	1.31	.987		1.23	.430		
Enjoyment in Interaction	MEHRIT	3.08	.277	2.39**	3.28	.458	4.909**	0.63
	CT	3.35	.485		3.23	.430		

**p < 0.05; *** p < 0.01; **** p <.001

significantly greater than those made by the CT group on all items with the exception of *Compliance*, which showed no significant difference. Between-group comparisons of the time one scores are non-significant except in the case of the *Enjoyment in Interaction* item, for which a significant pre-test difference is observed. Such a difference is unfortunate because it is impossible to correct statistically for it[2], and it thus casts this result into some uncertainty because it is not clear how or whether the higher pre-treatment *Enjoyment in Interaction* score for the CT group might affect treatment outcomes.

PLS-4 and CASL data preparation and analysis

Licensed speech language pathologists who were unknown to the children and blind to group assignment conducted all speech assessments. Children were assessed with either the CASL or the PLS-4 depending on age and ability. All children were assessed with the same instrument at 0 and 12 months (i.e. no child was assessed by the PLS-4 at 0 months and with the CASL at 12 months). To provide a small measure of control of differences due to maturation, developmental quotients were derived from the total score for the PLS-4 and CASL. Data were entered into SPSS (IBM, USA) and checked for accuracy by two research assistants working independently. No significant differences were observed between groups for the pre-treatment developmental quotients: $t(1,49) = 1.27$, $p > .05$. The analysis with developmental quotients indicates that children in both the MEHRIT ($t(24) = -2.197$, $p = .038$, $d = .451$; $M_1 = .64$; $SD_1 = .32$; $M_2 = .72$; $SD_2 = .39$) and CT groups ($t(25) = -4.138$, $p < .001$, $d = .915$; $M_1 = .54$; $SD_1 = .26$; $M_2 = .64$; $SD_2 = .32$) improved significantly from pre- to post-treatment. Finally, an analysis of covariance was conducted controlling for pre-treatment age and developmental quotient with treatment group as the independent variable and developmental quotient as the dependent variable. Results indicate that pre-treatment age ($F(1,47) = 2.926$, $p = .094$) and developmental quotient ($F(1,47) = 2.161$, $p = .148$) are not significant covariates, and that there is no significant difference between the MEHRIT (mean (M) = .08, SD = .04) and CT (M = .10, SD = .02) groups ($F(1,48) = 1.589$, $p = .214$, $\eta^2 = .022$).

Regression analysis of mCBRS and language assessments

Finally, because we have made some modifications to the CBRS, we cannot entirely rely on validity based on prior research (Kim and Mahoney, 2004; Mahoney and Perales, 2003; Mahoney et al., 2007). Moreover, given that MEHRIT is focused largely on improving children's social interaction abilities, it is important to establish that there is a predictive link between improvements in social interaction and language development. To that end, a regression analysis was conducted to determine whether the behaviors tracked in the mCBRS are predictive of language development as measured by the PLS and CASL.

A multiple regression analysis was first conducted with the difference scores of all five items in the mCBRS, plus pre-treatment language age equivalent and developmental quotient as predictors. Change in language scores was entered as the dependent variable. A regression analysis indicated that as a block the seven items constituted a significant predictor of language change ($R = .620$, $F(7,43) = 3.841$, $p = .003$). The individual predictors were examined to determine which of the items was a significant predictor of language change. Pre-treatment developmental quotient was determined to be a significant predictor of

language change. Among the mCBRS items, *Initiation of Joint Attention* and *Involvement* were significant predictors of language change, while the *Enjoyment of Interaction* item was a marginally significant predictor. Results are summarized in Table 3

Caregiver behaviors

As with the child behavior rating scale, each video was scored independently by two different MEHRIT therapists who subsequently met and discussed discrepancies in scoring. Before discussion, average intraclass correlation coefficient was .78. There was 100% agreement following discussion. The same videos were used as for the mCBRS (pre and post 12 months of treatment).

Results of the caregiver analyses are summarized in Table 4. The average score on the fidelity measure prior to treatment was 1.5 (SD = .12) in the MEHRIT group and 1.21 (SD = .09) in the CT group. Groups did not differ significantly before therapy neither on the omnibus MANOVA ($\Lambda = .880$, $F(7, 43) = .838$ $p = .562$) nor on any individual item (p values range from 0.20 to 0.74). A repeated measures MANOVA was used to compare pre-post differences within each group. There is no overall difference between pre- and post-treatment scores ($\Lambda = .823$, $F(7,43) = 1.319$, $p = .265$), but there is a significant effect for group ($\Lambda = 3.923$, $F(7,43) = 3.923$, $p = .002$) and a significant group by pre-post interaction ($\Lambda = .630$, $F(7,43) = 3.608$, $p = .004$). Univariate analyses by group indicate that, following treatment, the MEHRIT group's scores improved significantly more than the CT group over the course of 12 months on all fidelity items with the exception of *Sensory-Motor Support* and *Support of Independent Thinking*.

