

# DIFFERENTIAL TREATMENT INTENSITY RESEARCH: A MISSING LINK TO CREATING OPTIMALLY EFFECTIVE COMMUNICATION INTERVENTIONS

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Research over the past 50 years has yielded several promising approaches and many specific intervention techniques designed to enhance the communication and language development of young children with intellectual and developmental delays and disabilities. Yet virtually no systematic research has been conducted on the effects of different treatment intensities. We review how intervention intensity has been defined in the literature and propose a set of terms borrowed from medicine that are intended to capture the dynamic aspects of this concept as an aid to further investigation. On the basis of this approach, we propose four types of knowledge that can be generated through the systematic study of treatment intensity and discuss appropriate methods for investigating the effects of differential treatment intensities. We conclude with three recommendations for the field. © 2007 Wiley-Liss, Inc. MRDD Research Reviews 2007;13:70–77.

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**Key Words:** communication; language; early intervention; dose; treatment intensity

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Scientists have been studying the effects of interventions designed to enhance the communication and language development of young children with developmental delays and disorders for more than 50 years. Hundreds of studies have been published in that time. There is substantial evidence for at least the limited efficacy of a number of intervention approaches for a number of crucial skills with a range of clinical populations [McLean and Cripe, 1997; Law et al., 2004; McCauley and Fey, 2006; Yoder and McDuffie, 2006]. There is also substantial evidence that early intervention in general (which typically includes a focus on communication and language skills) can be effective across a number of dimensions. Effectiveness varies by how it is defined (i.e., short-term vs. long-term gains; proximal vs. distal measures), what specific population of children is targeted (e.g., at-risk vs. severely impaired), what skill domain is targeted (e.g., expressive vs. receptive language), and on how long the intervention is conducted (i.e., duration) [Guralnick, 1997]. For example, in general, the effects of early intervention appear to be substantial for socioeconomically disadvantaged children [Heckman, 2006]. However, beyond these general pa-

rameters, we do not yet have data that demonstrate what the ultimate potential of early intervention may be. Treatment intensity is a general variable that may be a key to optimizing intervention effects. In this article, we examine the possibility that research on intensity variables can make interventions increasingly effective in ways that alter the trajectories of development for children ranging from at-risk to those with severe delays and disorders.

As important as the systematic study of differential educational/behavioral treatment intensities may seem, at present there is very little literature on this topic for any domain of development, including communication and language.

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***Without exception, direct comparison studies in which intensity is treated as the independent variable, with all other intervention variables kept constant, have not been reported, even in the autism literature.***

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In contrast, when a therapeutic drug is developed, systematic research is virtually *always* conducted on its effects at different dosages [Piantadosi, 1997]. Drug dosage studies (often referred

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to as dose-finding studies) are performed in part to determine side effects and safety of new drugs, but an equally important reason is to estimate the therapeutic effects of different dosage levels. Why have behavioral scientists not yet adopted a similar approach to the development of effective communication and language interventions?

It is time to begin the creation of a systematic research base examining this critically important dimension of treatment efficacy—the effects of different treatment intensities on communication and language development. The purpose of this paper is to explore several issues germane to this goal. We first review and critique how treatment intensity has been defined in the literature to date and propose several terms that we believe can advance the study of treatment intensity. Second, we discuss an issue that often overlaps with and sometimes confounds discussions of intensity—the effects of massed versus distributed trial teaching episodes. Third, we propose four types of knowledge that can be generated by systematic research on treatment intensity. Fourth, we briefly discuss methodological and design issues that must be considered in treatment intensity research. We conclude with three recommendations for further consideration.

