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Is More Better? Milieu Communication Teaching in Toddlers With Intellectual Disabilities

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Abstract

Purpose—The authors sought to determine whether a program of 5 weekly doses of milieu communication teaching (MCT) would yield improvements in children's communication and word use compared with a once-weekly delivery of the same treatment.

Method—Sixty-four children with intellectual and communication delay were randomly assigned to receive 60-min sessions of MCT either 1 time or 5 times per week over a 9-month treatment. Growth curves were fit to data collected at 5 points before, during, and after the MCT was delivered.

Results—With groups collapsed, significant growth across the experimental period was observed on all measures, but this was not associated unconditionally with treatment intensity. Children who played with 9 or more objects during a standard play assessment, an empirically identified cut-point, benefitted more from the high- than from the low-intensity treatment on lexical measures (Hedges's *g* range = .49 to .65).

Conclusions—More MCT is not always better for all children. Clinicians can expect that increasing the frequency of MCT sessions will yield moderate enhancement of outcomes if the child has high interest in objects.

Keywords

children; communication; developmental disorders; early intervention; efficacy; intervention; language disorders

When speech-language pathologists (SLPs) intervene with young children who are significantly delayed in acquisition and use of first words, they must determine whether their early focus on intentional child communication acts should target (a) spoken words; (b) some alternative communication form, such as manual sign or a speech-generating device (Dunst, Meter, & Hamby, 2011; Launonen, 1996; Romski, Sevcik, Cheslock, & Barton, 2006); or (c) prelinguistic communication, such as using preverbal means, including gestures, vocalizations, and eye contact (Warren et al., 2006; Wilcox & Shannon, 1998). Members of our research team have long been involved in the development and study of an intervention, *prelinguistic milieu teaching* (*PMT*), which targets children's prelinguistic communication as a foundation for later spoken word production. The principal goal of

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PMT is to facilitate the child's development of a solid foundation of nonverbal communication on which the child may build a rich system of linguistic communication.

Once the child is making frequent use of intentional communication or conventional symbols are emerging, PMT can be followed by language intervention, such as *milieu language teaching* (MT; Hancock & Kaiser, 2006), forming a sequential approach that we refer to as *milieu communication teaching* (MCT; see Fey et al., 2006, for a detailed clinical description). The outcomes of randomized trials of different versions of MCT have been generally positive, but effects have been modest and somewhat inconsistent within or across participant cohorts (e.g., Fey et al., 2006; Warren et al., 2008; Yoder & Stone, 2006; Yoder & Warren, 2002).

One hypothesis for the moderate effects observed for MCT is that the intervention has not been sufficiently intensive (Warren et al., 2008; Warren, Fey, & Yoder, 2007). The service delivery model we have adopted for PMT and MCT to date has involved three or four 20-min sessions per week in the home or child care center for a total duration of 6 months.

It is possible that the relatively low-intensity versions of MCT studied to date have led to greater or lesser effects among different subgroups of children with different communication and cognitive profiles (Warren et al., 2007). For example, Yoder, Warren, and Hull (1995) observed a positive association between PMT outcomes in intentional communication and object play. PMT requires clinicians to develop play-based routines within which communication needs naturally arise and PMT prompts can be administered. In one study of a typically low-intensity model of PMT, PMT was shown to facilitate children's interest in playing meaningfully with a broad range of objects (McDuffie, Lieberman, and Yoder, 2010). Thus, even a low-intensity implementation of PMT may strengthen play skills to the extent needed for the communication intervention to be successful. On the other hand, one might speculate that larger and/or more frequent doses of play-based teaching episodes in PMT sessions would result in even more substantial and more consistent gains among children who exhibit weak play skills from the outset of intervention. Thus, gains in object interest as the result of high-intensity PMT may lay the groundwork for, or mediate, larger and more consistent PMT effects on communication and language performance.

There is evidence to suggest that several other conditions may have moderating effects on MCT intensity. For example, Yoder and Warren (1998) observed that children whose parents were more responsive to child communication attempts made significantly greater gains in the PMT group than in the contrast treatment. Yoder and Warren (2002) noted that the rate of growth in requesting was significantly greater for recipients of MCT than for control group participants. This held true, however, only for those participants who did not have Down syndrome (DS). Children with DS had steeper gains in requesting if they were in the no-treatment control group than if they had received MCT. In their randomized trial of a modified version of MCT, Fey et al. (2006) reported effects favoring the group that received MCT; in contrast to the findings of Yoder and Warren (2002), children with DS responded no differently than the participants with developmental delays not associated with DS.

Fey et al. (2006) also observed that MCT, offered three or four times a week for 20 min, did not elevate levels of parental stress. It could be, however, that families that begin a high-intensity MCT protocol with high levels of stress do not subsequently benefit from high-intensity intervention to the same extent as do families with lower stress. For example, in a study of families of children with autism spectrum disorders, Osborne, McHugh, Saunders, and Reed (2008) observed that children benefitted from greater doses of their eclectic intervention packages only if their parents started the study with relatively low stress.

Thus, it seems plausible that variables, such as object play, parent responsivity, presence or absence of DS, or levels of parental stress, could interact in some way with intensity of MCT. The current investigation was designed to test these possibilities.

A Model of Treatment Intensity

Warren et al. (2007) described communication intervention intensity using pharmacological terminology. In this model, *dose* represents the length of a standard session and the number or rate of teaching episodes produced during such a session. *Dose form* reflects the type of activity (e.g., drill vs. routines vs. play, individual vs. group) within which the teaching episodes are executed. *Dose frequency* represents the frequency per day, week, or month with which a dose is delivered. *Cumulative intervention intensity*, the total number of intervention episodes, is the product of dose, dose frequency, and total intervention duration.

According to a survey by Brandel and Frome Loeb (2011), clinicians in schools provide children with more severe communication problems with more intensive treatment. In practice, this represents a change from one to two or three 20-min sessions per week. This specific modification of dose frequency, however, appeared to be based more on caseload issues than on specific characteristics of the children involved and the nature of their problems as they relate to intervention efficacy. In fact, there are few studies in the literature designed in ways that make them suitable to guide clinicians in their decisions about the intensity of communication intervention (for examples of such studies, see Barrett, Littlejohns, & Thompson, 1992; Cirrin et al., 2010; Denton et al., 2011; McGinty, Breit-Smith, Fan, Justice, & Kaderavek, 2011; Proctor-Williams & Fey, 2007; Ukrainetz, Ross, & Harm, 2009).

In the present investigation, we compared the effects of MCT when delivered in a typically low-intensity package, one 60-min session per week, with MCT when administered in five weekly 60-min sessions. Both interventions were provided for 9 months rather than the previously studied 6 months. This basic design enabled us to compare the effects of a nearly fivefold increase in dose frequency and cumulative intervention intensity. The highest levels of dose frequency and cumulative intervention intensity we tested are substantially higher than past examples of MCT. We also were interested in the possibility that these two combined aspects of intensity would interact with one or more variables demonstrated by our previous research to be associated with effects of MCT. Thus, we included measures of child object play, parent responsivity, presence or absence of DS, and parental stress as potential moderators or mediators of intensity effects.

Experimental Questions

The primary question addressed in this study was “Does a program of higher intensity MCT lead to significantly better outcomes than a lower intensity version of MCT?” The specific aspects of treatment intensity that we chose to alter systematically were dose frequency and cumulative intervention intensity. More specifically, we wanted to know whether a program of five weekly doses of 1-hr MCT (*high intensity, HI*) would lead to significant differences in children’s intentional communication and word use or parents’ level of stress when compared to a once-weekly (*low intensity, LI*) delivery of the same treatment.

Secondary questions about several potential moderators and one potential mediator of effects of treatment intensity were of special interest:

1. Do the effects of intensity of MCT on communication and language outcomes vary depending on pre-experimental status with regard to (a) child-differentiated object

play, (b) parental responsivity, (c) presence or absence of DS in the child, (d) child intentional communication, and (e) level of parental stress?

2. Are any observed effects of intensity on child communication and language outcomes associated with pre- to posttreatment changes in level of differentiated object play?

Method

Participants

The study was conducted at Vanderbilt University in Nashville, Tennessee, and at the University of Kansas Medical Center in Kansas City, Kansas. It was approved by the Institutional Review Boards at both institutions.