To investigate the significant group effect, pre-post differences on individual items were also investigated for each group and showed that the MEHRIT group improved significantly on all of the items with the exception of the *Sensory-Motor Support* item, which was statistically unchanged. As expected, the CT group remained largely unchanged over the course of 12 months. Scores on the *Joining* item, however, declined significantly.

Finally, we investigated caregivers' post-treatment performance as potential predictors of change in child outcomes (Table 3). A series of seven regression analyses were conducted with ratings of caregiver behaviors at 12 months post-treatment entered as a single block of independent variables, and each of the child behaviors (six social interaction items plus the language assessment scores) entered as the dependent variable. Results indicate that each of the items is significantly associated with improvements that are observed in at least one of the child social communication measures. *Sensory Motor Support* appears to be the least useful of the strategies because it is associated only with change in children's ability to initiate joint attention, but all other items are associated with changes in three to four child outcomes. Perhaps the most important of these are those associated with language change: *Expression of Enjoyment of the Child*, *Joining*, *Support of Reciprocity*, and *Support of Independent Thinking*. These four caregiver behaviors are also significantly associated with changes in *Involvement* and *Initiation of Joint Attention*, which are in turn the only child behaviors significantly associated with language change. There were no significant associations for *Compliance*. Finally, we conducted similar regression analyses substituting caregiver's pre-treatment scores for the post-treatment scores used as dependent variables in the analyses above. Caregiver behaviors before treatment were not significantly associated with of any of the changes in child outcomes.

Table 3 Regression matrix depicting associations among child and caregiver behaviors

	Post-treatment caregiver behaviors						
Change in child behaviors	Co-regulation	Enjoyment of child	Sensory-motor	Joining	Use of affect	Support of reciprocity	Independent thinking
Language change		R = .331, β = 2.67 t = 2.451**		R = .333, β = 3.85, t = 2.47**		R = .349, β = 3.13, t = 2.6**	R = .457, β = 5.4, t = 3.6***
Attention to interactive activity	R = .284, β = .185, t = 2.08**				R = .344, β = .264, t = 2.56**		
Involvement	R = .309, β = .220, t = 2.27**	R = .271, β = .168, t = 1.87**		R = .391, β = .348, t = 2.97***	R = .360, β = .303, t = 2.71***	R = .267, β = .185, t = 1.94*	R = .387, β = .353, t = 2.94***
Initiation of joint attention		R = .280, β = .147, t = 2.04**	R = .275, β = .185, t = 2.00**	R = .427, β = .321, t = 3.30***	R = .318, β = .226, t = 2.35**	R = .377, β = .220, t = 2.85***	R = .366, β = .282, t = 2.75***
Enjoyment of the interaction	R = .318, β = .155, t = 2.35**	R = .302, β = .129, t = 2.22**			R = .252, β = .145, t = 1.82*	R = .259, β = .123, t = 1.88*	R = .292, β = .182, t = 2.14**
Compliance							
	Change in children's social-interaction behaviors						
	Attention to interactive activity	Involvement	Enjoyment of the interaction	Initiation of joint attention	Compliance	Pre-treatment dev. quotient	Pre-treatment language age equivalent
Language change		R = .330, β = 4.29, F(1,49) = 5.996**	R = .245, β = 4.64, F(1,49) = 3.126*	R = .420, β = 6.47, F(1,49) = 10.524***		R = .527, β = 18.26, F(1,49) = 18.89***	