#### WHAT IS “TREATMENT INTENSITY?”

Instead, various authors define “intensity of intervention” as the quality and quantity of services delivered in a given period of time [Barnett and Escobar, 1990], the number of hours of intervention over a specific time period (e.g., 40 hr per week for 2 years) [Lovaas, 1987], the level of participation in a service offered over time [Hill et al., 2003], the ratio of adults to children in an intervention context (individual treatment vs. small group) [Graff et al., 1998], or in a few cases the number of specific teaching or therapeutic episodes per unit of time [Guralnick, 1998; Proctor-Williams and Fey, in press]. In all cases, “duration,” as measured in one or more time units (minutes or hours per day/week, and/or months or years) is an implicit or explicit dimension of intensity, and it often is the only reported dimension (e.g., “the intervention was conducted 1 hr per day, 5 days per week, for 2 years”).

Perhaps the main advantage of defining intensity as essentially the duration of treatment (e.g., hours per week or month of intervention) is that it is easily understood by a wide range of audiences, including parents, clinicians, and legislators. However, this advantage is offset by

the fact that duration of treatment does not tell us anything about the intensity in which the presumed “active ingredients” of an intervention are implemented. These active ingredients are the procedures presumed by the interventionists to teach or enhance new learning and behavior [Fey, 1986; McCauley and Fey, 2006]. This requires a more molecular measure of the frequency with which episodes specifically hypothesized to influence learning take place. Such an approach requires defining and quantifying specific teaching or treatment episodes. Once the assumed locus of learning is defined in observable behavioral terms, data can be collected on teaching episode occurrence. Then, it is possible to determine the density of teaching episodes for some specified unit of time, such as per minute or hour. Assuming a valid and observable definition of a teaching episode, the product of rate per

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***There is no standard or widely accepted definition of treatment intensity in the communication and language intervention literature or, for that matter, the literature on early intervention in general.***

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minute or hour, the number of hours of intervention per specified time period (e.g., a day or a week), and the full length of the intervention in weeks, months, or years gives us a much more precise definition of intervention intensity than do the commonly used intensity metrics (e.g., number of hours of treatment received per month). To differentiate this type of measurement approach to intensity from the broad range of less precise indicators found in the literature, it is necessary for the field to adopt precise terms that capture the dimension of intensity that is of particular interest.

#### PROPOSED TERMINOLOGY FOR MEASURING INTERVENTION INTENSITY

We propose that researchers and practitioners in communication sciences and disorders adopt five terms that cover the primary variables that make up inter-

vention intensity. Although we are aware of the dangers of adopting terms that are too heavily based on a medical model, our definitions are based directly on the familiar uses of these terms by both professionals and lay persons dealing with medical, and particularly pharmacological, interventions [i.e., Piantadosi, 1997].

#### Dose

We define dose as the *number of properly administrated teaching episodes during a single intervention session*. A teaching episode is designed to contain one or more interventionist (or confederate) acts hypothesized to lead a child directly toward a given intervention goal. *Dose* is a function of three important subcomponents: the average rate of teaching episodes per unit of time, the length of the intervention session, and the distribution of episodes over the session. The first two of these dimensions should always be specified. For example, in our ongoing research on the effects of different intensities of early communication intervention [Warren et al., 2007], we are attempting to apply a designated *dose* of 60 teaching episodes per 1-hr intervention session, or one teaching episode per minute, on average.

#### Dose Form

In medicine, the term dose form applies to the physical form in which the active ingredient is dispensed. For example, a drug might be delivered orally by tablet, capsule, or liquid, or by injection or inhalation. By analogy, in communication intervention, dose form can refer to the typical task or activity within which the teaching episodes are delivered. Suppose that a presumed active ingredient in a word-teaching intervention is imitation of the form in the presence of the lexical referent. The *form* of the recommended dose could be delivered in highly structured, intrusive drills in which the adult simply makes referents available and then prompts for an imitation. At the other end of the “intrusiveness continuum” [Fey et al., 1995], imitative prompts might be provided only when a child is highly engaged in a play routine or conversation that renders a target word meaningful and adaptive. Either of these dose forms or other possibilities that lie between these extremes may be appropriate for different children or for a given child at different points in treatment, and this variation is likely to have significant effects on treatment outcomes. Therefore, it is important to specify *dose form* so that appropriate teaching episodes can be

identified and counted as delivered in the prescribed form.

