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# Comparing Spoken Language Treatments for Minimally Verbal Preschoolers with Autism Spectrum Disorders

Rhea Paul

*Sacred Heart University, paulr4@sacredheart.edu*

Daniel Campbell

*Yale University*

Kimberly Gilbert

*Hofstra University*

Ioanna Tsiouri

*Larisa University Hospital, Greece*

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Corresponding Author	Family Name	<b>Paul</b>
	Particle	
	Given Name	<b>Rhea</b>
	Suffix	
	Division	
	Organization	Yale Child Study Center
	Address	40 Temple St. # 7D, New Haven, CT, 06510, USA
	Division	Department of Speech-Language Pathology, College of Health Professions
	Organization	Sacred Heart University
	Address	5151 Park Ave., Fairfield, CT, 06825, USA
	Email	PaulR4@SacredHeart.edu

---

Author	Family Name	<b>Campbell</b>
	Particle	
	Given Name	<b>Daniel</b>
	Suffix	
	Division	
	Organization	Yale Child Study Center
	Address	40 Temple St. # 7D, New Haven, CT, 06510, USA

---

Author	Family Name	<b>Gilbert</b>
	Particle	
	Given Name	<b>Kimberly</b>
	Suffix	
	Division	
	Organization	Hofstra University
	Address	Hempstead, NY, USA

---

Author	Family Name	<b>Tsiouri</b>
	Particle	
	Given Name	<b>Ioanna</b>
	Suffix	
	Division	
	Organization	Larisa University Hospital
	Address	Larisa, Greece

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## 2 Comparing Spoken Language Treatments for Minimally Verbal 3 Preschoolers with Autism Spectrum Disorders

4 Rhea Paul · Daniel Campbell · Kimberly Gilbert ·  
5 Ioanna Tsiouri

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8 **Abstract** Preschoolers with severe autism and minimal  
9 speech were assigned either a discrete trial or a naturalistic  
10 language treatment, and parents of all participants also  
11 received in parent responsiveness training. After 12 weeks,  
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24  
25 **Keywords** Autism · Language · Treatment ·  
26 Intervention · Communication · Speech

Children with autism spectrum disorder (ASD) are almost 27  
universally delayed in the acquisition of spoken language. 28  
Although rates of functional use of speech have increased 29  
in this population during the last decade (Rogers 2006), the 30  
acquisition of spoken language remains an especially 31  
important attainment for children with ASD. Children who 32  
do not acquire speech as a primary means of communica- 33  
tion by school age tend to have restricted outcomes in 34  
terms of independence and integration (Howlin 2005). 35  
Therefore it is important to make every attempt to induce 36  
speech in preverbal children with ASD during the pre- 37  
school period in order to maximize opportunities for social 38  
interactions with family and peers and participation in 39  
mainstream settings in school and later life. The motivation 40  
behind this study is to investigate the most effective ways 41  
to induce speech in minimally verbal children with ASD. 42

A variety of intervention approaches—from the most 43  
structured discrete trial instruction methods to more open- 44  
ended, child-centered methods—demonstrate some effi- 45  
cacy both for increasing communication and eliciting first 46  
words from nonspeaking young children with ASD (See 47  
National Research Council 2001; Paul 2008; Prelock et al. 48  
2011; Rogers 2006 for review). One method that has a 49  
strong evidence base for eliciting first words from these 50  
children is Discrete Trial Training (DTT; Lovaas 1987) 51  
which makes use of the Skinnerian principles of operant 52  
learning (Skinner 1957). (Reichow and Wolery 2009) 53  
reviewed research using such methods for children with 54  
ASD and found that, although few studies consistently met 55  
standards for establishing evidence-based practice, 5/6 56  
studies that met minimum criteria showed significant 57  
improvement for children receiving DTT for expressive 58  
language, based on effect size. Moreover, the four studies 59  
comparing DTT to other methods for improving spoken 60  
language all demonstrated greater gains in both expression 61

A1 R. Paul · D. Campbell  
A2 Yale Child Study Center, 40 Temple St. # 7D, New Haven,  
A3 CT 06510, USA

A4 R. Paul (✉)  
A5 Department of Speech-Language Pathology, College of Health  
A6 Professions, Sacred Heart University, 5151 Park Ave., Fairfield,  
A7 CT 06825, USA  
A8 e-mail: PaulR4@SacredHeart.edu

A9 K. Gilbert  
A10 Hofstra University, Hempstead, NY, USA

A11 I. Tsiouri  
A12 Larisa University Hospital, Larisa, Greece

and comprehension for the DTT intervention than the alternative treatment. Thus DTT approaches would appear to have some degree of efficacy for facilitating early language development. Nonetheless, DTT approaches have long been criticized (e.g., Delprato 2001; Smith 2001), particularly in the area of communication skills (Fey 1986; Owens 2009; Prizant and Wetherby 2005), due primarily to the fact that gains made often fail to generalize outside the training setting, to be used for spontaneous, functional communication, or to be maintained by the ordinary contingencies of daily life, when tangible reinforcement is removed (Fey 1986; Stokes and Baer 1977).

Another approach to inducing first words in non-speaking children with disabilities was developed in response to these shortcomings. Milieu Communication Training (MCT) has been supported in a range of studies of children with disabilities (e.g., (Hester et al. 1995; Yoder and Warren 2002) including children with ASD (e.g., Hancock and Kaiser 2002; Ross and Greer 2003; Christensen-Sandfort and Whinnery 2011; Yoder and Stone 2006). MCT aims to address some of the identified shortcomings of DTT by means of several strategies, including

1. teaching within natural environments (Kaiser et al. 1992), since research has demonstrated increases in generalization (Hancock and Kaiser 2002), maintenance (Spradlin and Siegel 1982), and spontaneous use of language (Yoder and Warren 2002) in natural environments over isolated clinical settings;
2. mand-modeling (Rogers-Warren and Warren 1980), or providing a model of desired communicative act and correcting child responses;
3. time delay, involving the adult's providing a stimulus and then waiting approximately 5–15 s, for a child-initiated response (Kaiser 2010);
4. incidental teaching strategies (Hancock and Kaiser 2002; Hart and Risley 1975) such as free play in which the child controls the teaching episodes by signaling interest in the environment, which the adult has organized so that access to desired objects is contingent upon solicitation of adult assistance, which is followed by both praise and access to desired outcomes. For example, an adult may “accidentally” forget to give a child milk during snack, then would give a prompt for the child to request it (“What do you need?”), praising the child for correct responses, and giving the child the milk (contingent access).

In their research on MCT with young children with ASD, Yoder and colleagues (e.g., Yoder and Stone 2006) have incorporated parent responsiveness training into the MCT intervention package, and have argued for the importance, in this context, of not only increasing child communicative initiations, but of providing responsive

feedback to these initiations in order to effect lasting, functional change in communicative behavior.