*p <.10; **p <.05; ***p <.01; ****p <.001

Table 4 Summary of parent behavior scores from the *MEHRIT Fidelity Scale*

		Pre-post treatment comparison				Between-groups comparison	
Scale Item	Group	$Mean_1$	$Mean_2$	t(24)t(25)	Cohen's *d*	F(1,49)	Cohen's *d*
Co-regulation	MEHRIT	1.32 (1.0)	1.92 (1.22)	3.13**	0.64	12.45****	.996
	CT	1.23 (.86)	1.00 (.69)	–1.66	–0.33		
Expression of enjoyment	MEHRIT	1.80 (1.23)	2.60 (1.23)	3.464***	0.693	7.96***	0.79
	CT	1.69 (1.10)	1.53 (1.03)	–.625	–0.143		
Sensory-motor	MEHRIT	1.60 (.87)	1.88 (1.1)	1.429	0.282	1.97	0.393
	CT	1.31 (.83)	1.19 (.75)	–.570	–0.177		
Joining	MEHRIT	1.76 (.60)	2.16 (.80)	2.089**	0.422	10.63***	0.92
	CT	1.58 (.50)	1.19 (.63)	–2.606**	–0.526		
Reciprocity	MEHRIT	1.12 (.78)	1.76 (1.13)	2.78***	0.574	9.05***	0.863
	CT	.85 (.73)	.65 (.80)	–1.22	–0.25		
Independent Thinking	MEHRIT	.60 (.65)	1.0 (.87)	2.31**	1.03	1.93	0.389
	CT	.42 (.76)	.50 (.76)	.496	0.10		
Use of Affect	MEHRIT	1.92 (.15)	2.48 (.82)	3.219***	0.989	11.70****	0.962
	CT	1.65 (.80)	1.46 (.71)	-1.413	-0.241		

*$p < 0.10$; ** $p < 0.05$; *** $p < 0.01$ **** $p < .001$.

Discussion

This paper presents results that are generally consistent with findings from previous research on DSP-like interventions, which have generally been found to improve children's outcomes related to measures of social interaction (e.g. Kim and Mahoney, 2004; Ingersoll et al., 2005; Solomon et al., 2007; Green et al., 2010; Kasari et al., 2010). Results from this study suggest that MEHRIT is effective in improving the general quality of children's social interaction over and above that of a community treatment group. As compared with children in the community treatment group, children in the MEHRIT group showed significantly greater enjoyment in interactions with their parents, were significantly more attentive and involved in interactions with their parents, and initiated more joint attentional frames. Moreover, considering that most of the children in the CT group were receiving traditional behavioral interventions for autism, the fact that these children did improve on *Compliance* and *Attention to Interactive Activity* is not unexpected because such interventions generally place a good deal of emphasis on teaching children to be compliant and attentive to the caregiver. What is particularly worth considering is that children in the MEHRIT group seem to have made greater improvements in these areas than did children in the CT group (though this difference was only marginally significant in the case of *Compliance*) even though MEHRIT does not target compliance and targets attention in a much more child-directed way. Thus, the results suggest that this alternative approach may be beneficial for improving children's abilities in these areas.

Results concerning language development were less robust. The ratio of children's age equivalence language scores to their chronological age at testing improved significantly in both the MEHRIT and CT groups, suggesting that children in both groups are catching up to their age-matched peers. No significant difference, however, was observed between the

MEHRIT and CT groups. While these results provide some evidence that both the MEHRIT and treatments being offered through the community might be effective in improving children language, the lack of a no-treatment control group means that the effects of maturation cannot be entirely discounted because children's developmental quotients might have improved without any treatment at all. Moreover, the results fail to show an advantage for the MEHRIT intervention at improving children's scores on standard language measures. Therefore we cannot conclude that 12 months of MEHRIT improves children's performance on standard language tests.

Results from regression analyses, however, are somewhat at odds with the results obtained from the standardized language assessments. Initiation of joint attention, for example, has been shown to be a significant predictor of language development in other studies (Mundy et al., 1990; Tomasello and Farrar 1986), and the results here confirm those findings. Partially replicating Mahoney and colleagues (Kim and Mahoney, 2004; Mahoney and Perales, 2003; Mahoney et al., 2007), this study also suggests that both *Involvement* and *Enjoyment of Interaction* were significant predictors of language outcomes. Thus both within the results presented in this paper as well as the general pattern of results in the literature, there is something of a discrepancy. On one hand, research suggests that better social interaction is associated with better language ability. On the other hand, interventions designed to improve social interaction have failed to show improvements in standardized language tests. In the recently reported results of the PACT trial (Green et al., 2010), for example, parent-reported measures of language and social communication showed a strong effect in favor of PACT, but no difference between the community treatment group and the PACT group were observed on standardized assessor-rated measure of child language. Likewise, Aldred and colleagues (2004) and McConachie and colleagues (2005) found improvements only on parent-reported measures of child language. Only Ingersoll and colleagues (2005) reported a significant advantage for assessor-rated language ability due to their DSP intervention, but language was measured through analysis of video transcripts rather than from a standardized language assessment. Thus there are some apparent discrepancies that merit discussion.