We advertised for 18- to 27-month-old children from English-speaking homes, with general developmental delay, significant delays in the acquisition of words, and no diagnosis of autism. Inclusion criteria were (a) 20 or fewer spoken or signed words in the expressive lexicon, as reported by the primary caregiver on the MacArthur Communicative Development Inventories: Words and Gestures (MCDI; Fenson et al., 1993); (b) Bayley Scales of Infant and Toddler Development, Third Edition (Bayley–III; Bayley, 2006) cognitive composite score between 55 and 75; (c) Screening Tool for Autism in Two-Year-Olds (STAT; Stone & Ousley, 2003) score of under 2.75 for children 18–23 months old and a score of under 2 for children 24–7 months old, indicating low risk of autism; (d) normal hearing in at least one ear, as determined by a hearing screening; (e) normal, or corrected, vision per parent report; and (f) motor skills sufficient to sit unsupported and engage in play with an interventionist.

The scheme for recruiting and including participants is provided in Figure 1. From a total of 251 children assessed, 76 children were identified and enrolled. These children were randomly assigned, using a computer-based randomization system, to receive either one 1-hr (LI) or five 1-hr (HI) MCT sessions per week. Twelve children, six from each intensity-level group, were excluded from analyses because they attended fewer than 67% of the scheduled sessions or withdrew from the study and were lost to follow-up. Our research questions were fundamentally related to communication intervention adherence; that is, we were interested in determining the influence of high-intervention frequency on MCT outcomes rather than the effects of planned or assigned treatment intensity levels. Because of this, we report “per protocol” rather than “intention to treat” analyses (Dallal, 1998), utilizing only those participants who attended at least 67% of the sessions offered at planned intensity levels. After eliminating dropouts, there were 31 children in the LI group and 33 children in the HI group who completed their assigned intervention regimen.

Table 1 provides information on select demographic and communication characteristics of the LI and HI treatment groups. At study onset, LI and HI participants had average chronological ages of 22.5 months ($SD = 3.1$) and 21.6 months ($SD = 2.61$), respectively, and developmental ages of 12.7 months ($SD = 1.7$) and 12.1 months ($SD = 2.09$), respectively. One child with a Bayley–III cognitive composite score of 80 and a developmental age of 14 months was enrolled because she had a diagnosis of DS and otherwise met all criteria. Caregivers were biological parents except for three cases in which the caregiver was an adoptive parent. For all children except one, the parent serving as source of all data was the mother. As measured by the Parenting Stress Index/Short Form, Third Edition (PSI/SF; Abidin, 1995), parental stress was in the clinically significant range (i.e., raw score > 90) for eight parents, five in the LI group and three in the HI group.

In our three communication measurement contexts (see description below), the participants produced, on average, 0.70 intentional communication acts per minute at Time 1 (*SD* = 0.49). Their parents reported that the children spontaneously initiated an average of 3.3 content words or signs (*SD* = 3.19) and understood an average of 60 (*SD* = 65) content words at the outset of the study.

Pre-experimental group comparisons—The LI and HI groups were compared statistically on 34 variables at study entry, several of which are detailed in Table 1. There were no statistically reliable differences between groups on any variable (χs < 4.2, *t*s < 1.78, *p*s > .08, *d*s < .45). In addition, the HI and LI groups did not differ in the average number of hours per month attending nonproject interventions (HI grand mean across the 9-month intervention = 3.2, grand average *SD* = 2.4; LI grand mean across the 9-month intervention = 2.7, grand average *SD* = 2.4), $t(62) = 1.5$, $p > .13$.

Table 1 also includes the means and standard deviations for the two groups of six children who were enrolled in the study but were dropped from analyses. Careful examination of means and standard deviations for these two groups indicates that they are generally similar to those of their counterparts who were included in the study and to each other and that there is no clear pattern distinguishing either dropout group from the other or from either of the experimental groups. Thus, these participants were excluded from all further analysis.

The Three Intervention Components

MCT comprises Responsivity Education, Prelinguistic Milieu Teaching, and Milieu Teaching. All of the interventions have been described elsewhere (Fey et al., 2006; Warren et al., 2006, 2008). A manual is available from the corresponding author. Only essential details are presented here.

All intervention sessions were carried out either in the child's home or day care center. To encourage parents' adherence to their randomly assigned schedule of intervention, each month we provided them with a $25 gift certificate to a discount department store if they met with the clinician for at least 75% of their scheduled sessions.

Responsivity education—Caregivers of all participants in both groups were given and asked to read the Hanen Parent Program book, *It Takes Two to Talk* (Pepper & Weitzman, 2004), and they completed nine 1-hr individual responsivity education (RE) sessions in each participant's home within the first 3 months of the 9-month intervention period. Although both parents of each participant were invited to participate in RE, only one parent participated regularly in the sessions in all but three cases. RE sessions were scheduled typically on a weekly basis. In some cases in which parents were meeting all objectives adequately and their schedules demanded, twice-weekly sessions were held to ensure that the program was completed on time. The specific parent objectives of RE were (a) to get caregivers to increase responsiveness to the child's play actions and attempts to communicate (e.g., waiting for the child to act or communicate; following the child's lead; imitating child play acts and gestures, vocalizations, and eye contact; commenting on the child's acts and objects of attention); (b) to put the child's nonverbal communication acts into words (*linguistic mapping*; e.g., child stretches hand to a ball and looks at the parent who says, "ball," or, "a ball"); (c) to add semantically to the child's topic (*follow-in comments*; e.g., child says, "ball," and the parent responds, "You can bounce it"); or (d) to copy and add structure and meaning to the child's use of words (*recasts*; e.g., child says, "ball," and the parent responds, "Yeah, it is a ball").

Placement in PMT and MT—Children who produced fewer than five spoken words, based on parent report on the MCDI and observation of their first communication sampling session, began MCT in PMT. Based on this criterion, all children randomized to the LI group began in PMT. All but four children who were allocated to the HI group also used fewer than five words at study onset and were enrolled in PMT. Based on parental report of their relatively frequent word production, these four children should have been placed in MT. One correctly began in MT, as planned. The three others were misplaced in PMT as their first treatment. This mismatch could have diminished the rate at which these children learned new skills, particularly words. The three children received seven, 23, and 32 PMT sessions, respectively, before moving to MT. We inspected the gains from Time 1 to Time 5 made on each variable in each of the observational contexts to determine whether the growth of these children might have been attenuated by their participation in the wrong intervention. This yielded no clear relationship between time in PMT and outcomes.

PMT principles and methods—PMT was designed to increase the frequency, clarity, and complexity of the child's nonverbal communication acts (see Fey et al., 2006). Clinicians sought to produce one teaching episode per minute, on average. Whether children's goals included use of coordinated eye gaze to object and person, vocalizations, or gestures, or some combination of these nonverbal communication means, clinicians first arranged the environment to create multiple opportunities for the children to communicate. They followed the children's leads and developed child-clinician routines based on the children's actions and interests rather than their own. After establishing a routine, clinicians created communication contexts by interrupting or altering the routine in some way. They then used one or more prompts to get the children to produce target communication acts, using only the amount of support needed. Each PMT teaching episode was completed when the clinician recoded the child's apparent meaning into words, using linguistic mapping.

MT principles and methods—Each child was evaluated by a supervising clinician (see next section) during each of the supervisors' twice-monthly visits. Special attention was placed on the number of words produced by the children during these sessions. When supervising clinicians observed the children to be spontaneously producing five or more content words, the children progressed to language intervention at the same dose frequency to which they originally had been assigned. Three children in the LI group and one in the HI group failed to earn this advancement and continued in PMT for the full 9-month intervention period.

For the other 28 children in the LI group and 32 in the HI group, language (i.e., spoken words/semantic relations), rather than production of prelinguistic communicative acts, became the targeted communicative behavior at some point during the 9-month intervention. These participants all received MT. The basic goal of MT is to establish and/or increase the frequency and/or complexity of the child's verbal communicative acts (Hancock & Kaiser, 2006). If a child spontaneously used fewer than 40 words or signs, clinicians worked in conjunction with supervisors and parents to select five to 10 words as lexical targets for MT. If less supportive prompts did not yield the child's production of the lexical target, the clinician was free to use a direct elicitive prompt, for example, "Say 'eat.'" When children spontaneously used more than 40 words or signs, multiword semantic relations became the goal. All correctly implemented MT teaching episodes ended with the clinician's phonemic or grammatical recast of the child's utterance. As for PMT, clinicians targeted one teaching episode per minute during MT.