One aim of the present study was to examine the usefulness of a DTT treatment that we believed would be especially efficacious for minimally verb children with ASD. A primary reason that some children who were tried on DTT to induce speech did not succeed was that they were unable to produce any vocal imitation. Vocal imitation is the necessary first step in a DTT approach, since only with some vocal behavior to shape can the child's behavior be modified toward speech. We believed that a DTT approach developed by (Tsiouri 2002) had potential to address this problem. This procedure, Rapid Motor Imitation Antecedent (RMIA) training, required the child to produce a series of simple motor imitations before being presented with opportunities to imitate verbal “mands” (requests) or “tacts” (labels). This instructional strategy utilized the child's motor imitation repertoire to facilitate the emergence of first instances of vocal imitation (“echoics”), which could then be shaped into verbal imitation and eventually to independent word production. The unique contribution of RMIA is hypothesized to reside in its capacity to induce vocal imitations through behavioral momentum (Mace et al. 1990; Nevin et al. 1983). Several researchers (e.g., Mace and Belfiore 1990; Mace et al. 1990) have demonstrated that behavioral momentum can be harnessed to elicit behaviors previously resistant to treatment, and have shown that when children's compliance with easy instructions was highly reinforced, compliance persisted when more difficult instructions, with which the children were normally non-compliant, were chained after a series of easy behaviors. Both Tsiouri and Greer (2003) and we (Paul 2009; Tsiouri et al. 2012) have been able to show, in published case series, that this momentum can, in fact, lead to production of first words in some minimally verb preschoolers with ASD.

Because so few DTT approaches have been subjected to experimental procedures such as controlled trials comparing them with alternative approaches, we also aimed to provide such a contrast in this study. Because of the known efficacy of MCT for increasing communication (and sometimes, speech) in minimally verb young children, we believed comparing RMIA to MCT would constitute a fair test of the relative efficacy of the two approaches and, at least, MCT would have positive benefits in increasing communication in participants who received this treatment. But, since most recent research on MCT had incorporated a parent responsiveness training component, as well as to address some of the limitations of DTT in terms of generalization, a parent responsiveness training component was included in BOTH interventions. Thus, the study contrasts two intervention packages, one consisting of RMIA plus parent responsiveness training, and the other of MCT with parent responsiveness training.

167 We were also interested in the identification of pre-  
 168 treatment characteristics of participants that could be  
 169 associated with positive responses to each of these treat-  
 170 ment packages. Research suggests that the relative efficacy  
 171 of one treatment over another is likely to vary by pre-  
 172 treatment child characteristics (National Research Council  
 173 2001; Yoder and Stone 2006). Thus, the identification of  
 174 pre-treatment variables associated with enhanced response  
 175 to one treatment or the other would aid in identification of  
 176 treatments most likely to work best for particular children.

177 Thus, the package of intervention developed for this  
 178 study included assignment of participants to one of two  
 179 clinician-delivered interventions:

- 180 1. a DTT program enhanced with a behavioral momen-  
 181 tum component (RMIA), to help children acquire the  
 182 vocal/verbal imitation skills necessary for speech  
 183 acquisition, or
- 184 2. an MCT program of naturalistic, play-based  
 185 intervention.

186 Regardless of which intervention the child received,  
 187 parents of all participants were provided with Parent  
 188 Responsivity Training, following Yoder and Warren (2002).

189 The aims of the study were:

- 190 1. to determine whether either RMIA or MCT were more  
 191 effective overall, in conjunction with parent respon-  
 192 siveness training, in eliciting spontaneous functional  
 193 speech from minimally verbal schoolers with ASD;
- 194 2. to examine pre-treatment subject characteristics as  
 195 moderators of response to treatment in order to identify  
 196 subject profiles that could predict better response to  
 197 one treatment package or the other.

198 **Methods**

199 **Participants**

200 Participants were recruited through written and electronic  
 201 media advertisements. Flyers and brochures were distrib-  
 202 uted to local special education departments and early  
 203 intervention providers. Additional participants were  
 204 recruited through the university's website. A speech-lan-  
 205 guage pathologist screened all interested individuals. All  
 206 participants' families completed informed consent proce-  
 207 dures approved by the Institutional Review Board for the  
 208 Protection of Human Subjects. Inclusion criteria were:

- 209 • DSM-IV-TR (2000) diagnosis of Autistic Disorder or  
 210 PDD-NOS as conferred by an experienced clinical team  
 211 and confirmed by scores within the autism spectrum  
 212 range on the *Autism Diagnostic Observation Scale*

–*Module 1* (Lord et al. 2000) administered by highly  
 trained clinicians;

- spontaneous expressive vocabulary by parent report of  
 fewer than 15 words as measured by the *Communication  
 and Symbolic Behavior Scales-Caregiver Questionnaire*  
 (Wetherby and Prizant 2003)—73 % of the participants  
 had fewer than 5 words reported—and fewer than 8  
 intelligible words produced during a 20-min clinician-  
 child play observation *Communication and Symbolic  
 Behavior Scales-Behavioral Observation* (Wetherby and  
 Prizant 2003)—91 % produced fewer than 5 words;
- expressive language age-equivalent of less than  
 18 months as measured by the *Vineland Adaptive  
 Behavior Scales—II* (VABS-II; Sparrow et al. 2005)  
 Expressive Language subdomain;
- non-verbal mental age of at least 12 months as  
 measured by the *Mullen Scales of Early Learning*  
 (Mullen 1995), Visual Reception subdomain;
- generalized motor imitation, which for the purposes of  
 this study, was defined as the ability to accurately  
 imitate a repertoire of motor actions using the (Meltzo  
 1988) motor imitation procedure.

Exclusionary criteria consisted of any uncorrected  
 vision or hearing disability. Table 1 provides a description  
 of participants at their entrance into the intervention pro-  
 gram. One-way analysis of variance revealed no significant  
 differences between the two treatment groups on any of  
 these pretreatment variables.

Assessment Procedures

*Pre-treatment Assessment*

Each participant completed two, 2-h evaluations to ensure  
 they met entrance criteria for the study and to collect  
 information on their pre-treatment level of functioning.  
 The following standardized measures were included:

- I. *Mullen Scales of Early Learning* (Mullen 1995) was  
 used to establish nonverbal cognitive level;
- II. *The Autism Diagnostic Observation Schedule—Mod-  
 249*ule 1 (ADOS; Gotham et al. 2008) was used to confirm  
 250 diagnosis of ASD;
- III. *Communication and Symbolic Behavior Scales—Devel-  
 252*opmental Profile (CSBS; Wetherby and Prizant 2003)  
 253 was used to assess frequency and types of spontaneous  
 254 words used, frequency of joint attentional communica-  
 255 tive acts, and frequency of symbolic play behaviors.

Each participant completed a motor imitation assess-  
 ment (Meltzoff 1988), which included imitation of actions  
 with objects (e.g., shaking a rattle), gross motor imitation  
 (e.g., stomping feet, tapping knees), fine motor imitation

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**Table 1** Participant characteristics

Rapid motor imitation antecedent (RMIA) Tx			Milieu communication training (MCT) Tx		
Subject	Age	Gender	Subject	Age	Gender
007TS	5.90	Female	005TS	3.64	Male
015TS	4.08	Female	008TS	2.71	Male
020TS	5.47	Male	016TS	2.80	Female
033TS	3.66	Male	049TS	3.70	Male
036TS	6.15	Male	070TS	2.63	Male
043TS	4.76	Female	074TS	4.14	Male
046TS	3.44	Male	077TS	3.49	Male
060TS	3.53	Female	061TS	3.15	Male
076TS	4.76	Male	075TS	3.22	Male
081TS	2.40	Male	078TS	4.88	Male
			079TS	3.32	Male
			080TS	4.56	Male

(e.g., touching nose, touching mouth), and oral motor imitation (e.g., opening mouth, smiling, puckering). Standardized measures were administered by a speech-language pathologist and licensed clinical psychologist. In addition to direct observation measures, parents completed questionnaires including the *Vineland Adaptive Behavior Scales-II* (Sparrow et al. 2005), the *MacArthur-Bates Communicative Development Inventory* (Fenson, et al. 2007), the Caregiver Questionnaire of the *CSBS*, and a description of current and previous intervention. Parents were also videorecorded while engaged in a 10 min play session with their children with a standard set of toys (following Yoder and Warren 2002), and the percentage of parental acts responsive to the child's focus was computed.