### Dose Frequency

This is the number of times a dose of intervention is provided per day and per week. For example, in our ongoing study of the effects of different intensities of communication intervention, we are comparing two dose frequencies—one weekly 1-hr dose at one episode per minute (low intensity) compared with five weekly 1-hr doses at one episode per minute (high intensity).

### Total Intervention Duration

The effects of even highly efficacious interventions are likely to be diminished if they are stopped too early or continued too long without revision. Thus, total duration refers to the time period over which a specified intervention is presented. For example, each child in our present study is scheduled to receive the intervention for 9 months. Thus, the total intervention duration of the treatment is 9 months.

### Cumulative Intervention Intensity

This is the product of *dose* × *dose frequency* × *total intervention duration*. It could be further specified to accommodate the notion of dose form. So, over a week-long period the cumulative intervention intensity delivered by a clinician might be 100 in a relatively constrained drill-like activity in the clinic and 50 in more naturalistic, play-like situations. Cumulative intervention intensity can provide a useful general indicator of overall intensity. For example, in our ongoing study, the low-intensity group receives a 40-week intervention that includes ~60 defined teaching episodes per 1 hr, one session per week. The dose form is play in the child's home, using toys brought in by the clinician or the child's own favorites. This yields a preplanned cumulative intervention intensity of 2,400 teaching episodes. In contrast, our high-intensity intervention is also 40 weeks but includes 60 teaching episodes per hour, five times per week. This yields a cumulative intervention intensity of 12,000 episodes. In our ongoing study, we have attempted to control for *dose*, *dose form*, and *total intervention duration*. Our independent variables are *dose frequency* and, ultimately, *cumulative intervention intensity*.

For example, suppose a *dose* were eight teaching episodes over an 8-min period with a *dose frequency* of once per day, 7 days per week. Over an intervention duration of 40 weeks, the *cumulative intervention intensity* would be roughly the same (2,240 teaching episodes) as our low-intensity *cu-*

*mulative intervention intensity* described earlier. Consequently, while these interventions vary substantially in *dose* and *dose frequency*, they result in nearly the same *cumulative intervention intensity*. Thus, it might be instructive in intervention studies to attempt to hold *cumulative intervention intensity* roughly constant, but vary other dimensions to identify optimal configurations (in terms of efficient learning) of the variables that constitute intensity. Alternatively, one could increase cumulative intervention intensity by manipulating intensity components, such as dose or dose frequency, independently. We readily acknowledge that researchers (ourselves included) may struggle to control or even account for the range of variables that may influence treatment intensity. But this does not justify ignoring them.

To illustrate both the need for and value of the proposed definitions, suppose that two children received the same communication intervention an average of 100 min per day, 5 days per week, 48 weeks per year for 2 years. Child A

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***Cumulative intervention intensity is an inherently dynamic concept because it results from the values obtained by multiple variables.***

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receives an average dosage of four teaching episodes per minute and Child B receives an average dosage of two episodes per minute across this time period. Consequently, at the end of 2 years, Child A would have received twice as many teaching episodes as Child B—a cumulative difference of 96,000 episodes! Yet, a simple number of “hours of treatment” metric would suggest that they experienced identical treatment intensity.

The facts at this point would seem to give a significant advantage to Child A, on the basis of cumulative intensity. Consider, however, that the form of the dose for Child B involves naturally occurring situations in which the child is highly self-motivated to communicate. This is contrasted with the form for Child A, which involves prompts for the child to perform the act under highly contrived conditions in which the child's real need to communicate is low. In this case, the form of the doses received by the children

may serve to equate learning among children or, perhaps, even give the advantage to Child B.