MCT clinicians and clinician training—Two SLPs served as supervisor in Tennessee, and one SLP served this role in Kansas. Over the course of the project, five different adults

served as regular MCT clinicians in Tennessee, and three served as clinicians in Kansas. Because of the intensity of the HI intervention and the costs involved in utilizing SLPs, we identified suitable paraprofessionals who could be trained to deliver PMT and MT under the supervision of an SLP. All clinicians had baccalaureate degrees in a related field, such as special education, and had had training with children with special needs. They also completed a minimum of 20 hr of in-project training and received a rating of *excellent* on an evaluation measure that evaluated their use of MCT prompt and consequence strategies before they were considered trained and competent to administer the intervention.

Each clinician was then supervised twice monthly by the project supervisors. One session per month was videotaped, and videotapes were evaluated formally as a check on fidelity of administration of treatment procedures. For fidelity checks, 30 min of each 60-min session were coded by the supervisor at the site opposite the clinician whose session was being evaluated.

Fidelity of treatment dose, frequency, and duration—A set of Group (HI vs. LI) × Site (Kansas City vs. Nashville) analyses of variance (ANOVAs) revealed no main effects or interactions involving site in any of the fidelity of treatment analyses, $F(1, 60) = 3.86$, $p > .05$. The average rates of correct teaching episodes per minute ($M = 1.10$, $SD = 0.30$) did not differ across intensity groups, $F(1, 60) = 1.69$, $p > .20$, and the mean proportion of teaching episodes implemented correctly was uniformly high: .99 ($SD = .03$) and .96 ($SD = .04$) for the HI and LI groups, respectively. Children in the HI ($M = 149.3$, $SD = 12.17$) group attended approximately 4.19 times more sessions than did participants in the LI ($M = 35.67$, $SD = 2.31$) group, just short of the maximum target of five times more sessions for the HI group, $F(1, 60) = 2609.23$, $p = .000$

Proportionally more of the sessions were complete (45–60 min) for the LI group ($M = .99$, $SD = .02$) than the for HI group ($M = .98$, $SD = .02$), $F(1, 60) = 4.37$, $p = .04$. However, the extremely high rate of complete sessions for both groups makes it unlikely that this small difference in session completeness could influence the results of our analyses. Finally, intervention lasted almost exactly 9 months for both the HI ($M = 8.98$ months, $SD = 0.10$) and the LI ($M = 8.94$ months, $SD = 0.10$) groups. Thus, the clinicians at both sites successfully delivered the intervention at the planned dose, dose frequency, and intervention duration.

Communication Sampling Contexts

Child communication performance was recorded and evaluated in three contexts. Examiners were blind to treatment assignment in each condition. In the first context, the adult examiner completed the Communicative Temptations and Sharing Books components of the Communication and Symbolic Behavior Scales (CSBS; Wetherby & Prizant, 1993). The second context, parent–child free play (PCFP), was a play session involving a participant, a parent, two sets of toys, and three books. The parent and child played for 10 min. Then, the examiner introduced three board books to the parent “to look at” with their child. This activity lasted for 5 min, for a total PCFP length of 15 min. In the third sampling context, examiner–child semistructured play (ECSS), the examiner played with the child and provided limited scaffolding of the child’s communication and play behaviors. One of three toy sets was used at a time. The examiner switched to a new toy set when the child became disinterested in the current toys, when the child indicated a desire to change, or when the examiner wished to redirect a distressed child. During play, the examiner imitated the child’s actions, modeled appropriate use of the toys, or modeled a higher level of play with the toys. She responded naturally to the child’s communication behaviors by interpreting, acknowledging, or expanding on the content of the child’s communication efforts, but never

directly requested the child to produce a communication act, other than for a clarification of a preceding child act. ECSS sessions lasted 15 min.

Dependent Variables

CSBS, PCFP, and ECSS samples were coded using the ProcoderDV software (Tapp, 2003) by teams of two trained coders at the Kansas City site, all of whom were blind to participant group assignment. Each communication sample was coded for child communication behaviors, including (a) behavior regulators (e.g., requests, commands, protests that obligate the partner to respond), (b) declaratives (e.g., comments or statements that do not require a response), (c) total intentional communication acts (i.e., behavior regulators + declaratives + other intentional communication acts), and (d) number of different words produced. This process yielded four scores for each participant for each sampling context at each of five testing points (Times 1–5): immediately before intervention; after 3, 6, and 9 months of intervention; and 6 months later, at a 15-month maintenance session. A copy of the coding system is available from the authors.

Communication coding and coding reliability—For all samples, one member of the coding team was deemed the primary coder. One out of every five samples was selected at random for reliability purposes. The primary coders did not know whether the sessions they were coding would be used for reliability purposes. A member of the coding team who was not the primary coder transcribed and coded each reliability sample independently of all other personnel.

Using the absolute model, intraclass correlation coefficients (ICCs) were calculated to estimate the reliability of the primary coders' child behavior coding for each coded dependent variable at each time period, for each sampling context. For the 80 CSBS samples included in the coding of child acts reliability analyses, ICCs ranged from −.11 to .99 for an average of .90. The only ICC below .75 involved coding of number of different words at Time 1, a time at which most participants used no words, providing little variability in scores. For the 80 PCFP samples selected for reliability analysis, ICCs ranged from .73 to .99, with an overall average of .92. For the 80 ECSS samples used in the reliability analysis, ICCs ranged from .74 to .98, with an overall average of .88. In general, these reliability analyses demonstrate that variation in participant scores was mostly due to variation in participant performance rather than inconsistency in across-observer coding.

For each child communication variable within each sampling context, participant scores were converted to rates by dividing the score by the duration of the session. Rates were then averaged across the three contexts to form aggregate scores. All analyses involving these child variables were based on these aggregated rates.

Parent report of word usage—The participants' comprehension and production of words also were evaluated at each data collection point, using the vocabulary checklist portion of the MCDI. Parents were asked to modify the standard procedure by indicating words that were understood, spoken (and possibly also signed), and signed only. The variables derived were (a) the MCDI number of words understood, (b) the MCDI number of different words spoken, and (c) the MCDI number of different words spoken plus those signed (number of spoken words + words that were signed only). All three variables excluded sound effects and animal sounds (e.g., *ouch, uh-oh*), routinized games and routines (e.g., *hi, thank you, yes*), as well as caregiver names (e.g., *mommy, poppy*). Thus, only words that readily can be placed into a lexical or functional category (e.g., noun, verb, adjective) were included in these lexical variables.

Parental stress—At Times 1 and 4, parents filled out the PSI/SF as a potential moderator and as an outcome variable of intervention intensity effects. We used the Total Stress score as a general measure of stress in the parents' lives in their roles as parents.

Potential Moderating Variables

Parent responsive acts and coding reliability—The PCFP setting also served as the source of data on parent responsiveness to the child's intentional communication efforts. The coded behaviors were strategies taught by the *It Takes Two to Talk* curriculum (Pepper & Weitzman, 2004). Two passes of the media files were conducted, each using a different behavior sampling method (i.e., timed event or partial interval).

To evaluate parent responsivity, a blinded assistant first inspected each adult utterance to determine whether it was a linguistic mapping utterance (or recast) of the child intentional communication act or a "follow-in comment" about the child's play act. To be scored a linguistic mapping or recast, the adult response had to retain the referential context of the child's utterance and either put into words the meaning of the child's nonverbal communication act or copy one or more words from the child's verbalization and add phonemic, grammatical, or semantic detail. To be coded as a follow-in comment, the adult response had to be a topic-contingent verbal comment (i.e., not a behavior regulator) that did not meet the structural requirements of linguistic mapping (or recasting). For all analyses, the number of linguistic mappings and the number of follow-in comments were calculated. Twenty percent of the sessions were randomly selected for reliability estimation and recoded by a second blinded coder. The ICCs ranged from .87 to .95 and .93 to .99 for follow-in comments and linguistic mapping, respectively, depending on the measurement period at which they were collected.

Parents respond positively to their children during play in ways that are not necessarily verbal and are not necessarily topically or structurally related to child communication attempts. Onsets and offsets of parents' use of these acts were difficult to identify precisely. Therefore, we used a partial-interval time-sampling procedure to code the third category of parent responsivity. The coders observed a 5-s interval of the PCFP and, at the end of each interval, judged whether the child had been engaged with an object or an adult during that interval. If the interval contained such engagement, parent responsivity was coded. For this coding category, parental responsivity included (a) physically imitating, complementing, or expanding on the child's play; (b) using gesture or language to prompt the child to communicate about a play object or event (e.g., "Tell me what that is"; "Do the people go inside or outside?"); and (c) complying nonverbally, and possibly verbally, to child requests/protests. The analyzed variable was the proportion of codable intervals in which the parent produced such a response to the child's play behaviors or to a child's command. Twenty percent of the sessions were randomly selected for reliability estimation and recoded by a second coder. The ICCs ranged from .81 to .97, depending on the measurement period.