#### 275 *Follow-up and Maintenance Assessments*

276 Within 2 weeks of the completion of the 36 treatment sessions, each child was re-assessed, using the same procedures as for pre-treatment assessment, with the exception of the 278 *Mullen*, which was not re-administered at this time. Three to 280 6 months following the end of treatment the entire assessment battery, including the *Mullen*, was re-administered. 282 Assessors at Follow-up and Maintenance were blind to the treatment assignment of the participants, and were different 283 from the clinicians delivering the intervention as well as 284 from the examiners at the Pre-treatment Assessment. 285

#### 286 *Pre-treatment procedures*

287 Based on the responses to the motor imitation probes during Pre-treatment Assessment, participants who had 288 generalized motor imitation in their repertoire (as defined 289 by performance of 60 % correct or better on the motor 290 imitation probes) were randomly assigned to either MCT or 291 RMIA treatment. 292

Participants who were unable to imitate 60 % of actions during the Pre-Treatment Assessment were provided with ten, 30-min training sessions on motor imitation in order to develop their generalized motor imitation repertoire. A standard DTT format was used to teach the participants to independently and accurately imitate motor actions, through gradual prompt fading and reinforcement procedures, within a specific inter-response time (1 s). The goal for this training procedure was to teach the child to imitate at least 6 different motor actions (three gross and three fine) in sequence within 6–8 s. Following this training, children who achieved this criterion in motor imitation were randomized to one of the two treatments; however five children who did not achieve the criterion for motor imitation were non-randomly assigned to the MCT group, resulting in a design for this study that is only quasi-experimental, rather than a standard randomized controlled trial. Figure 1 summarizes the in-take procedure for this study.

#### Treatment Procedures

Participants assigned to one of the two treatments received 36 45-min sessions over the course of 12 weeks with certified speech-language pathologist (SLP) specifically trained in RMIA by the third author and in MCT by the fourth (all clinicians were trained in both approaches, with periodic retraining throughout the course of the study). Fidelity of treatment was monitored by having the each treatment's trainer (third and fourth authors) code, via video recording, a randomly selected sample of 10 % of the treatment sessions (clinicians were blind to which sessions were being rated for fidelity). This procedure revealed an average of 96 % agreement between clinician and consultant as to the appropriateness of the clinician's response to child behaviors within our established criteria for fidelity with RMIA treatment; and 92 % for MCT.

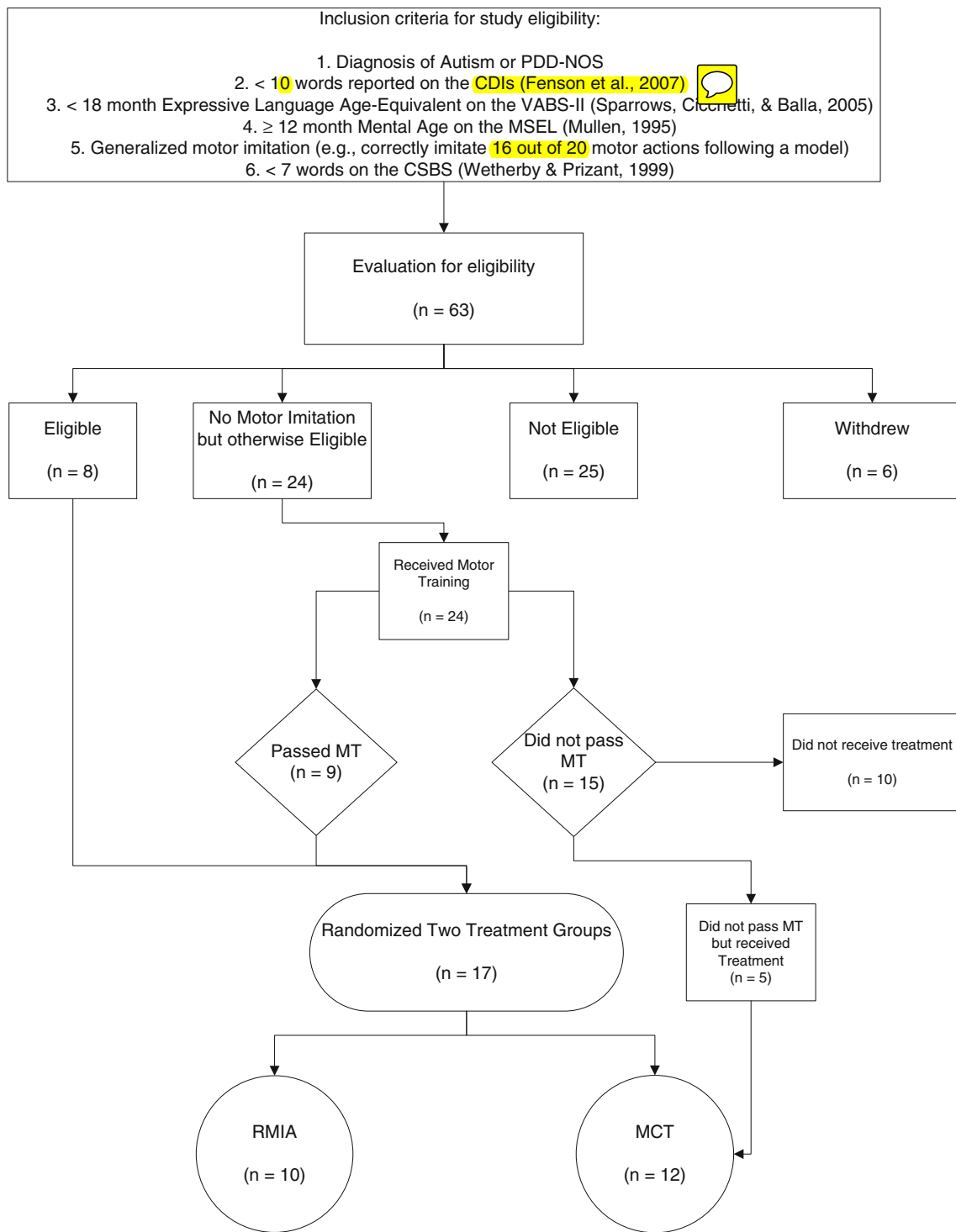


Fig. 1 Flow chart for study inclusion

327 *RMIA training procedures*

328 Preferred items used during treatment were selected indi-  
 329 vidualy for each participant, using a variation of the  
 330 Multiple Stimulus Without Replacement Preference  
 331 Assessment procedure (DeLeon and Iwata 1996) conducted

before the onset of the study, as well as periodically 332  
 throughout the intervention to ensure reinforcers remained 333  
 powerful. The instructor obtained the participant's atten- 334  
 tion, then rapidly and randomly presented three large (hand 335  
 and foot movements) and three small (pointing to parts of 336  
 the face) motor actions with the antecedent, "Do this," 337

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338 allowing the participant 1 s to respond to each action. The  
 339 participant imitated actions one by one as they were pre-  
 340 sented. If the participant failed to imitate more than one  
 341 action in the sequence within the 1 s. Time frame, the  
 342 sequence was begun again. Immediately after the comple-  
 343 tion of the 6 motor actions, the instructor said the target  
 344 word and displayed the target item (preferred items for  
 345 requests and non-preferred for labels). The child was  
 346 required to say the target word (or a predetermined  
 347 approximation of the word, which was gradually shaped  
 348 toward the target word through the course of the inter-  
 349 vention) in order to receive the preferred item (for requests)  
 350 or to receive a choice of two preferred items different from  
 351 the target (for labels). Detailed descriptions of the RMIA  
 352 procedures can be found in Tsiouri and Paul (2012).