In short, without explicit measurement of rate of application of teaching episodes (or dosage) and duration of the intervention along with careful consideration of dose form, the differences in the amount of intervention these two children received would *not* be apparent. We could easily generate countless examples like this of how variations (whether they are accounted for or not) of one or more of the underlying variables that inherently contribute to intervention intensity can lead to misleading comparisons and conclusions.

### Defining Teaching Episodes

The proposed components of treatment intensity require the explicit determination of a teaching episode for a given intervention in a way that allows an episode to be observed and counted. For many reasons, this is a challenging task. First, even the simplest treatments are fundamentally multifaceted. For example, a technique termed “recasting” is, on the surface, one of the most straightforward language intervention procedures available [Camarata and Nelson, 2006]. It requires practitioners to follow statements made by a child with expansions that preserve the basic meaning of the child's utterance while adding syntactic or semantic information. Thus, a child might exclaim “He run”, and the practitioner might recast with “He is running”, or “He runs fast.” However, the effective use of this technique requires a dose form in which the practitioner follows the child's attentional lead while carefully maintaining the pace to ensure the interaction stays positive and the child stays engaged. These added dimensions can make the seemingly simple procedure of recasting demanding even for experienced clinicians. Second, it may be difficult or impossible to specify fully what aspects of a multifaceted procedure are fundamental to language teaching and which are non-essential. For example, for teaching grammar, recasts that correct child errors (e.g., Child: “He run.” Adult: “He is running.”) may be more powerful than those that build upon simple but grammatical child utterances (e.g., Child: “He runs.” Adult: “He runs, and he wins.”) [Saxton, 2000, 2005; Saxton et al., 2005]. Or, recasts that focus the child on a specific target (e.g., Child: “I got a wing.” Adult: “a rrrring”) may be more effective than those that correct multiple errors (e.g., Child: “I got a wing.” Adult: “You *do* have a rrrring.”)

[Camarata, 1995]. If a clinician's definition of a teaching episode is so broad that it includes types that are unlikely to foster development, the effects of the intervention will be diluted, regardless of the density of their application. Third, as noted earlier, the conditions under which a child processes and learns from a presented therapeutic agent, such as recasting, may depend on social, affective, and attentional circumstances at the moment of the episode. For example, a child might require fewer exposures to therapeutic agents, such as recasts, when fully interested and engaged than when relatively disconnected from the activity and the adult conversational partner.

Defining what constitutes a teaching episode gets even more complicated with broader approaches, such as milieu teaching [Hancock and Kaiser, 2006], that subsume many procedures. These approaches require the provision of various "enabling conditions" (e.g., developmentally progressive social routines) combined with a range of techniques, such as time delay, prompts for imitation, and recasting, to be employed based on the initiation or response of the child. Consequently, individual teaching episodes can be very brief exchanges, or longer interactions consisting of several conversational turns. When a "teaching episode" can include so many variants, it is probable that some children are getting more desirable input that is more likely to teach than are others, even when the overall frequency of episodes is the same.

We readily acknowledge that defining teaching episodes can be a surprisingly complex task. However, specification of what counts as a teaching episode is necessary to precisely measure and reliably estimate dose and related variables (e.g., *dose frequency*, *cumulative intervention intensity*). The difficulty inherent in defining teaching episodes should not be considered a weakness of the proposed approach. In fact, we suggest that one of the benefits of commencing the systematic study of treatment intensity as we conceptualize it is that it requires clinicians and researchers to identify what specific aspects of their approaches are assumed to be essential for learning. In other words, a focus on treatment intensity should lead to a complementary focus on specification of what constitutes a teaching/learning moment in the intervention (i.e., a definition of a teaching episode), on the contexts in which application of the episodes are acceptable (i.e., the dose form), on the frequency with which these episodes are provided in intervention (i.e., dose), on the daily or weekly schedule for providing the

intervention (i.e., dose frequency), and on the overall duration of the treatment. This strikes us as fundamentally important to the development of optimal interventions.