Developmental Play Assessment (DPA)—The DPA (Lifter, 2000) was used at Times 1 and 4 to provide measures of the child's ability to play with objects in their intended or a symbolic manner at the beginning and end of the intervention period. In this 15-min procedure, three sets of toys were presented one at a time for a period of 5 min each in a context in which the examiner provided limited or no scaffolding of child actions on objects. After the first standard set of toys was presented, the examiner made comments describing child actions, responded to child requests, imitated child actions, and gave the child objects one at a time, if necessary. Examiners were instructed to refrain from modeling or prompting new actions on the objects.

Two dependent variables, number of different toys on which the child used functional or symbolic play (i.e., *object interest*) and number of different functional or symbolic play actions the child used (i.e., *object knowledge*) were coded using the custom-designed computer software Playcoder (Tapp & Yoder, 2003). Variables were coded by a primary observer who was blind both to group assignment and to the sessions that were to be checked for reliability. A second observer who was blind to group assignment independently coded randomly selected sessions that represented approximately 20% of the total number of sessions. ICCs for object interest were .97 and .83, for object knowledge, .93 and .91, at Times 1 and 4, respectively.

Results

Changes in Parent Responsivity

The parent component of MCT, provided to parents in both groups, was designed to facilitate greater parental responsivity to child play behaviors and communication attempts. We measured parents' use of target behaviors during the 15-min PCFP session. To evaluate parent change, we performed a series of Group (HI vs. LI) × Site (Kansas City vs. Nashville) repeated-measures ANOVAs, with parent responsivity measures as the dependent variables. One parent did not participate in one of the test sessions, so analyses were performed on only 63 individuals with no missing data. Neither site nor treatment group was significant as a main effect or interaction for any of the three measures of parental responsivity (Fs < 1.8, ps > .14). There was a significant effect of time for all measures (Fs > 4.81, ps < .005), indicating significant change over time.

Follow-up testing revealed that at Time 1, parents in both groups used a positive strategy to facilitate play and social interaction in approximately 10% of codable intervals (SD = 6.0). They increased this level modestly but significantly to 14% (SD = 0.05) by Time 3 (d = +0.40) and then leveled off, making no more significant changes across the children's intervention period or beyond (ps > .98).

In their use of verbal strategies, parents exhibited an increase from an average of 37 follow-in comments (SD = 16.53) during the Time 1 session before intervention to an average of 51 (SD = 22.53) at the end of the parent treatment (i.e., Time 2), 3 months later (d = +0.65). There were no other significant parent changes in the use of follow-in comments from Time 2 to Time 5 (ps > .85).

In contrast to the pattern of early change followed by greater stability shown on other measures, parents made significant increases in their use of linguistic mapping/recasting across each of the testing intervals (ps < .02, ds = +0.41 to +0.65), except from Time 3 to Time 4 (p = .20). They started at a very low rate of two mappings/recasts per 15-min session (SD = 2.86) and increased in linear fashion over the entire course of the study to a peak average of nearly 15 per session (SD = 14.28).

Main Effects of Time on Child Communication and Language

For analysis of child variables, we used growth curve modeling to test the primary and secondary research questions (Singer & Willet, 2003). The Hierarchical Linear Modeling (HLM) software was used to implement mixed-level modeling analyses (Raudenbush, Bryk, & Congdon, 2004). To increase the probability that the assumption of homoscedacity of variance was met, we log10 transformed dependent variables. To aid interpretation, we fit the data to a nested model including only random and fixed intercept and slope. Time was treated as a continuous variable and was centered at Time 5, 6 months after the conclusion of intervention, unless otherwise noted. For all of our growth curve analyses, the participants' intercept scores can be interpreted as the best estimate of the outcome level at

the end of the respective analysis period, generally Time 5. The slope is the average rate of change over the study period.

We first tested for main effects of time on the participants' rate of communication and language growth by examining whether the slope for each variable averaged across all participants was greater than zero. This is a test of the fixed effect of the slope in the Level 1 model with all participants together in a single group. One analysis was performed for each of the seven dependent variables. These analyses revealed that the average trajectory from Time 1 to Time 5 was positive and differed significantly from zero for all seven variables. Thus, regardless of the intervention they received, the study participants made statistically significant growth on our communication and language variables across the study period.

Main Effects of Intensity of Treatment for Time 1 to Time 5

Next, we examined our main research questions by testing for main effects of intensity of treatment (i.e., HI vs. LI) over Times 1 to 5. Table 2 provides the intensity coefficients on the intercepts and the back-transformed estimated average dependent variable score at Time 5 for each group. The values in Table 2 may appear different between groups, but within-group variability was great, and our analyses revealed no significant effects of treatment intensity ($.94 > p > .15$).

Interactions Between MCT Intensity and Predicted Moderators on Growth from Time 1 to Time 5

It is possible that effects of varying levels of MCT intensity depend on the moderating influence of children's status on key pre-experimental variables. The a priori putative moderators included measures of differentiated object play (i.e., object interest and object knowledge from the DPA), parental responsivity, presence or absence of DS, number of intentional communication acts, and level of parental stress (i.e., PSI/SF score) at Time 1. Each of these variables at Time 1 was tested as a moderator of between-intensity level differences on each of the dependent variables at Time 5. We used the methods discussed in Preacher, Curran, and Bauer (2006) to identify the cut-point on the moderator variable at which intensity groups differ significantly on the outcome. We interpreted interactions to be significant only when two or more participants had pretreatment scores at or beyond the cut-point on the predictor variable at each intensity level (Aiken & West, 1991).

Only one predicted pretreatment variable met this criterion. This was object interest, the number of objects the child played with using actions that are specific to the characteristics of the toy, during the 15-min DPA. We term the class of play most relevant to the object interest variable "meaningful" play. Time 1 object interest interacted with intensity level to moderate three of the seven child communication dependent variables at Time 5 (i.e., the intercept of the growth curve). This included the growth curve estimates of the MCDI words understood at Time 5, $t(60) = 2.3$, $p = .03$; MCDI words spoken, $t(60) = 2.3$, $p = .02$, as exemplified in Figure 2; and MCDI words spoken plus those signed at Time 5, $t(60) = 2.1$, $p = .04$. Details of these analyses, including effect sizes, are presented in Table 3. As illustrated in the figure and table, children who engaged in functional or symbolic play with nine or 10 objects (i.e., the computed cutoff point) or more during the Time 1 DPA learned to use and understand more words if they received 5 hr of MCT per week (i.e., in the HI group) than if they were treated only 1 hr a week (i.e., in the LI group). Many children in both groups played with sufficiently large numbers of objects to be affected by the moderating influence of object interest.

Analyses on growth from Time 1 to Time 4—We also sought to identify changes in the participants' differentiated object play and level of parental stress that might have been

associated with the intervention. Significant between-group differences are essential to view these variables as mediators of the effects of intervention intensity. Main effects for intensity on these variables were tested with a *t* test on the residualized gain scores from Time 1 to their second and final testing, at Time 4. No significant between-group differences were observed for these variables (.69 > *p* > .30), indicating that there were no significant changes associated with treatment intensity for any of these variables between Times 1 and 4. Because there was no effect of dose frequency on play, there cannot be mediated effects of dose frequency through play.

Our main growth curve analyses included data from all five time points and focused on effects of intensity level on growth exhibited up to Time 5. This linear approach to the study of intervention effects observed from the pretreatment testing (i.e., Time 1) to the 6-month posttreatment maintenance period (i.e., Time 5) missed any predictable effects that may have been present at another point of key interest, the end of the intervention period at Time 4.

To examine this possibility in an exploratory fashion, we used simple growth models to test the growth of the MCDI and communication-sample variables only up to Time 4, with time centered at Time 4. All variables met the assumptions for growth modeling. Similar to findings at Time 5, there were no main effects of MCT intensity on any communication or language variables at Time 4 (.82 > *p* for intensity on intercept < . 14; .93 > *p* for intensity on slope < .06). This was true even after considering the obvious covariates (e.g., IQ, developmental age, presence or absence of DS). On the other hand, Time 1 object interest interacted with intensity to predict estimates of Time 4 performance on all three of the MCDI variables. As was the case for the Time 5 analyses, children who played meaningfully with more than nine toys at Time 1 benefited more from the HI MCT than from the LI MCT. For the test of the product term on the intercept, *p* values ranged from < . 001 to .02 across the MCDI measures; Hedges's g ranged from .71 to .82. These effect size values are generally taken to be large in studies of the effects of communication interventions.