### 353 *Milieu Communication Training Procedures*

354 During each session, the clinician attempted to establish  
 355 play routines that were enjoyable and motivating to the  
 356 child, and engineer the environment to include multiple  
 357 motivating opportunities for the child to communicate,  
 358 such as placing desired items in closed containers the child  
 359 could not open without help, or requiring the indication of  
 360 a choice between two playthings before access to any play  
 361 objects was provided. When the child was highly motivated  
 362 to communicate, clinicians attempted to stimulate initiating  
 363 joint attention through time delay, and mand-modeling the  
 364 use of recently learned communicative behaviors, focusing  
 365 on spoken, rather than general communicative responses,  
 366 and shaping earlier occurring communicative behaviors  
 367 toward speech. More detailed description of the MCT can  
 368 be found in Paul and Sutherland (2005), Warren and Yoder  
 369 (1998), and Yoder and Stone (2006).

### 370 *Parent Responsivity Training*

371 To promote generalization of language learned in both  
 372 clinician-delivered interventions provided in this study,  
 373 procedures of Parent Responsiveness Training (Yoder and  
 374 Warren 2002) were followed. At least one parent of each of  
 375 the participants was required to attend 4, 2-h parent edu-  
 376 cation classes. Parents completed the classes during the  
 377 time their child was enrolled in treatment. Instruction was  
 378 provided in the form of lecture, video, modeling and hands-  
 379 on practice during class. Homework was assigned and then  
 380 discussed during the next class. Parents were also provided  
 381 with individual coaching. The purpose of the parent com-  
 382 ponent was to guide parents to increase their use of  
 383 responsive strategies to help their children engage in pro-  
 384 ductive, interactive play with objects and to facilitate their  
 385 children's communication and language development. It  
 386 should be noted that Parent Responsivity Training,

387 although an integral part of the treatment package provided  
 388 in this study, cannot be considered an independent variable,  
 389 since parents in both treatment groups received this  
 390 training.

## 391 **Results**

392 Three sets of results are presented: 392

- 393 1. Descriptive statistics for average performance on 393  
 394 several variables measuring language and communi- 394  
 395 cation before and after intervention for each treatment, 395  
 396 with tests of differences before and after treatment 396  
 397 within each group, and after treatment between the two 397  
 398 treatment groups; 398
- 399 2. Proportions of children within each treatment group 399  
 400 who met Tager-Flusberg et al.'s criteria (2009) for the 400  
 401 attainment of functional spoken language after 401  
 402 treatment; 402
- 403 3. An assessment of the effect of pre-treatment moderator 403  
 404 variables on expressive language outcomes across the 404  
 405 two treatments. 405

### 406 *Changes Pre-Post Treatment*

407 Table 2 presents the scores on variables collected imme- 407  
 408 diately post-treatment (12 weeks following the pre- 408  
 409 treatment assessment) and at the maintenance point 409  
 410 (3–6 months following the post-treatment assessment). 410  
 411 One-way Analysis of Variance (SPSS 19) revealed no sig- 411  
 412 nificant differences between the two treatment groups' 412  
 413 scores on any of the outcome variables at either the 413  
 414 post-treatment or maintenance time point. 414

415 Paired *t* tests were then used to look for differences in 415  
 416 our outcome variable of interest, spoken language output, 416  
 417 between assessment time points within each treatment 417  
 418 group. For the group that received RMIA, significantly 418  
 419 more words were produced during the *CSBS* play session 419  
 420 ( $t = 2.9$  [9],  $p < .02$ , Cohen's (1988)  $d = 1.7$  [very large]) 420  
 421 and on the number of words said as reported by parents on 421  
 422 the *CDI* ( $t = 2.3$  [8],  $p < .05$ , Cohen's  $d = 1.0$  [large]) at 422  
 423 the post-treatment assessment relative to pre-treatment. 423  
 424 There were no significant differences in these variables 424  
 425 from post-treatment to the maintenance time point, but 425  
 426 there was a significant difference between pre-treatment 426  
 427 and maintenance for both *CSBS* ( $t = 2.6$  [9],  $p < .03$ , 427  
 428 Cohen's  $d = .93$  [large]) and *CDI* ( $t = 2.4$  [7],  $p < .05$ , 428  
 429 Cohen's  $d = 1.2$  [very large]) word counts. The same 429  
 430 pattern of results was seen for the age-equivalent scores on 430  
 431 the *Vineland Adaptive Behavior Scales* Expressive Lan- 431  
 432 guage scale (pre-tx—post-tx:  $t = 2.4$ [8],  $p < .04$ , Cohen's 432  
 433  $d = .82$  [large]; post-treatment—maintenance: NSD). 433

**Table 2** Description of participants at pre-treatment

Tx group	Mean (and SD) Age (yrs.)	% male	Mean (and SD) Mullen VR AE <sup>1</sup>	Mean (and SD) VABS-II EL AE <sup>2</sup>	Mean (and SD) VABS-II RL AE <sup>3</sup>	Mean (and SD) CSBS <sup>4</sup> : number of spoken words	Mean (and SD) reported words said on CDI <sup>5</sup>	Mean (and SD) number of attentional acts on CSBS	Mean (and SD) number of symbolic play acts on CSBS	Mean (and SD): % correctly imitated motor actions	% needing motor training	Mean (and SD) ADOS-SA <sup>6</sup>	Mean (and SD) PDI <sup>7</sup> %
RMIA	4.3 (1.2)	63.6	22.6 (4.6)	10.0 (4.8)	14.8 (8.2)	1.7 (2.3)	4.6 (5.7)	1.0 (1.3)	3.1 (3.9)	44.9 (28.2)	63.6	14.0 (3.8)	38.3 (15.7)
MCT	3.5 (0.8)	90.9	22.2 (5.6)	9.4 (0.6)	12.6 (8.6)	1.4 (2.2)	3.8 (3.6)	0.6 (0.9)	4.8 (4.2)	31.8 (30.7)	63.6	14.6 (3.9)	37.4 (19.3)