### **MORE IS NOT NECESSARILY BETTER**

Both theory and research suggest that cumulative intervention intensity makes a meaningful difference in language learning [e.g., Chapman, 2000]. Consider as one high profile example the sizable differences in the amount of language children experience over 30 months as discovered by Hart and Risley [1995] in their seminal study of lexical development and school success. All 42 young children in this study were observed for the same amount of time (1 hr per month), but their exposure to features of language hypothesized to foster language development (i.e., which might be considered the cumula-

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***It is important to note that a focus on cumulative intensity can lead to the misleading notion that massed teaching episodes are always best, when in fact, distributed teaching trials may in some cases lead to more efficient learning.***

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tive intervention intensity they experienced) during this time varied by as much as a factor of 3. These differences were associated, in large part, with socioeconomic status (SES), with professional parents providing many more models of language features to their children than were presented by welfare parents. With some notable exceptions, though, parents with high cumulative intensities tended to make similar *proportional* use of many elements of "enriching language" as did parents with low cumulative intensities. The differences in cumulative intensity arose primarily because parents in high SES homes simply talked more to their children than did the parents in low SES homes. The more language the children heard, the more they were exposed to positive features of input. From the perspective of treatment intensity, the dose

of positive language models was much greater for children from high SES backgrounds than for those from low SES backgrounds. Furthermore, Hart and Risley showed that differences in parent presentation of these quality features to their children accounted for large amounts of variance in the children's later vocabulary development [Hart and Risley, 1992] and even later school success [Walker et al., 1994].

### **Effects of Massed Versus Distributed Trials**

A robust finding across many domains of human cognition is that learning is more efficient when the same number of teaching trials is distributed over several sessions than when they are massed into one or a few sessions [Janiszewski et al., 2003]. This appears to hold true for typical language acquisition and was also demonstrated in several intervention studies with children with intellectual disabilities [Bambara and Warren, 1993; Riches et al., 2005].

To illustrate, the prediction from this distributed-trial research would be that a child who received 60 teaching episodes over a single 1-hr session would not learn, generalize, and maintain learning of target behaviors as well as if he were exposed to 20 teaching episodes for each of three 20-min sessions distributed across a week. This would be the case even though the number of teaching episodes per hour of intervention would be the same and the *cumulative intensity* would be the same. This example further suggests the value of measuring *dose*, *dose frequency*, and *total intervention duration* and calculating *cumulative intervention intensity* separately so that we can determine how each of these variables impacts intervention effectiveness.

In real-world intervention contexts, it is easy to think of factors that may affect the impact of massed versus distributed teaching. For example, in some cases, the teaching goal may be pragmatically inappropriate if teaching episodes are presented too close together. Consider a case in which the goal is to increase self-initiated social initiations. It may be most effective to use a relatively low *dose and dose frequency* of teaching episodes over a relatively long *intervention duration*. In contrast, a much higher *dose and dose frequency* distributed across a shorter *intervention duration* might be optimally effective in teaching imitation skills or the production of common object words. The characteristics and developmental level of the specific child also

may influence the effects of massed and distributed teaching. Thus, a child who is relatively easy to engage and initiates communication frequently may progress rapidly with a lower *dose* and *dose frequency* relative to a less engaged or easily distracted child, or a child at a lower developmental level with few complex play or social skills.

As a final example, there is substantial evidence that children with language learning problems require more teaching episodes than do typical language learners to show evidence of learning [Rice et al., 1994; Gray, 2003, 2005]. Consider a case, then, in which the specification of dose form makes it necessary for teaching episodes to arise in naturalistic contexts in which the child is playing attentively in a particular way. Setting up the environment to create conditions for the delivery of the appropriate form of the dose can itself take a substantial amount of time. In a short session, it may be impossible to make the necessary environmental arrangements and then supply the child with a sufficiently high dosage to ensure learning. Such brief sessions may be ineffective regardless of the dose frequency or cumulative intensity. Alternatively, longer sessions may result in child boredom (i.e., less high quality attentional engagement), thus making engagement in turn-taking routines, which enable teaching, less likely if the session length is too long. Our main point is that high doses of teaching episodes per se may not necessarily be the most effective approach. More learning may result by increasing the dose frequency (i.e., number of sessions per week) while applying lower doses across longer durations for some types of goals, with some types of children, and with some dose forms. Our secondary point is that, in many cases, it is possible to formulate reasonable clinical hypotheses regarding the effects of manipulating the components of cumulative intensity.