Discussion

This study was planned as the first attempt to isolate experimentally the effects of treatment intensity on the outcomes of a comprehensive communication and language intervention (Warren et al., 2007). The intervention we utilized, milieu communication teaching (MCT), was developed for young children with general developmental delay and limited expressive vocabulary (Warren, Yoder, Gazdag, Kim, & Jones, 1993; Yoder & Warren, 1998, 1999, 2002). It has been studied extensively as a spoken language intervention in 20-min doses, with dose frequency of three or four sessions weekly, with an intervention duration of 6 months. With few exceptions (Warren et al., 2008), these studies have produced modest effects of MCT on participants' rates of intentional communication acts (Fey et al., 2006) or significant conditional effects on subgroups of participants' intentional communication and lexical output (Yoder & Warren, 1998, 1999, 2002).

Unlike most other language-oriented studies targeting intensity, we controlled key intervention variables, such as types of goals, activities, and procedures, as well as several intensity variables. This included the rate of teaching episodes and length of sessions (i.e., dose), and treatment duration (Warren et al., 2007). Thus, with the exception of dose frequency and cumulative intervention intensity, the HI and LI interventions were administered in approximately the same manner. We hypothesized that this version of MCT, offered in 1-hour doses over a 9-month period, would yield more and larger effects when

presented with a dose frequency of five times per week (i.e., HI) than with a once-weekly regimen (i.e., LI).

Our unconditional growth curve models indicated that, as a single group, participants exhibited significant growth from Time 1 to Time 5 on each of our dependent communication variables. However, this growth was not necessarily due to MCT at either level of intensity. To examine the effects of MCT intensity at both Time 4 and Time 5, we tested for but did not find a main effect on any dependent variable. To explore conditional (i.e., subgroup) effects of MCT intensity for growth to Time 4 and to Time 5, we tested the statistical interactions between treatment intensity level and several potential Time 1 moderators of variability, including measures of object play skills, parent responsivity, presence or absence of DS, frequency of child intentional communications, and parental stress. Only one of these variables moderated the effects of dose frequency on our child communication outcomes; there were consistent, moderate to large interactions between Time 1 object interest and intensity level on all three MCDI lexical variables. In each case, children who played meaningfully with nine or more objects during the 15-min DPA at Time 1 made significantly more growth in vocabulary if they received the HI than if they participated in the LI intervention.

Evaluating Conditional Intensity Effects

These conditional effects associated with object play were the only significant effects among many statistical tests; that is, our experiment-wise error exceeded .05, as is true of almost all treatment studies in the field of communication disorders. Therefore, it is reasonable to question whether observed effects are replicable. We can provide no definitive answer to this question, but the significant outcome we observed is coherent and plausible for three reasons. First, as described in the Introduction, it is theoretically reasonable that children who have strong functional or symbolic play skills would benefit most by more frequent MCT. The more advanced play skills of these children may better prepare them to learn from daily exposures to the teaching episodes found in HI MCT, which are all presented within an object-play context. Second, over the duration of the study, children with high object interest were likely more highly engaged with play objects than were children with low object interest. This greater engagement may have made it possible for our staff and the children's parents to deliver more idealized, child-specific teaching episodes to these children. It seems reasonable to suggest that a more intensive intervention would have its greatest benefit when its teaching episodes are tailored to suit the specific needs and special interests of the targeted child, Third, within this study, level of object interest interacted with intensity group to predict outcomes at both Time 4 and Time 5. That is, the moderating influence of object interest on the effects of treatment intensity was observed both at the end of intervention and at 6-month follow-up. Further, these effects were focused on our vocabulary measures, rather than spread less discriminatingly across our communication and language variables. Thus, the finding that object interest moderated the effects of treatment intensity on lexical comprehension and production has been replicated over time and is specific, rather than random. On the other hand, there was no evidence that object play skills improved as a result of either level of treatment intensity. Consequently, object play did not act as a mediator of MCT intensity effects as we had expected it would.

Evaluating the Noneffects of Treatment Intensity

Despite our observation of moderated effects of MCT intensity (i.e., dose frequency), the main story of our study is that a more than fourfold increase in the frequency of MCT sessions and in the accumulated number of MCT teaching episodes did not result in large, unconditional main effects favoring the HI group. In this section, we consider whether our findings reflect a true noneffect of treatment intensity or whether they are the result of some

weakness in intervention design or delivery or insufficient rigor in some key aspects of our study, leading us to miss effects that otherwise should have been detectable.

Service delivery considerations—In our attempt to create a fivefold difference in MCT intensity, we had two major objectives in presenting the intervention to the participants. First, within each 60-min session, regardless of group, the clinician was to arrange for an average of one correctly implemented teaching episode per minute. Second, clinicians had to maintain the schedule of one session per week for the LI group and five sessions per week for the HI group. If we failed to meet these specifications, our trial could not be viewed as a test of the hypothesis that increased MCT intensity would lead to greater effects on communication and language growth.

We presented considerable evidence, however, that, as planned, the two interventions differed substantially only in cumulative treatment intensity (i.e., the total number of successful treatment episodes across the entire 9-month intervention period) and dose frequency (i.e., the frequency of sessions per week). For example, clinicians in each group presented just over one complete intervention episode per minute for the intervention duration of almost exactly 9 months. Although the LI group participants attended a significantly greater percentage of scheduled sessions (91%) than did the HI group participants (81%), the children in the HI group attended an average of 149 sessions compared to only 36 for the LI group. Similarly, whereas the LI group had significantly more sessions that lasted the planned 45 to 60 min, the percentage of complete sessions was extremely high, 96%, even for the HI group. In sum, there is no credible evidence that we failed to deliver each intervention session in the same manner for both groups or to achieve a clear distinction between groups in their treatment intensities, more specifically, in their dose frequencies.

Parent and nonproject interventions as potential maskers of treatment effects —Our design does not permit a conclusion that the parent intervention, which was provided to both intensity groups, contributed to the substantial changes in parent communication and language behavior we observed over the duration of the parent intervention (i.e., increased nonverbal play interaction strategies and verbal follow-ins) or of the entire study (i.e., increased linguistic mapping and recasting). Nevertheless, the changes observed in parent behaviors following the parent intervention were precisely those that we sought to facilitate. With their enhanced interactional and responsivity skills, parents in both groups may have provided their children with high-quality, if not ideal, interventions outside the contexts of our milieu teaching conditions. If this is so, the effects of the parent intervention may have minimized the differential effects of the dose frequencies of our two milieu interventions.

We have no evidence from within our project to rule out this possibility. However, Tannock, Girolametto, and Siegel (1992) evaluated a parent-intervention model, the Hanen Early Language Parent Program (Manolson, 1985), on which our responsivity education was based, and they found it to have no effects on child communication or language performance when offered to a group of young children with developmental delays similar to those in our study. Although there are reports of substantial improvements following the Hanen and similar approaches (e.g., Buschman, Jooss, Rupp, Feldhusen, Pietz, and Philippi, 2009; Girolametto, 1988), there is no reason to expect RE to lead to gains in both groups that would completely neutralize or overshadow the gains of 5 hr per week of clinician-directed intervention.

It should be recalled that all children received community-based intervention during the intervention phases of our study. Specifically, the children in the study attended an average of approximately 3 hr of nonproject speech-language intervention monthly ($SD = 1.88$) over

the course of the study. The intensity groups did not differ significantly in this regard. It is possible that gains emanating from these efforts, combined with the effects of the parent intervention, marginalized potential effects of our HI milieu intervention. Alternatively, it is possible that adding the project intervention at high intensity to an ongoing community-based service resulted in a protocol that was too intensive, thus reducing the size of intervention effects for the HI approach. Neither of these explanations of our results seems likely, however, and neither changes the bottom line.

Were effects missed due to low power?—One could argue generally that our measures were not sufficiently sensitive or that the study otherwise lacked power to find differences between intensity groups. We cannot reject this possibility out of hand, but there are several factors that diminish its likelihood. First, we demonstrated rigor in measurement, as shown by consistently high ICCs for those measures requiring substantial observer judgment. In addition, we improved the stability of our communication sample variables by averaging across communication contexts. Second, we did observe effects involving growth over time on all of our measures, as well as interactions involving object interest and intensity. Thus, our design was not without sufficient power to observe at least some of the effects we predicted we would see. Third, we used growth curve modeling with five measurement periods, a more statistically powerful method than end-point analyses, to test our predictions.