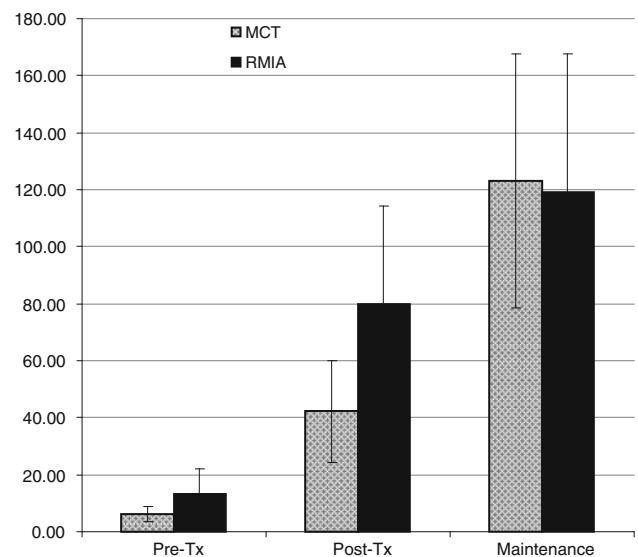
1 Mullen Scales of Early Learning (Mullen 1995) Visual Reception Age-equivalent score (months)  
 2 Vineland Adaptive Behavior Scales-II (Sparrow et al. 2005) Expressive Language Age-equivalent score (months)  
 3 Vineland Adaptive Behavior Scales-II (Sparrow et al. 2005) Receptive Language Age-equivalent score (months)  
 4 Communication and Symbolic Behavior Scale-Developmental Profile (Wetherby and Prizant 2003) Spoken Word (Type) Inventory during 20 min play session  
 5 MacArthur-Bates Communicative Development Inventory (Fenson et al. 2007)  
 6 Autism Diagnostic Observation Scale-Module 1 (Lord et al. 2000) Social-Affective Algorithm score  
 7 Parent-Child Interaction (Yoder and Warren 2002) percentage parents' responsive communication acts (Cohen (1988))

These data suggest that, on average, children who received RMIA produced more words and used more language in everyday situations after treatment than before, and these gains were maintained for at least 3–6 months.

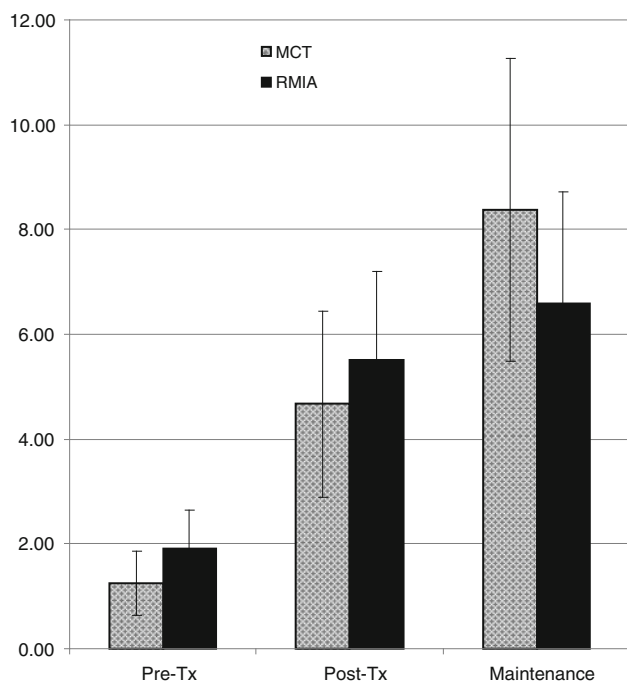
Similar analyses were conducted for the children who received MCT. In this group, an analogous pattern of change was seen for the number of words produced on the CSBS (pre-tx- post tx:  $t = 2.5[11]$ ,  $p < .03$  (Cohen 1988)  $d = .73$  [medium]; pre-tx—maintenance:  $t = 2.5$  [7],  $p < .04$ , Cohen's  $d = 1.2$  [very large]; post-tx-maintenance: NSD) and CDI (pre-tx- post tx:  $t = 2.3[9]$ ,  $p < .05$ , Cohen's  $d = .89$  [large]; pre-tx—maintenance:  $t = 2.6$  [6],  $p < .04$ , Cohen's  $d = 1.3$  [very large]; post-tx-maintenance: NSD). However, for the adaptive use of language on the Vineland Adaptive Behavior Scales-Expressive Language Scale none of the differences over time reached significance for the group receiving MCT. CSBS and CDI data are displayed in Figs. 2 and 3.

Proportion of Children Achieving Verbal Language Milestones

Tager-Flusberg et al. (2009) set out criteria for determining whether children with ASD undergoing an intervention for expressive language can be considered to have made progress from one broad stage of language development to the next. All children in the current study would be considered to be in the pre- or minimally verbal stage prior to intervention, producing infrequent communicative acts, using very few words, and no word combinations. All but one scored below 15 months on the Expressive Language Age Equivalent score of the Vineland Adaptive Behavior Scales

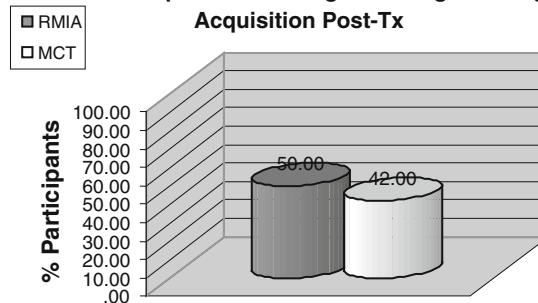


**Fig. 2** Mean (and standard error) Number of words spoken by parent report on CDI (Fenson et al. 2007) at three time points



**Fig. 3** Mean (and standard error) Number of words produced during CSBS Behavior Sample (Wetherby and Prizant 2003) at three time points

**Percent of Participants Achieving First Stage of Language Acquisition Post-Tx**



**Fig. 4** Percent of participants in each treatment group who met Tager-Flusberg et al.'s (2009) criteria for first stage of language development at post-treatment

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464 (one child scored at 18 months) before treatment. In order  
 465 to be considered to have progressed to the next stage, that  
 466 of first words, Tager-Flusberg et al. suggest the following  
 467 criteria:

- 468 • Language age equivalent  $\geq$  15 months, or five differ-  
 469 ent word types and 20 word tokens in spontaneous  
 470 speech
- 471 • Production of consonant–vowel syllables, or production  
 472 of 4 different consonants in spontaneous speech
- 473 • Expression of at least two different communication  
 474 functions (e.g., request, comment, social interaction)  
 475 with words in spontaneous speech.

476 We examined outcomes in the current study to deter-  
 477 mine how many participants in each group met these cri-  
 478 teria. Five of the ten children who received RMIA met the  
 479 benchmarks; all met Vineland Expressive Language Age-  
 480 equivalents above 15 months (the child who started at 18  
 481 months achieved 30 months on this measure after  
 482 12 weeks of treatment), parent report of more than 35  
 483 words on the CDI; more than 7 different word types pro-  
 484 duced during a CSBS play session (all but one of the five  
 485 were above 35 tokens), as well as expression of at least two  
 486 different communicative intentions with words, and four  
 487 different consonants used in CV syllables by the post-  
 488 treatment assessment. All 5 retained or exceeded these  
 489 levels at the maintenance assessment. For the group  
 490 receiving MCT, 5 of the twelve children reached the

491 benchmarks of Vineland Expressive Language Age-  
 492 equivalents above 15 months, parent report of more than  
 493 20 words on the CDI; more than 5 different word types  
 494 produced during a CSBS play session (all but one of the  
 495 five were above 50 tokens), as well as expression of two  
 496 different communicative intentions in words, and four  
 497 different consonants used in CV syllables by the post-  
 498 treatment assessment. Again, all 5 retained or exceeded  
 499 these levels at the maintenance assessment. Figure 4 pre-  
 500 sents the percentage of participants in each group who  
 501 achieved these milestones to acquire a basic form of  
 502 functional spoken language after intervention.