To begin with, parent reports such as obtained by Green and colleagues (2010) may well have been influenced by placebo effects, and it is not illogical to suppose that the biasing effects may be larger for parent-mediated interventions because parents are an essential part of the intervention delivery. This could explain the discrepancy between parent reports and assessor-rated tests, but would not explain the discrepancy in results derived from observation or transcripts taken during interaction. There are, however, important qualitative differences between these two assessment methods. In particular, the standardized testing situation may be less conducive to getting a child with autism to attend to and cooperate with the assessor when compared with analysis of transcripts derived from playful interactions between the child and a familiar caregiver. That is, the child may essentially under-perform in a standard testing environment. Secondly, standardized tests measure language that is largely removed from the context of a typical social interaction. What is measured in fact focuses largely on semantics, syntax and morphology, while the use of language (or pragmatics) gets much less attention or none at all. While there is likely to be a high degree of correlation among these language areas in typically developing individuals, the same cannot be said for individuals with autism who have disproportionate difficulties with usage-based aspects of language. Observations derived from play-based interactions may also measure the content and form of a child's language (number of tokens produced, mean length of utterance, morphemes produced etc.), but the nature of the interactive situation also lends itself to measuring

natural language use, as is seen in Ingersoll and colleagues (2005) who measured occurrences of spontaneous and appropriate language. Moreover, because DSP treatments and other communication-focused interventions typically target language use over form and content, there may be a mismatch in the immediate goals of the interventions being compared. MEHRIT, for example, does not focus on language until the child has mastered stages 1–4 (i.e. after a child has gained some facility with attention, regulation, and non-verbal reciprocity). Thus, gains in vocabulary seen in children prior to stage 4 are largely made through incidental exposure during the course of social interactions (as is the case with typically developing children) rather than targeted language-specific activities or exercises. More work is needed to resolve these issues. In particular, studies that examine functional aspects of language as well its content and form would be helpful in determining the respective strengths of DSP and traditional behavioral approaches to treatment.

Finally, data on changes in caregiver interaction behaviors as measured by the MEHRIT fidelity scale reflect positive changes in caregiver behaviors. In particular, caregivers in the MEHRIT group improved significantly more than the CT group in *Joining*, *Supporting Reciprocity*, and *Supporting the Child's Independent Thinking*. The changes, however, are relatively slight given that caregivers in the MEHRIT group move up roughly one level from 'interactions are rarely appropriate to MEHRIT' to 'interactions are sometimes appropriate to MEHRIT'. This is at least in part due to the fact that the scale is intended for use with professional clinicians who have a great deal more background in autism and child development, but may also reflect the fact that MEHRIT represents an approach to treatment that is quite different from the behavioral-based approach that parents are accustomed to. There are some data corroborating this supposition. In her dissertation, Mastrangelo (2009) administered a family outcomes survey to a group of parents enrolled in the MEHRIT study: 43.5% of parents reported that the intervention was difficult to understand at first. The learning curve may, therefore, be rather steep, resulting in slow progress towards mastery of the intervention.

Nonetheless, results suggest that the small improvements made by caregivers in the study made a significant difference in children's development. The regression analyses show an association between improvements in caregiver behaviors and improvements in children's social-communicative functioning. To be sure, it is not clear from this analysis alone whether improvements in caregiver behaviors are responsible for the improvements in children's functioning or the other way around. However, considering these results together with the between-groups results lends support to the notion that changes in caregiver behaviors facilitated at least some of the improvements in children's functioning. That is, where between-group differences exist on parent and child outcomes, the MEHRIT group improved significantly more than the CT group, and only the MEHRIT group makes significant improvements in caregiver behaviors over the course of the 12 months. It appears, therefore, that MEHRIT is targeting important caregiver behaviors. Items included in the fidelity scale are associated with improvements either in children's social interaction skills or language developmental quotients (or both). Other interventions have targeted similar caregiver or therapist behaviors. In particular, DSP and other social-interaction-focused interventions generally make use of strategies similar to one or more of MEHRIT's *Joining*, *Reciprocity*, *Support of Independent Thinking*, and *Expression of Enjoyment of the Child* items (e.g. Aldred et al., 2004; Green et al., 2010), and we mention some studies above attesting to the effectiveness of the interventions. However, to our knowledge, there are no studies that have demonstrated that the individual strategies used

in such interventions are associated with improvements in child outcomes. The case of co-regulation used as an intervention strategy is even more noteworthy because there seem to be scant few articles on co-regulation among children with autism. However, one recent study (Gulsrud et al., 2010) did find a positive effect of an intervention targeting joint engagement on outcomes related to emotion and co-regulation. This is not quite the same, however, as specifically using co-regulation as an intervention strategy, but it does establish an association between co-regulation and improvements in a key social-interaction skill.