Were the growth model or moderators used adequate for the task?—There are two aspects of our analytic decisions that could have affected our ability to detect larger intensity effects: (a) the growth model may have been too simple, and (b) intensity effects could have occurred within subgroups described by variables we did not anticipate. Because we decided to model growth using a straight line, we may have reduced our probability of detecting dose frequency effects. A more complex model may model growth more reliably particularly for linguistic outcomes. Analyzing dose frequency effects within currently unidentified subgroups may be a more powerful test of dose frequency effects than the approach we used. These are topics of future research.

Study Limitations

In planning our study, we assumed that a substantial boost in the intensity of MCT would yield unconditional main effects favoring our HI treatment group. Therefore, we did not include a no-treatment or business-as-usual control group as a comparison to the HI and LI groups. Inclusion of such a group would have enhanced our ability to conclude confidently whether one or both of our implementations of MCT yielded unconditional main effects of intensity on the participants' communication and language development. Similarly, with other controls, we might have been able to measure the specific contributions of our parent intervention to the gains we observed over time

A second general limitation is that we were able to test only two levels of intensity. The MCT intensity boost that we created for our HI group may not have been enough to make a meaningful difference in outcomes across our entire sample. We could have further increased the intensity by boosting the number of sessions per day or increasing the number of teaching episodes per minute. It should be noted, however, that there is substantial disagreement regarding optimal doses. For example, Rogers and Dawson's (2010) Early Start Denver Model trains its facilitators to administer teaching episodes across language, cognitive, social, behavioral, and motor domains up to rates as high as six per minute. Hancock and Kaiser (2006), on the other hand, recommend that parents administer milieu language teaching episodes only 8 to 10 times per 20-min session in their enhanced milieu teaching to avoid overloading either the child or the facilitator. In our case, one could also

argue that 1-hr sessions are too long and that 20-min, three-times-weekly sessions, as we have done in our other studies, may be better than one 60-min session per week.

We chose to target a five-times-a-week dose frequency compared to a one-time-a-week regimen because this fivefold increase seemed to be large enough to yield between-group intensity effects yet still clinically manageable and, thus, of substantial interest to clinicians currently delivering MCT-like interventions. Experimentally, this configuration also was ideal, because the content and form of MCT as well as session length were easily controlled across intensity groups, making dose frequency an appropriate independent variable.

MCT delivered in even higher (or lower) doses or with different intensity configurations than those we tested may be more efficacious than our HI intervention, yielding effects that are broader and less conditional than we observed in our study. But this claim can always be made with any intervention found to have effects more limited than expected. Thus, it would be inappropriate to conclude that our results suggest that MCT, in some form and some ideal intensity, cannot generally and clinically significantly benefit children such as those in our study. On the other hand, we believe it is more important to view our results as evidence that, at least for MCT-like interventions targeting spoken-only intervention goals among children with developmental delays like those included in our study, “more of the same” does not always lead to better intervention outcomes.

Research and Clinical Implications

Although there is still a dearth of research studying the effects of communication and language interventions that differ in their content and form, we are now at a point at which clinicians and researchers must direct their investigative attention toward ways to deliver existing interventions that maximize their efficiency and benefits. This includes careful evaluations of the intensity of intervention (Warren et al., 2007). Other recent studies of language-based interventions have demonstrated that increasing the dose frequency does not always yield better results. For example, Denton et al. (2011) observed no effects of a comprehensive reading program whether delivered two or four times a week for 16 weeks. Ukrainetz et al. (2009) demonstrated that an 11-hr phonemic awareness intervention was no more or less effective whether offered three times per week for a short period or one time per week a longer period. In their study on the effects of a print-referencing intervention on print knowledge, McGinty et al. (2011) showed that higher dose frequencies can even diminish outcomes under certain circumstances. For example, they observed that an increase in dose frequency (i.e., four compared to two teaching sessions per week) led to better print knowledge outcomes, but only when print-referencing teaching episodes were kept low. Thus, there was no significant advantage of frequent sessions without a reduction in dose. Similarly, the most efficient way to produce the best outcomes was by increasing the dose of print referencing while keeping dose frequency low. These studies and their complex outcomes reveal the multidimensional complexity of the construct of intervention intensity.

Like the current investigation, these other intensity investigations were designed in an effort to maximize the benefits of interventions known or expected to have at least some weak effects when offered at a low intensity. Although there are some notable exceptions (e.g., Al Otaiba, Schatschneider, & Silverman, 2005; Barrett et al., 1992), the most clear and consistent outcome of studies of increases in dose frequency may be that such increases can yield surprisingly limited effects that often must be qualified by child status at the outset of intervention or by adjusting other features of intensity, such as dose. Much more work must be done to determine whether there are consistent patterns of intensity outcomes across studies and across intervention content domains.

Until this work is done, clinicians should judge modifications in treatment intensity as one of several options for program adjustment when an existing intervention program is not yielding satisfactory results (see McCauley & Fey, 2006, Chapter 1). They should recognize that intensity is a complex construct that can be broken down into a number of interacting components, like dose, which may be realized as rate of teaching episodes per session and length of a single session, and dose frequency, or the frequency of intervention sessions. They should also consider that a decision to modify intensity to facilitate treatment outcomes will not always result in an increase in cumulative intervention intensity. For example, the clinician may opt to decrease session length while increasing session frequency, yielding no net change in cumulative intervention intensity. Alternatively, a clinician might reduce the frequency of sessions while increasing the rate of teaching episodes per session, again accomplishing no or only a small net change in cumulative intensity (McGinty et al., 2011).

We conclude that, with populations similar to the one studied here (e.g., young children with developmental delays not including autism and producing few or no words or signs), the impact of high-intensity MCT may be less than desired unless the clinician considers the child's play skills before deciding to ramp up the intervention in dose frequency. We suggest that children who play meaningfully with a variety of objects may respond favorably to MCT that is provided in relatively large doses over as many as five sessions weekly. There is less justification for increasing the intensity of MCT to five weekly sessions for children with developmental delays who do not possess such positive play skills.

What, then, are the alternatives to MCT as we have delivered it? One possibility for children with low object play is to engage them in interventions that directly teach play, including symbolic play, with a variety of objects prior to initiating MCT-like communication intervention. One model of an MCT-modified intervention was designed and tested for children with autism by Yoder and Stone (2006) and McDuffie et al. (2010). Another intervention designed to enhance the symbolic play skills of children with autism was developed and tested by Kasari, Freeman, and Paparella (2006). These approaches are alike in that they directly seek changes in play behavior as well as or rather than in communication. It is possible that MCT outcomes can generally be enhanced by adopting the preliminary or simultaneous goal of expanding children's actions and the number of objects on which they act (McDuffie et al., 2010).

Another alternative to existing models of MCT, with its emphasis on gestures, nonword vocalizations, and spoken language, is to target symbolic comprehension and production using augmentative and alternative communication (AAC; Dunst et al., 2011; Launonen, 1996; Romski et al., 2010). For example, in a study involving young prelinguistic children similar to those who participated in the present investigation, Romski et al. found that early use of speech-generating devices in both input to and output for the children may lead to better overall vocabulary outcomes and statistically equivalent speech outcomes when compared to those yielded by a speech-only model of intervention. Interestingly, the procedural hierarchy that Romski et al. found to lead to the greatest gains in overall and spoken vocabulary was similar to that used in MCT. In other words, this intervention differed from MCT more in the communication modality adopted than in the delivery of the intervention itself.

The next generation of research must focus on identifying which children benefit most from treatments emphasizing spoken language as the ultimate goal. We must also continue efforts to determine the best intervention models for delivering treatments that lead to generalized, flexible communication outcomes. It seems unlikely that we can achieve these goals without

carefully evaluating rather than just assuming the benefits of modifications in treatment intensity.

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References

Abidin, RR. Parenting Stress Index. 3rd ed.. Psychological Assessment Resources; Odessa, FL: 1995.

Aiken, LS.; West, SG. Multiple regression: Testing and interpreting interactions. Sage; Newbury Park, CA: 1991.

Al Otaiba S, Schatschneider C, Silverman E. Tutor-assisted intensive learning strategies in kindergarten: How much is enough? Exceptionality. 2005; 13(4):195–208.

Barrett J, Littlejohns P, Thompson J. Trial of intensive compared with weekly speech therapy in preschool children. Archives of Disease in Childhood. 1992; 67:106–108. [PubMed: 1739321]

Bayley, N. Bayley Scales of Infant and Toddler Development. Third Edition. PsychCorp; San Antonio, TX: 2006.

Brandel J, Frome Loeb D. Program intensity and service delivery models in the schools: SLP survey results. Language, Speech, and Hearing Services in Schools. 2011; 42:461–490.