503 Moderator Variable Analysis

504 To investigate possible moderating effects on response to  
 505 treatment, we performed multivariate linear models in  
 506 which CDI post-treatment was regressed on treatment  
 507 group (represented as a dummy variable, with 0 = RMIA  
 508 and 1 = MCT), a moderator covariate, and an interaction  
 509 of treatment and moderator, using Preacher's calculator  
 510 (Preacher et al. 2006; <http://www.quantpsy.org/interact/mlr2.htm>). The results of these analyses appear in Table 3.  
 511 Examining these data suggests, first, that for all the pur-  
 512 ported moderators except age, the model provided a good  
 513 fit to the data, as seen in the significant F statistics for these  
 514 models. We then pursued further moderator analyses for  
 515 the variables for which a good fit was attained.

516 When these variables—Mullen VR, EL and RL age-  
 517 equivalent scores, Vineland EL and RL age-equivalent  
 518 scores, % correct Motor Imitation, % parent responsiveness  
 519 in Parent–Child Interaction, CSBS Joint Attention and  
 520 Play—were used as moderators of treatment, only CSBS  
 521 Joint Attention (JA) scores showed a main effect ( $p < .01$ ).  
 522 This effect suggests that children with higher JA pre-  
 523 treatment scores pre-treatment did better than those with  
 524 lower scores, regardless of which treatment was  
 525 administered.  
 526

**Table 3** Outcome variables at post-treatment (Post-Tx) and maintenance (Maint.) time points

Treatment group	Mean (and SD) <i>Mullen</i> VR AE <sup>1</sup>		Mean (and SD) <i>VABS-II</i> EL AE <sup>2</sup>		Mean (and SD) <i>VABS-II</i> RL AE <sup>3</sup>		Mean (and SD) <i>CSBS</i> <sup>4</sup> : number of spoken words		Mean (and SD) <i>CDI</i> <sup>5</sup> number of spoken words by parent report	
	Post-Tx	Maint.	Post-Tx	Maint.	Post-Tx	Maint.	Post-Tx	Maint.	Post-Tx	Maint.
RMIA	*	30.0 (13.2)	1.2 (0.6)	1.6 (1.1)	1.3 (0.8)	1.7 (1.2)	5.1 (5.2)	6.6 (6.7)	88.6 (106.8)	119.3 (136.3)
MCT	*	30.5 (6.7)	1.1 (0.4)	3.0 (3.0)	1.4 (0.6)	3.4 (4.7)	5.0 (6.4)	8.4 (8.2)	75.1 (89.3)	121.1 (123.4)

<sup>1</sup> *Mullen Scales of Early Learning* (Mullen 1995) Visual Reception Age-equivalent score (months)

<sup>2</sup> *Vineland Adaptive Behavior Scales-II* (Sparrow et al. 2005) Expressive Language Age-equivalent score

<sup>3</sup> *Vineland Adaptive Behavior Scales-II* (Sparrow et al. 2005) Receptive Language Age-equivalent score

<sup>4</sup> *Communication and Symbolic Behavior Scale-Developmental Profile* (Wetherby and Prizant 2003) Spoken Word (Type) Inventory during 20 min. play session

<sup>5</sup> *MacArthur-Bates Communicative Development Inventory* (Fenson et al. 2007)

\* Mullen data were not collected at Post-Treatment

Table 3 also shows that the interaction terms were not statistically significant for *Mullen* VR and EL, *Vineland* EL, % correct Motor Imitation, % parent responsiveness in Parent–Child Interaction, *CSBS* JA and Play, indicating that levels of these pre-treatment moderator variables did not affect the children’s tendency to respond differentially to one of our two treatments or the other. For *Mullen* Receptive Language and *Vineland* Receptive Language age-equivalent scores, there were significant interaction effects in these analyses, at  $p = 0.047$  and  $p = 0.016$ , respectively. To explore the interactions between these moderator variables and treatment response, we ran a Region of Significance (RoS) analysis (Bauer and Curran 2005, Preacher et al. 2006) to determine the range of values of the moderator for which the relationship between our *CDI* outcome and treatment was statistically significant. The *CDI*-treatment relationship for any given value of the moderator variable is described by the “simple intercept” and “simple slope,” which are functions of the moderator that describe the effect of treatment on *CDI* for any particular value of the moderator; the region of significance is then defined to be the set of moderator values where the simple slope is significantly different from zero. These results are reported in Table 4.

The Region of Significance for *Mullen* Receptive Language was outside the interval from 0 to 18 months age-equivalent score, with a simple slope of -101.35 at the lower endpoint of this interval and 218.37 at the upper endpoint. Higher values of *Mullen* RL pre-treatment are thus correlated with a stronger response to treatment under MCT than under RMIA (because the simple slope is positive for these values), and lower values of *Mullen* RL are correlated with greater improvement under RMIA (because the simple slope is negative). For *Vineland* Receptive Language age-equivalent scores, the RoS was also outside the interval 0–18 months, with a simple slope

of -173.19 at the lower endpoint and 77.91 at the upper endpoint. These values are consistent with the results for receptive language as measured by the *Mullen* and can be interpreted analogously. Moreover, together these results suggest that the cut-off score for deciding which treatment to employ is a receptive language age-equivalent of about 18 months; with those scoring lower more likely to succeed with RMIA while those scoring above an 18 month level likely to do better with MCT. Graphs of the RoS analyses for these moderator variables appear in Fig. 5.

**Discussion**

Results of this study suggest that, on average, minimally verbal preschoolers with ASD benefit from a relatively brief treatment package including parent responsivity training in conjunction with either

1. discrete trial treatment enhanced with a behavioral momentum component in the form of rapid motor imitation antecedent training (RMIA), or
2. milieu communication training (MCT) focused specifically on eliciting speech.

Gains made in these speech interventions were found to be maintained once the treatment concluded. Approximately half the children in each treatment group progressed from a classification of minimally verbal to the first stage of spoken language development as defined by Tager-Flusberg et al. (2009). This finding suggests that at least half of minimally verbal preschoolers like these with ASD do seem to have the capacity to acquire spoken language as a functional form of communication with focused intervention, strengthening the suggestion that this kind of intensive speech treatment should be provided during the preschool period (Tables 5 and 6).

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**Table 4** Effect sizes of pair-wise comparisons across time points within treatment groups

Comparison	Cohen's d*	Effect Size descriptors
Rapid motor imitation antecedent (RMIA) Tx		
<i>CSBS</i> <sup>1</sup>		
Pre-Post Tx <sup>+</sup>	1.7	Very large
Pre Tx-Maintenance <sup>+</sup>	.93	Large
Post Tx—Maintenance	.08	NS
<i>CDI</i> <sup>2</sup>		
Pre-Post Tx <sup>+</sup>	1.0	Large
Pre Tx-Maintenance <sup>+</sup>	1.2	Very large
Post Tx-Maintenance	.25	Small
<i>VABS</i> <sup>3</sup> expressive language		
Pre-Post Tx <sup>+</sup>	.82	Large
Pre Tx-Maintenance	.82	Large
Post Tx-Maintenance	.33	Small
Milieu communication training(MCT) Tx		
<i>CSBS</i> <sup>1</sup>		
Pre-Post Tx <sup>+</sup>	.73	Medium
Pre Tx-Maintenance <sup>+</sup>	1.2	Very large
Post Tx-Maintenance	.20	Small
<i>CDI</i> <sup>2</sup>		
Pre-Post Tx <sup>+</sup>	.89	Large
Pre Tx-Maintenance <sup>+</sup>	1.3	Very large
Post Tx-Maintenance <sup>+</sup>	.42	Small
<i>VABS</i> <sup>3</sup> expressive language		
Pre-Post Tx <sup>+</sup>	.64	Medium
Pre Tx-Maintenance <sup>+</sup>	.91	Large
Post Tx-Maintenance	.65	Medium