### **WHAT CAN BE LEARNED FROM RESEARCH ON DIFFERENTIAL TREATMENT INTENSITIES?**

There are many types of knowledge that can be generated by the systematic study of differential treatment intensities. First, as should be obvious by the previous discussion, we may learn that a treatment that is moderately effective at one intensity level (i.e., dose, dose frequency, and cumulative intervention intensity) is more or less effective at another intensity level. Our research group has already demonstrated empirically that,

when it is administered in a relatively low intensity (i.e., a dose of ~1 episode per minute for a 20-min session, with a dose frequency of three to four weekly sessions, over a 6-month duration), prelinguistic milieu teaching (PMT) is moderately efficacious in facilitating early communication and language development in young children with evidence of mild to moderate mental retardation [Yoder and Warren, 2001, 2002; Fey et al. 2006]. This 1 hr/week intensity of direct child intervention represents roughly 1% of a young child's waking hours and thus would seem unlikely to change the trajectory of the child's development when we consider the complexity of the human communication and language system that must be acquired. It is reasonable and important to ask, then, whether more of the same yields greater efficacy and effectiveness.

A second type of knowledge that may emerge from studying the effects of different intervention intensities is that changes in intensity variables may have systematically different effects on children with different cognitive and communication profiles. For example, it is well established in the literature of experimental psychology [Hilgard and Bower, 1975; Wachs, 2000] that variables (i.e., behaviors) often operate differently under conditions that vary on "intensity" or "dose size." For example, our past research suggests that under low-intensity conditions (i.e., 1 total hour per week for 6 months) children with developmental delays and initially low functional play skills may not respond well to PMT [Yoder et al., 1995]. This is because the dose form of PMT episodes is positive, interactive play routines between the child and adult. Children with low functional play skills are difficult to engage and maintain in these sorts of routines. Thus, for these children, it is difficult to maintain a relatively high dose, even if treatment sessions are long.

A similar pattern may occur for children who are initially low in task persistence, such as some children with Down syndrome [Ruskin et al., 1994; Fidler et al., 2005]. If the goal of intervention is to teach requests to these children, it may be difficult for clinicians to create high doses of teaching episodes without fundamentally changing the dose form by creating artificial conditions that might weaken the effect of the active intervention ingredients. Thus, it is reasonable to hypothesize that such children will perform poorly in response to an intervention that limits dose by having short sessions (e.g., 20 min vs. 1 hr) or

provides a low dose frequency of communication intervention (e.g., one session per week vs. five sessions). However, they might be expected to perform more positively in interventions that provide larger doses by increasing the length of treatment sessions or by offering a higher dose frequency. Indeed, the greater effect of higher cumulative intensity may be mediated through the effects that more intense implementation has on play and task persistence. That is, children who are initially low on these two dimensions may benefit from more intense early communication intervention because they develop play and task persistence as an incidental, but highly beneficial, side effects of the intervention. This change in play behavior, in turn, enables optimal implementation of the intervention.

A third type of knowledge that may result from studying treatment intensity is a better understanding of the kind of side effects that may occur when children and families experience higher levels of cumulative intervention intensity. For example, it could be that higher cumulative intensities of intervention either increase or decrease problem behaviors in some subgroups of children. At higher intensities, the stress on some parents may increase to a level that impacts their interaction with the child and/or compels them to drop out of the intervention. This seems especially likely if the intervention plan places a significant and persistent burden on the family. Furthermore, because stress has been shown to be related to parents' tendency to control their children's behavior [Girolametto and Tannock, 1994], additional stress could ultimately lead to a much larger and longer-lasting negative impact that actually limits the child's development [Brinker et al., 1994]. Alternatively, assuming that at least some parental stress stems from the child's delays in communication, a more intensive and effective intervention may actually reduce parental stress. For example, Robertson and Weismer [1999] found that an intervention that addressed vocabulary development among late talkers had a positive impact on word usage and on levels of parental stress.