Cirrin FM, Schooling TL, Nelson NW, Diehl SF, Flynn PF, Staskowski M, Adamczyk DF. Evidence-based systematic review: Effects of different service delivery models on communication outcomes for elementary school-age children. Language, Speech, and Hearing Services in Schools. 2010; 41:233–264.

Dallal, GE. Intention-to-treat analysis. 1998. Retrieved from www.jerrydallal.com/LHSP/itt.htm

Denton CA, Cirino PT, Barth AE, Romain M, Vaughn S, Wexler J, Fletcher JM. An experimental study of scheduling and duration of “tier 2” first-grade reading intervention. Journal of Research on Educational Effectiveness. 2011; 4:208–230. [PubMed: 21796271]

Dunst CJ, Meter D, Hamby DW. Influences of sign and oral language interventions on the speech and oral language production of young children with disabilities. CELL reviews. 2011; 4(4):1–20.

Fenson, L.; Dale, P.; Reznick, S.; Thal, D.; Bates, E.; Hartung, J.; Reilly, J. MacArthur Communicative Development Inventories. Singular Publishing Group; San Diego, CA: 1993.

Fey ME, Warren SF, Brady NC, Finestack LH, Bredin-Oja SL, Fairchild M, Yoder P. Early effects of responsivity education/prelinguistic milieu teaching for children with developmental delays and their parents. Journal of Speech, Language, and Hearing Research. 2006; 49:526–547.

Hancock, TB.; Kaiser, AP. Enhanced milieu teaching. In: McCauley, RJ.; Fey, ME., editors. Treatment of language disorders in children. Brookes; Baltimore, MD: 2006. p. 203-236.

Kasari C, Freeman S, Paparella T. Joint attention and symbolic play in young children with autism: A randomized controlled intervention study. Journal of Child Psychology and Psychiatry. 2006; 47:611–620. [PubMed: 16712638]

Launonen, K. Enhancing communication skills of children with Down syndrome: Early use of manual signs. In: von Tetzchaner, S.; Jensen, MH., editors. Augmentative and alternative communication: European perspectives. Whurr; London, United Kingdom: 1996. p. 213-231.

Lifter, K. Linking assessment to intervention for children with developmental disabilities or at-risk for developmental delay: The developmental play assessment (DPA) instrument. In: Gitlin-Weiner, K.; Sandgrund, A.; Schafer, C., editors. Play diagnosis and assessment. 2nd ed.. Wiley; New York, NY: 2000. p. 228-261.

McCauley, RJ.; Fey, ME. Introduction to treatment of language disorders in children. In: McCauley, RJ.; Fey, ME., editors. Treatment of language disorders in children. Brookes; Baltimore, MD: 2006. p. 1-17.

McDuffie AS, Lieberman RG, Yoder PJ. Object interest in autism spectrum disorders: A treatment comparison. Autism. 2010; 1:1–10.

McGinty AS, Breit-Smith A, Fan X, Justice LM, Kaderavek JN. Does intensity matter? Preschoolers' print knowledge development within a classroom-based intervention. Early Childhood Research Quarterly. 2011; 26:255–267.

Osborne LA, McHugh L, Saunders J, Reed P. Parenting stress reduces the effectiveness of early teaching interventions for autistic spectrum disorders. Journal of Autism & Developmental Disorders. 2008; 38:1092–1103. [PubMed: 18027079]

Pepper, J.; Weitzman, E. It takes two to talk:A practial guide for parents of children with language delays. The Hanen Centre; Toronto, Ontario, Canada: 2004.

Preacher K, Curran P, Bauer D. Computational tools for probing interactions in multiple linear regression, multilevel modeling, and latent curve analysis. Journal of Educational and Behavioral Statistics. 2006; 31:437–448.

Proctor-Williams K, Fey ME. Recast density and acquisition of novel irregular past tense verbs. Journal of Speech, Language, and Hearing Research. 2007; 50:1029–1047.

Raudenbush, SW.; Bryk, AS.; Congdon, R. HLM 6 for Windows. Scientific Software International, Inc.; Lincolnwood, IL: 2004. Computer software

Rogers, SJ.; Dawson, G. Early Start Denver Model for young children with autism: Promoting language, learning, and engagement. The Guilford Press; New York, NY: 2010.

Romski M, Sevcik RA, Adamson LB, Cheslock M, Smith A, Barker RM, Bakeman R. Randomized comparison of augmented and nonaugmented language interventions for toddlers with developmental delays and their parents. Journal of Speech, Lnaguage, and Hearing Research. 2010; 53:350–364.

Romski, M.; Sevcik, RA.; Cheslock, M.; Barton, A. The system for augmenting language: AAC and emerging language intervention. In: McCauley, RJ.; Fey, ME., editors. Treatment of language disorders in children. Brookes; Baltimore, MD: 2006. p. 123-147.

Singer, JD.; Willet, JB. Applied longitudinal data analysis: Modeling change and event occurence. Oxford University Press; New York, NY: 2003.

Stone, W.; Ousley, O.; Vanderbilt University. Unpublished manuscript. Nashville, TN: 2003. STAT Manual: Screening tool for autism in two-year-olds.

Tannock R, Girolametto L, Siegel LS. Language intervention with children who have developmental delays: Effects of an interactive approach. American Journal of Mental Retardation. 1992; 97:145–160. [PubMed: 1384566]

Tapp, J. ProcoderDV (Version 3.0.5). Vanderbilt Kennedy Center; Nashville, TN: 2003. Computer software

Tapp, J.; Yoder, P. Playcoder (Version 1.1.2). Vanderbilt University; Nashville, TN: 2003. Computer software

Ukrainetz TA, Ross CL, Harm HM. An investigation of treatment scheduling for phonemic awareness with kindergartners who are at risk for reading difficulties. Language, Speech, and Hearing Services in Schools. 2009; 40:86–100.

Warren, SF.; Bredin-Oja, SL.; Fairchild, M.; Finestack, LH.; Fey, ME.; Brady, NC. Responsivity education/prelinguistic milieu teaching. In: McCauley, RJ.; Fey, ME., editors. Treatment of language disorders in children. Brookes; Baltimore, MD: 2006. p. 47-75.

Warren SF, Fey ME, Finestack LH, Brady NC, Bredin-Oja SL, Fleming KK. A randomized trial of longitudinal effects of low-intensity responsivity education/prelinguistic milieu teaching. Journal of Speech, Language,and Hearing Research. 2008; 51:451–470.

Warren SF, Fey ME, Yoder PJ. Differential treatment intensity research: A missing link to creating optimally effective communication interventions. Mental Retardation and Developmental Disabilities Research Reviews. 2007; 13:70–77. [PubMed: 17326112]

Warren SF, Yoder PJ, Gazdag GE, Kim K, Jones HA. Facilitating prelinguistic communication skills in young children with developmental delay. Journal of Speech and Hearing Research. 1993; 36:83–97. [PubMed: 7680733]

Wetherby, AM.; Prizant, BM. Communication and symbolic scales manual: Normed edition. Chicago, IL: 1993. Riverside

Wilcox, MJ.; Shannon, M. Facilitating the transition from prelinguistic to linguistic communication. In: Warren, SF.; Reichle, J., editors. Transitions in prelinguistic communication. Brookes; Baltimore, MD: 1998. p. 385-416.

Yoder P, Stone WL. A randomized comparison of the effect of two prelinguistic communication interventions on the acquisition of spoken communication in preschoolers with ASD. Journal of Speech, Language, and Hearing Research. 2006; 49:698–711.

Yoder PJ, Warren SF. Maternal responsivity predicts the prelinguistic communication intervention that facilitates generalized intentional communication. Journal of Speech, Language, and Hearing Research. 1998; 41:1207–1219.

Yoder PJ, Warren SF. Maternal responsivity mediates the relationship between prelinguistic intentional communication and later language. Journal of Early Intervention. 1999; 22:126–136.

Yoder PJ, Warren SF. Effects of prelinguistic milieu teaching and parent responsivity education on dyads involving children with intellectual disabilities. Journal of Speech, Language, and Hearing Research. 2002; 45:1158–1174.

Yoder PJ, Warren SF, Hull L. Predicting children's response to prelinguistic communication intervention. Journal of Early Intervention. 1995; 19:74–84.