<sup>a</sup> Cohen (1988)

<sup>+</sup> Statistically significant difference ( $p < .05$ )

<sup>1</sup> *Communication and Symbolic behavior Scales-Developmental Profile* (Wetherby and Prizant 2003)

<sup>2</sup> *MacArthur-Bates Communicative Development Inventory* (Fenson et al. 2007)

<sup>3</sup> *Vineland Adaptive Behavior Scales-II* (Sparrow et al. 2005)

595 Our moderator analyses show, first, that children with  
 596 better joint attention pre-treatment do better with either  
 597 treatment than do those with very low joint attention. This  
 598 finding supports others in the literature suggesting that  
 599 language learning is mediated by joint attention (e.g.,  
 600 Mundy et al. 1990; Paul et al. 2008; Watt et al. 2006). In  
 601 the context of the present study it suggests, further, that for  
 602 minimally verbal children, those with some joint attention  
 603 tend to respond to a treatment focused on eliciting spoken  
 604 communication, particularly when it is combined with  
 605 parent responsivity training. The frequency of joint atten-  
 606 tional (JA) acts necessary to provide this mediation  
 607 appears, in our data, to be quite low; 55 % of the partici-  
 608 pants in this sample showed NO JA during the *CSBS*.

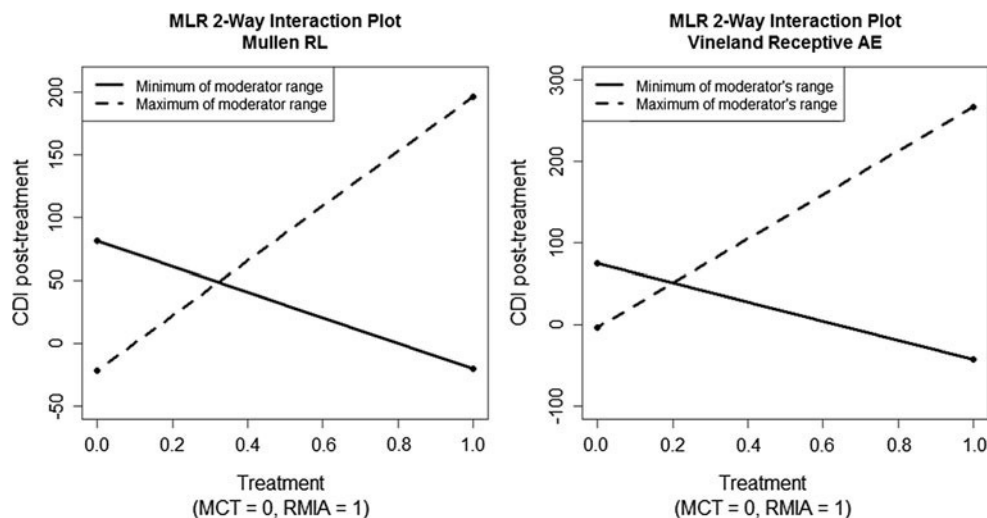
The 45 % who did produced between 1 and 4 JA acts during the 20 min *CSBS* behavior sample. Even this low level of JA initiation seems to enhance response to treatment focused on spoken language. Thus, any minimally verbal preschooler who shows some initiation of JA during a semi-structured play session would seem to be a good candidate for some focused intervention to elicit spoken communication.

Our analyses also suggest that the level of pre-treatment receptive language skill, as measured either directly on the *Mullen* or by parent report on the *Vineland*, moderates response to these two treatments differentially. Children who start out with relatively strong receptive skills do better in with MCT treatment; those who start out with relative lower receptive skills do better with RMIA. MCT treatment may work better for these relatively good comprehenders because they are more able to deduce linguistic information from relatively natural play-based interactions in which words and referents are saliently matched. The children with low receptive skills may do better in RMIA because the less natural, more intensely structured DTT interactions require less deductive ability and present fewer stimuli to distract the child from the word relations being presented. The Region of Significance finding suggests that a receptive language level of about 18 months is necessary to derive most benefit from MCT; children with less receptive language, at least those who can be taught to produce motor imitation, may do better with RMIA.

Clinical Implications

As we have seen, both these treatments had positive effects, on average, for the severely impaired minimally verbal preschoolers in this study, and we were able to identify two elements to assist clinicians in matching children to treatments. That is, the study suggests that minimally verbal preschoolers with ASD with nonverbal levels above 12 months who show some, even very limited, expression of joint attention pretreatment are more likely to respond to a speech-focused treatment than those who do not. We would argue that any child meeting these criteria should receive an intensive speech-focused treatment, in addition to any transitional AAC program implemented, in order to maximize the child's opportunity to acquire spoken language during this critical preschool period. Children with virtually no joint attentional behaviors are less likely to respond to speech-focused treatment and may derive more benefit from an approach focused more intensely on AAC. Second, for children for whom speech-focused treatment appears indicated, those with receptive language scores above 18 months may do better with MCT, while those with lower levels of receptive language who are able to master motor imitation can be tried with RMIA. Our

**Fig. 5** Plots of the interaction effect of moderator variable and treatment on *CDI* post-treatment. The plot on the left shows the effect when the moderator variable is *Mullen* Receptive Language; the plot on the right is for *Vineland* Receptive AE score. For both plots, the solid line compares *CDI* post-treatment between the two treatments (MCT = 0, RMIA = 1) at the lower end of the moderator variable's range, and the dashed line depicts the same for the upper end of the moderator's range



**Table 5** Results of regression analyses

Moderator variable	R <sup>2</sup>	F statistic for model fit	Intercept	Main effect of treatment	Main effect of moderator	Tx-Moderator interaction
Age	.414	2.821	49.573	38.041	14.468	-32.288
Mullen VR	.510	4.158*	44.096	26.822	6.777	1.290
Mullen RL	.544	4.764**	38.812	29.976	-3.810	11.842*
Mullen EL	.668	8.035***	59.814*	-2.704	9.422	3.363
Vineland receptive AE	.621	6.154**	43.756	34.028	-26.634	132.535*
Vineland expressive AE	.478	3.429*	46.795	16.543	12.035	129.264
CSBS joint attention	.800	16.03***	51.150**	23.756	48.340*	20.763
CSBS play	.652	7.500***	34.600	57.257	8.000	8.751
Motor skills	.567	5.228**	49.775*	22.305	1.441	0.255
PCI resp.	.525	3.868*	45.681	44.608	-1.560	3.838

<sup>1</sup> parent report of expressive vocabulary size on the *MacArthur-Bates Communicative Development Inventory* (Fenson et al. 2007)

\* Significance at the 0.05 level

\*\* Significance at the 0.01 level

\*\*\* Significance at the 0.001 level

For each moderator variable, a linear regression model was fit with treatment (0 = MCT, 1 = RMIA), moderator, and treatment-moderator interaction as predictors and *CDI*<sup>1</sup> post-treatment as response. Moderator variables for which the interaction term's *p* value was less than 0.05 were investigated further using Region of Significance analysis

**Table 6** Results of the Region of Significance analysis for moderators whose interaction with treatment is statistically significant

Moderator	Region of significance		Simple intercept at minimum	Simple slope at minimum	Simple intercept at maximum	Simple slope at maximum
	Minimum	Maximum				
Mullen RL	-158.10	5.60	81.07	-101.35	-21.81	218.38
Vineland receptive AE	5 months	17.6 months	74.12	-117.06	-3.65	269.94

For both measures, the region of significance is outside the interval

660 results suggest that 3-5 sessions per week for 3-6 months is  
 661 a sufficient time frame to determine whether a child is  
 662 responding to a treatment. It is always possible to try a  
 663 second approach if an intensive trial of the first does not

work, but these guidelines can be helpful in choosing an  
 initial program for young children with ASD.