Limitations

There are a number of limitations to this study that are important to consider. First, although participants were randomly assigned to each group, the community treatment group is neither a no-treatment group (which would be unethical) nor is it a group receiving a uniform type or dosage of treatment, a fact that no doubt contributed to the heterogeneity of the CT group's gains. Although the CT group compares favorably with the MEHRIT group in terms of average number of hours spent in professionally delivered treatment (3.9 hours for the CT group as compared with 2 hours of training for the MEHRIT group), the total number of hours spent in 'therapeutic interactions' was likely greater for the MEHRIT group because parents in the MEHRIT group were interacting with their children on a daily basis. We assume that these interactions took place in the context of the strategies learned through the program (although we cannot verify this). Time logs from parents in the MEHRIT group indicate that they spent an average of 25 hours (range: 13–35) each week interacting with their child, and most reported that they eventually used the techniques they learned for all their interactions with their child (e.g. during meals, getting dressed, going shopping etc.). These facts make it difficult to gauge the total effect of dosage when comparing the two groups.

Second, although we took pains to avoid any biases in the sample, the nature of the study design results in an unavoidable self-selection bias. That is, parents signed up for the study if they were (1) amenable to a DIR-based approach, (2) able to attend 2 hours of therapy each week during the day, (3) willing and able to complete the assessments for the study, and (4) able to spend a least 3 hours per day interacting with their child. From phone logs, we estimate that 45% of families cited the time requirement or scheduling as reasons for not signing up for the study. Added to this is the number of children who withdrew from the study early on in order to accept the government-funded treatment program. Waiting lists for the government-funded treatment program were 2–3 years when these families signed up for the study. However, a large increase of funding shortly after the study began resulted in significantly shortened waiting list times, with the result that families who intended to finish the study withdrew in order to take advantage of the 20–30 hours of free treatment that the government offered them. This circumstance resulted in 9 families withdrawing from the MEHRIT treatment group and 13 withdrawing from the CT group. We cannot be sure of the effect of this attrition on the outcomes. We decided not to continue to collect measurements from these children because the different methods used by the several government treatment centers, and the variance in the amount of time individuals were receiving treatment through our program, would have effectively erased any homogeneity in treatment among the individuals who withdrew, and the 20–30 hours of treatment these individuals were receiving was not comparable to the 3.9 hours (on average) being received by the rest of the CT group.

Third, the cost associated with the MEHRIT therapy program is approximately $5000 per child per year, which is considerably less than the estimates of therapy for most therapist-delivered programs that typically provide 20–30 hours treatment (Flanders et al., 2005; Motiwala et al., 2006). However, as noted above, the average number of weekly hours of treatment (albeit parent-delivered) in the CT group is similar to that received by a typical therapist-delivered intervention program, and we believe it unlikely that favorable results would have been obtained in this study if caregivers were constrained by other duties such that they could not have spent a good deal of time interacting with their child. Families in both groups, in fact, were discouraged from enrolling in the study if at least one caregiver was not available to spend at least 3 hours per day interacting with their child (approximately 20 hours per week). As we noted above, a substantial portion of families cited the lack of time as a reason for not signing up for the study. Thus, we underscore the sampling bias that results from the parent-involvement component of this study. In addition, about half of the families in the study had incomes greater than the median Canadian income. The authors, therefore, caution against drawing the conclusion that a 20 hours per week program (such as the Intensive Behavioral Intervention program funded by the government of Ontario) can be easily replaced with a 2 hours per week program without regard for how well the requirements of the program fit the needs and resources of each family. Additional study is needed to determine if the program is suitable for families with less time available, as well as for lower income families.

Finally, while the results presented here are generally favorable and consistent with results from other DSP and social-communication based interventions, the authors underscore the need to continue to evaluate the MEHRI autism intervention program in particular. While MEHRIT is aimed at improving children's social interaction and communication skills, this paper reports only a small number of measures that might be of interest to researchers evaluating intervention programs. In particular, it is not presently known what effect, if any, IQ or autism severity have on the effectiveness of MEHRIT, nor the effect MEHRIT might have on IQ or the severity of autistic symptoms. We therefore remain cautiously optimistic and await further studies of the intervention, as well as studies of similar social communication-based interventions.

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Notes

1. In actuality, we view the model as somewhat more complicated because the degree of mastery of later capacities can also affect function in lower levels. Consider, for example, that a child who is able to communicate with the adult is able to use communication to support his or her own regulation (e.g. by telling the adult that something is upsetting him or her).
2. Researchers often use an analysis of covariance to "control for" such a difference, but it has been suggested that such a tactic is inappropriate. See Miller and Chapman (2001), who cite several treatments of the topic dating back to 1957.

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