The potential side effects of highly intensive (e.g., 25–40 hr at home) interventions need to be studied carefully. There is virtually no systematic literature on this issue relative to children with intellectual and developmental disabilities.

A fourth reason for studying treatment intensity is to highlight the important role that cumulative intensity can have on child development. When study-

ing the relative benefits of different intervention approaches, cumulative treatment intensity should ideally be controlled. For example, at a particular dose and cumulative intensity level, we could ask what the relative effects of a discrete trial training method such as the Applied Behavior Analysis (ABA) approach used with children with autism are when compared to a more naturalistic milieu teaching approach. However, the comparative studies that have been completed to date have *not* controlled cumulative intensity. Instead, the currently available comparative studies have compared treatments that differ on intensity and type of approach [e.g., Smith et al., 2000; Eikeseth et al., 2002; Sheinkoph and Siegel, 2004]. Readers and authors of such studies have, in some cases, mistakenly concluded that results of such studies inform us that a certain cumulative intensity level (e.g., between 25 and 40 hr per week) is optimal [e.g., National Research Council, 2001]. The problem with such studies is that the intervention approaches differ from each other on many dimensions. Thus, any head to head comparison of different approaches that attempts to either control for or systematically vary dose, dose frequency, and/or cumulative intensity will inevitably be confounded by all the variables that cannot be controlled. Furthermore, any comparative analysis of different interventions must recognize that inherent differences in intensity will be at least one of the differences between any two interventions. We are not implying that different interventions should not be compared, but we are suggesting that it will be very difficult for such comparisons to shed light on the issue of the effects of intensity per se. These questions are best answered when comparing a single treatment at different cumulative intensity levels.

## METHODOLOGICAL AND DESIGN ISSUES

Case studies and within-subject group comparisons are likely to be most useful for initial pilot and feasibility research on intensity, and quasi-experimental designs may be appropriate for early studies on the effects of manipulations of treatment intensity [Fey and Finestack, in press]. Most types of treatment intensity efficacy comparisons like those we have advocated, however, should be carried out using randomized clinical trials. Participants with predetermined characteristics (e.g., low vs. high play, low vs. high persistence) can be randomly assigned to two or more levels of one of the key variables of intensity (e.g.,

dose, dose frequency) while the other variables (e.g., dose form, total intervention duration, and/or cumulative intervention intensity) are measured or ideally held constant. No other design offers the ability to experimentally or statistically control for so many potentially confounding variables or cross-over effect.

Despite their strengths, randomized between-group studies can still be hampered by confounds, such as those related to attrition and to other differences in treatments that may arise as a direct result of the planned differences in intensity. First, there could be differential attrition between the treatment conditions that is actually due to the differences in intensity. For example, it could be that some individuals/families cannot tolerate a higher dose or dose frequency and drop out as a result. Families in either condition may drop out differentially because they perceive a lack of progress for their child and thus wish to seek other interventions or simply do not believe the cost in terms of their effort is warranted. Any of these effects would at the minimum restrict the generality of the treatment at this intensity. In the worst case, differential attrition could result in a bias such that children of families who stay in the study are those making good progress and families of those who drop out are responding poorly to the treatment.