Apart from the guidance in choosing intervention  
 approaches provided by this study, we believe it has a

664  
 665  
 666  
 667



668 second set of implications. This study was motivated in  
 669 part by a concern on our part that too many preschoolers  
 670 with ASD who did not spontaneously acquire spoken  
 671 communication were being assigned to augmentative and  
 672 alternative modes of communication (AAC) approaches  
 673 without a concentrated effort to elicit functional speech.  
 674 We do not debate the value of AAC for many children with  
 675 severe speech impairments, nor do we argue against the use  
 676 of AAC as a transitional modality for young children with  
 677 ASD or as a primary modality for older children who have  
 678 not acquired speech. But we do believe that the unique  
 679 learning challenges seen in ASD may constitute a special  
 680 case when it comes to providing communicative opportu-  
 681 nities for minimally verbal young children. That is, the  
 682 deficits that are unique to early communication in ASD,  
 683 including low level of social motivation inherent in the  
 684 autistic syndrome, reduced attention to child-directed  
 685 speech (Paul et al. 2007), immaturity of speech motor  
 686 development (Gernsbacher et al. 2008), reduced engage-  
 687 ment in reciprocal babbling (Paul et al. 2011), an inability  
 688 to use gaze cues to discern the relations between a speak-  
 689 er's words and their intended referents (Baron-Cohen et al.  
 690 1997) and generally poor imitation skills (Rogers et al.  
 691 2005) may lead, in some children, to lack of sufficient  
 692 attention to others' verbal output and motor speech patterns  
 693 along with fewer attempts to use these patterns for com-  
 694 municative purposes. These conditions can result in a  
 695 child's both trying less often and therefore getting less  
 696 practice in articulating speech and tending to rely on less  
 697 precise vocalizations and gestures for the few attempts that  
 698 are made. If this view is correct, then intervention that  
 699 actively focused attention on speech production and  
 700 enabled the child to learn through intensive guided practice  
 701 to produce a few accurate word forms, combined with  
 702 parent training to provide distributed opportunities for the  
 703 child to observe the connections between words and their  
 704 referents in affectively engaging settings, may be enough to  
 705 "turn on" the speech learning process, which may help  
 706 explain why for the children in this study who responded to  
 707 treatment, they tended to go on to acquire words that were  
 708 not explicitly taught in the intervention (See Tsiouri et al.  
 709 2012 for details). We have referred to this process as a  
 710 "speech insight," which could, in the context of respon-  
 711 sive parent interactions, lead not only to the use of newly  
 712 learned words in generalized settings, but to an expansion  
 713 of word use beyond those taught in the intervention, as the  
 714 child begins to "tune in" to words in the environment, to  
 715 see their connections to pleasing objects and activities  
 716 through responsive parent interactions, and to use newly  
 717 gained vocal output skills to practice and refine more word  
 718 productions.

719 All this suggests that, for minimally verbal children with  
 720 ASD, it may not be speech motor difficulty that obstructs

721 the acquisition of useful speech, as some have suggested  
 722 (e.g., Gernsbacher et al. 2008; Velleman et al. 2009). It  
 723 may be, rather, the failure to seek out opportunities for  
 724 reciprocal interactions mediated by vocal and verbal  
 725 exchanges, to "tune in" to speech models, and to "tune  
 726 up" production through emulation of significant others and  
 727 extensive practice in myriad playful interactions. This  
 728 "speech attunement" framework has been supported in  
 729 several studies of early speech development in young  
 730 children with ASD carried out in our laboratories (Schoen  
 731 et al. 2009, 2011; Shriberg et al. 2011), which suggest that  
 732 when young children with ASD learn to speak, their speech  
 733 skills are commensurate with and driven by their language  
 734 abilities and they show no evidence of apraxic or speech  
 735 motor disorders in their verbal productions.

736 We would suggest, then, that the results of the current  
 737 study should encourage clinicians to provide intensive,  
 738 speech-focused intervention for minimally verbal pre-  
 739 schoolers with ASD who show at least a modicum of joint  
 740 attention behavior. For those with low receptive language  
 741 and the capacity to learn motor imitation, RMIA may be a  
 742 good choice as an initial intervention approach. For those  
 743 with better receptive language but otherwise limited spo-  
 744 ken output, MCT may be the more appropriate option. For  
 745 those children without joint attention behaviors, a focus on  
 746 AAC modalities should be accompanied by attempts to  
 747 elicit the initiation of joint attention. When such behaviors  
 748 do begin to emerge, it would make sense to attempt speech-  
 749 focused treatment at that point in time.

750 We believe our results also argue for including training  
 751 in parent responsiveness as an accompaniment (not a  
 752 substitute) to clinician-delivered intervention. We believe  
 753 for these severely involved preschoolers, direct, focused  
 754 treatment—which requires carefully shaping vocal behav-  
 755 ior into intelligible speech, choosing words to introduce  
 756 that are within the child's phonological zone of proximal  
 757 development, and withholding reinforcement when targets  
 758 are not accurately met—necessitates the skill of a trained  
 759 intervention agent. However, we also believe that  
 760 expanding upon the gains made in these clinician-delivered  
 761 sessions, by providing multiple opportunities for practice  
 762 of spoken communication in an enjoyable interaction with  
 763 highly positive affective valence with parents, may greatly enhance the  
 764 effect of the clinician-delivered intervention. Although pre-  
 765 treatment parent responsiveness did not moderate treatment  
 766 in our study, perhaps due to the small sample size, Aldred  
 767 et al. (2012) recently reported that when parent respon-  
 768 siveness to children with ASD improved, children were  
 769 more likely to show a positive effect of communication  
 770 intervention. This finding supports our intuition that provid-  
 771 ing parent responsiveness training within our interven-  
 772 tion packages led to greater improvement in children's  
 773 response to the clinician-delivered treatment.

## 774 Limitations and Future Research

775 A primary limitation of the current study was the small  
776 sample size. The strict entry criteria, involving very limited  
777 spoken language in conjunction with at least a 12 month  
778 level in nonverbal cognition, as well as the logistical dif-  
779 ficulties of providing an intervention that required clinic  
780 attendance in addition to the child's ongoing school pro-  
781 gram, made recruitment difficult. The power to find dif-  
782 ferences in outcomes between the two treatments, as well  
783 as to identify moderators of response was thus limited.  
784 Future research with larger samples may enable more  
785 precise information about moderators that assist in  
786 matching children to specific treatment approaches. A  
787 second limitation was the decision to assign children non-  
788 randomly to the MCT condition if they could not master  
789 the motor imitation skills necessary for RMIA treatment.  
790 This resulted in our inability to use a completely random-  
791 ized design, which limits the generalizability of the find-  
792 ings. Despite this difficulty, we believe that comparisons of  
793 differing treatment methods, including contrasting DTT  
794 methods with more naturalistic approaches, is an essential  
795 element of treatment research. Without such direct com-  
796 parisons, more effective matching of children to treatments  
797 will not be feasible.

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