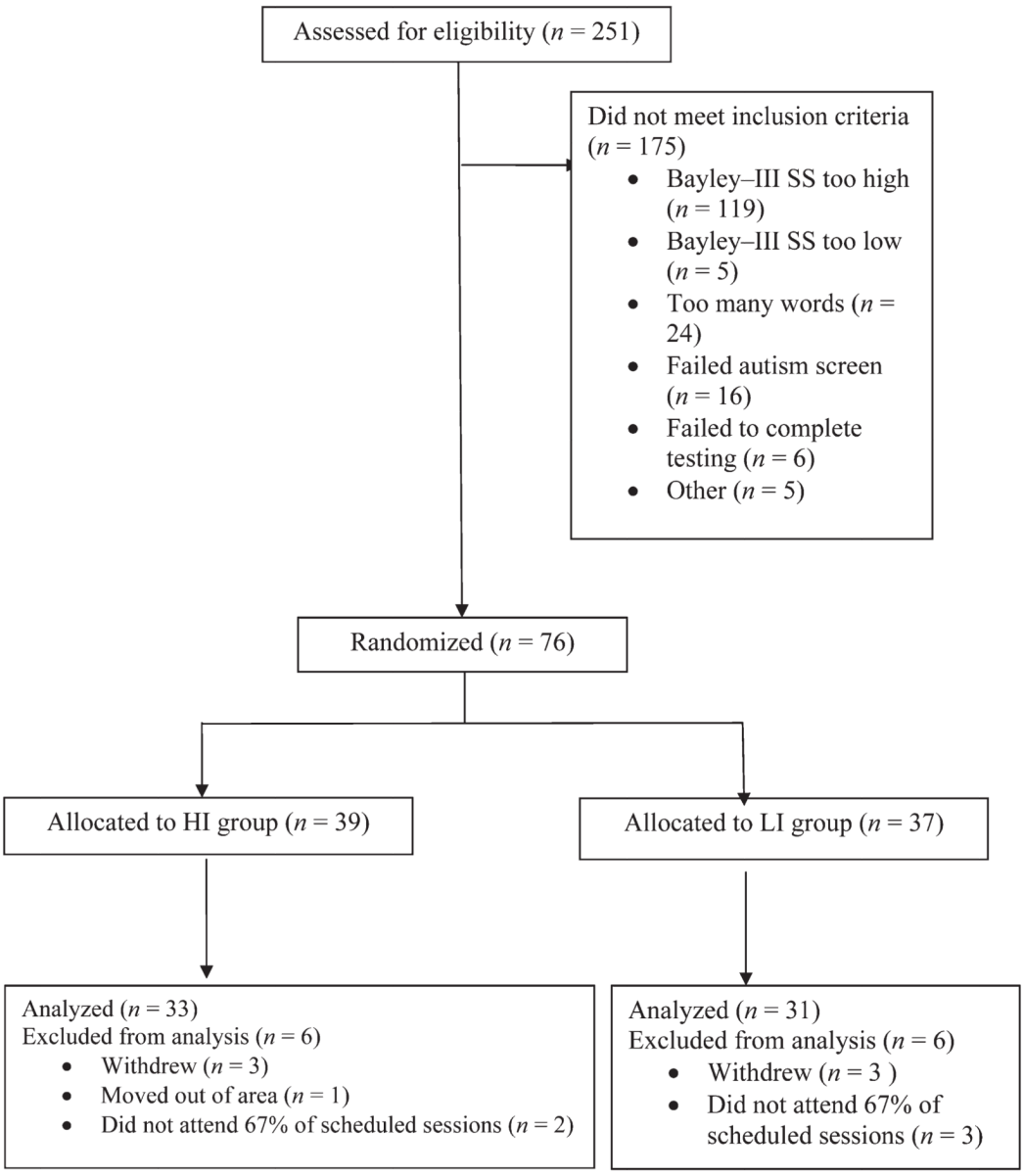

Figure 1.
Participant recruitment, enrollment, randomized allocation to either low-intensity (LI) or high-intensity intervention group (HI), and retention. Bayley–III SS = Bayley Scales of Infant and Toddler Development, Third Edition, standard score.

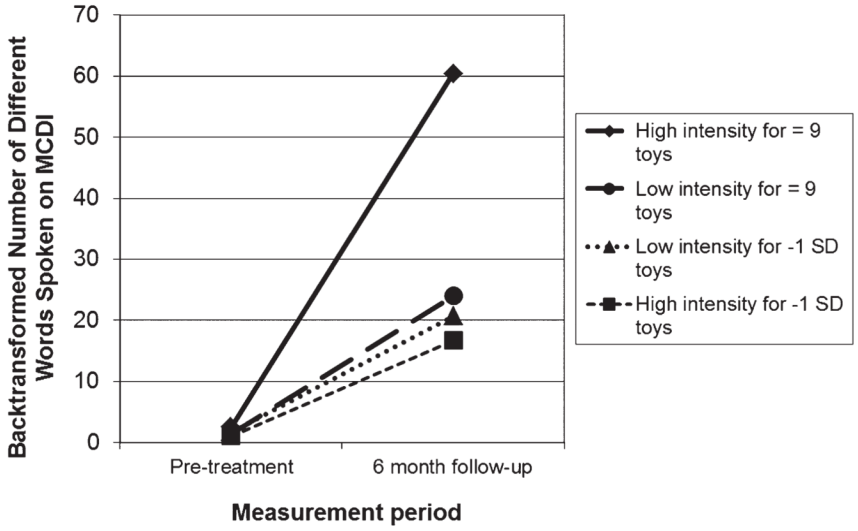

Figure 2.
Growth curves for number of words spoken for four prototypical children who vary by intensity level (i.e., LI, or HI) and initial object interest (i.e., number of objects chosen for functional play). MCDI = MacArthur Communicative Development Inventories.

Table 1

Time 1 characteristics of the low-intensity (LI) and high-intensity (HI) intervention groups.

Pre-experimental characteristic	**LI group participants (n = 31)**			**HI group participants (n = 33)**					**LI group dropouts (n = 6)**			**HI group dropouts (n = 6)**		
	n	***M***	***SD***	**n**	***M***	***SD***	***p***	***d***	**n**	***M***	***SD***	**n**	***M***	***SD***
Children with DS	16			19					2			0		
Boys Girls	20 11			20 13					3 3			6 0		
Chron. age (mos)		23.00	3.28		21.83	2.71	.13	0.05		24.12	3.02		22.45	2.71
Bayley-III dev. age (mos)		12.45	2.11		12.61	2.08	.77	-0.07		12.83	2.91		14.00	2.89
Primary caregiver level of education		7.03	1.22		7.00	1.23	.92	0.03		7.20	1.07		6.67	0.47
PSI/SF total raw score[a]		72.81	15.18		65.67	16.7 8	.08	0.45		82.00	15.07		72.67	24.26
DPA – No. of toys played with		9.00	2.45		8.70	2.19	.60	0.13		7.67	2.49		8.17	1.34

Note. DS = Down syndrome; Bayley-III = Bayley Scales of Infant and Toddler Development, Third Edition; PSI/SF = Parenting Stress Index/Short Form; DPA = Developmental Play Assessment.

[a]PSI raw score means are based on 28 families in the LI group and 25 in the HI group.

Table 2

Fixed-effect estimates at Time 5 for intensity group (LI or HI) and back-transformed means for eachintensity group for all variables analyzed with growth curves.

Dependent variable	Log10(x +1)		Estimated average at Time 5	
	Coefficient	*SE*	LI	HI
Rate of behavior regulators used	−0.01	0.03	0.68	0.64 acts/min
Rate of declaratives used	−0.03	0.05	1.30	1.10 acts/min
Rate of intentional communication used	−0.03	0.06	3.30	3.00 acts/min
Rate of different words spoken/signed per 10 min	0.01	0.14	5.80	5.90 words
MCDI: Different words understood	0.14	0.10	198	273 words
MCDI: Different words spoken	0.29	0.20	24	48 words
MCDI: Different words spoken + those signed	0.18	0.15	58	84 words

Note. The difference in average words spoken plus those signed and in the average words spoken at Time 5 between groups had a p value of > .24. MCDI = MacArthur Communicative Development Inventories.

Table 3

Dependent variables for which object interest moderated the effects of milieu communication teaching (MCT) intensity at Time 5, and related statistics.

				Upper Region of Significance # Above cutoff		
Dependent variable	***t*(df)**	***P***	***Hedges's g***	**Cutoff**	**HI**	**LI**
MCDI: Words understood	2.3(60)	.03	.49	9	12	15
MCDI: Different words spoken	2.3(60)	.02	.55	10	12	15
MCDI: Different words spoken + those signed	2.1(60)	.04	.65	10	12	15

Note. Children who played with many different objects (i.e., above the cutoff) performed significantly better in the HI treatment on these measures.