If differential attrition or differential out-of-project treatment attendance patterns occur, observed differences in outcomes can be difficult or in some cases impossible to interpret. Do they arise because the treatments differ in their relative efficacy or because the groups being compared are fundamentally different? The solution to this problem generally is to include and analyze data from all participants according to their assigned group regardless of whether or not they complete their intervention according to the protocol. This *intention to treat* analysis is effective with large groups found in trials of drugs or other medical treatments. It can raise serious problems in small studies, especially if substantial numbers of individuals drop out. Minimally, though, studies employing randomized designs must perform and report the results of comprehensive analyses of drop-outs to determine whether pre- or posttreatment differences exist between individuals who drop out and those who remain in the assigned groups.

A second problem that may arise in randomized trials comparing the same intervention at different intensities is that it may not be possible (or desirable) to keep the dose form in the higher inten-

sity treatment the same relative to dose form at a lower intensity. For example, suppose that a well-described language intervention delivered once per week for an hour is being compared with the same intervention delivered 1 hr a day, 5 days a week. Interventionists in the high-intensity treatment may inevitably become much more familiar with the children they treat because of increased exposure. In some cases, this could be a distinct advantage. For example, with more sessions and overall time in the high-intensity treatment, routines could be better established, and it may be easier and faster to arrange the environment each day to prepare for the delivery of an optimal dose of the intervention. The child and clinician also might develop a rapport that is more difficult to establish in once per week sessions. The clinician who develops a closer, more comfortable professional relationship with a child may be able to get greater attention, motivation, and participation from that child. Thus, differences in treatment efficacy that appear to be based on dose frequency may occur because of epiphenomena of dose frequency, including differences in dose or differences in child and family relationship with the staff member that enhance the child's uptake from teaching episodes.

There are clearly other, less positive side effects of high-intensity interventions that are possible as well. For example, in our more intensive 5 day per week intervention, it may be more difficult to keep the intervention fresh, interesting, and fun for the child and the clinician. As a result, the delivery of episodes may go down or they may lack the "luster" of episodes delivered in the once weekly intervention. In these cases, children might tend to pay less attention to the teaching and may be less motivated to participate and learn.

## CONCLUSION AND RECOMMENDATIONS

We have noted elsewhere that the field of communication and language intervention, like the field of early intervention in general, has only recently emerged from a lengthy period of developing various intervention techniques and testing them with small samples (e.g., from one to five participants) for short durations (e.g., a few weeks or months) [Warren and Yoder, 1997]. The initial phase resulted in the development of a number of promising intervention approaches. However, for even the most well developed approaches, little research has yet been conducted on their relative efficacy and effectiveness under varied

conditions using randomized between-group studies [McCauley and Fey, 2006]. We have made the case that treatment intensity research is of utmost importance in developing optimally efficacious interventions and have noted that it has nevertheless been virtually nonexistent to date. We have attempted to clarify the issues that must be considered for research to move forward on this dimension. We have not attempted to be exhaustive in our discussion of the many nuances of this issue. Instead our goal has been to lay out a potentially useful framework and provoke serious consideration of many of the most important issues.

Treatment intensity is a dynamic, multifaceted dimension of intervention. Much can be learned through the systematic investigation of this construct. We acknowledge that this research will inevitably be costly and challenging to conduct. Nevertheless, until such research is seriously pursued, further development of the empirical bases of communication and language intervention will be constrained. Therefore, we offer the following recommendations.

1. Researchers should provide greater detail as to how they define "intensity" in intervention research. Specifically, we recommend that researchers adopt the terminology and definitions we have proposed in describing *all* intervention implementations.
2. Researchers should commence the systematic study of differential treatment intensities for interventions that have shown promising effects at given intensity levels. Many intervention techniques and approaches have been reported in the literature. We know virtually nothing about their effectiveness at different doses, dose frequencies, and cumulative intensities.
3. The National Institutes of Health, the U.S. Department of Education, as well as other agencies and foundations should explicitly invite and fund research on differential intensities of well-developed behavioral interventions. This type of research is expensive to conduct rigorously. Nonetheless, funding agencies too must recognize that this is *necessary* for the further development of optimally effective scientifically based therapeutic intervention prac-

tices and thus encourage and support meritorious proposals accordingly. ■

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