

Pursuing Precision Speech-Language Therapy Services for Children with Down Syndrome

Jena McDaniel, M.S.¹ and Paul J. Yoder, Ph.D.²

ABSTRACT

The behavioral phenotype of individuals with Down syndrome (DS) offers one avenue for developing speech-language therapy services that are tailored to the individual's characteristics that affect treatment response. Behavioral phenotypes are patterns of behavioral strengths and weaknesses for specific genetic disorders that can help guide the development and implementation of effective interventions. Nonetheless, individual differences within children with DS must be acknowledged and addressed because behavioral phenotypes are probabilistic, not deterministic. Developing precision speech-language therapy services to maximize learning opportunities and outcomes for children with DS calls for increased collaboration among clinicians and researchers to address the needs, challenges, and opportunities on three interconnected themes: (1) moving effective interventions from research to practice, (2) making evidence-based, child-specific treatment intensity decisions, and (3) considering child motivation and temperament characteristics. Increased availability of intervention materials and resources as well as more specific recommendations that acknowledge individual differences could help narrow the research-practice gap. Clear descriptions of disciplined manipulations of treatment intensity components could lead to more effective intervention services. Last, addressing motivation and temperament characteristics, such as the personality-motivation orientation, in children with DS may help maximize learning opportunities. Focused attention and collaboration on these key themes could produce substantial, positive changes for children with DS and their families in the coming decade.

¹Department of Hearing and Speech Sciences, Vanderbilt University, Nashville, Tennessee; ²Department of Special Education, Vanderbilt University, Nashville, Tennessee.

Address for correspondence: Jena McDaniel, M.S., Department of Hearing and Speech Sciences, Vanderbilt University, 615-936-5136, or MCE 8310 South Tower, 1215 21st Avenue South, Nashville, TN 37232 (e-mail: jena.c.mcdaniel@vanderbilt.edu).

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Learning Outcomes: As a result of this activity, the reader will be able to (1) explain key components of the behavioral phenotype of individuals with Down syndrome; and (2) discuss ways to address challenges of moving evidence interventions from research to practice, making evidence-based treatment intensity decisions and considering child motivation and temperament characteristics.

President Barack Obama launched a new Precision Medicine Initiative and called for “the right treatment at the right time” in his 2015 State of the Union address.¹ Along with medicine, speech-language pathology must move toward more individualized, evidence-based treatments by establishing speech-language therapy services that are tailored to the individual’s characteristics that affect treatment response. These precision services could not only maximize gains for children with speech and language disorders, but also positively impact their families and broader treatment systems that are struggling to meet their needs. One potential avenue for facilitating more effective services is through behavioral phenotypes. Behavioral phenotypes are patterns of behavioral strengths and weaknesses for specific genetic disorders.^{2,3} By further defining behavioral phenotypes and the interactions between these phenotypic behaviors and the environment, including intervention services, more individuals can receive “the right treatment at the right time.”¹ Because of advances in defining the behavioral phenotype of Down syndrome (DS), individuals with DS in particular may benefit from using behavioral phenotypes to develop precision speech-language therapy services.

Despite notable gains in developing the evidence base for speech and language interventions for children with DS, much work remains to effectively match individual children with DS with particular intervention features. The purpose of this article is to describe the needs, challenges, and opportunities for providing more targeted and more effective speech-language therapy services to children with DS in the next decade. We focus on the needs, challenges, and opportunities for directing research and clinical efforts on three inter-

connected themes to maximize learning opportunities and outcomes for children with DS: (1) moving effective interventions from research to practice, (2) making evidence-based, child-specific treatment intensity decisions, and (3) considering child motivation and temperament characteristics. After providing an overview of some aspects of the behavioral phenotype of individuals with DS that are most likely to affect treatment response, we describe the needs and primary challenges related to addressing each theme in the context of the current evidence. Then, we discuss opportunities specific to each theme for moving toward precision speech-language therapy services.

Although this article focuses on individualizing effective intervention for children with DS, the general principles apply to numerous other populations. Behavioral phenotypes help families and professionals anticipate areas of relative strength and need for children with specific diagnoses across developmental domains and times and then plan accordingly without losing sight of individual differences. Behavioral phenotypes are probabilistic; they offer guidance about the probability of certain characteristics being present in varying degrees in individuals with a given genetic condition. Probability is not deterministic, but it has been described as the guide of life.⁴ Probabilities can influence decisions in a positive manner when applied thoughtfully. When working with children with DS, speech-language pathologists may benefit from looking beyond their strengths and weaknesses in speech and language skills alone to those in other domains (e.g., cognitive, social, and temperamental) that may be interacting with speech and language skills. Understanding how and when different aspects of the behavioral phenotype may

interact could produce positive chains of results rather than negative cascading effects by intervening in a precise, targeted manner.

BEHAVIORAL PHENOTYPE IN DOWN SYNDROME

Speech

Ninety-five percent of parents of children with DS “reported that their children had difficulty being understood by people outside of their immediate circle sometimes or frequently.”⁵ Even when compared with individuals with the same mental age, individuals with DS present with reduced speech comprehensibility, which is the extent to which an unfamiliar listener understands what a speaker says when contextual information (e.g., gestures, syntactic cues, semantic cues, and orthographic cues) is present.^{6,7} Speech errors observed in individuals with DS include delayed and disordered patterns.⁸ These challenges with speech comprehensibility often extend well past early childhood for individuals with DS, thereby influencing long-term outcomes for employment and independent living.^{9,10}

Language

Children with DS demonstrate a particular area of weakness in expressive language skills with relatively higher receptive abilities. They most often show delayed emergence of first words and continued expressive vocabulary and syntax deficits.^{11,12} In addition, children with DS omit grammatical markers and verbs more frequently than peers with the same mean length of utterance.¹³ These deficits may be related to decreased verbal working memory abilities that negatively impact language learning (e.g., disrupts word learning).^{14,15} Receptively, children with DS exhibit deficits compared with mental age-matched peers, particularly in syntax, but not to the extent of their expressive difficulties.¹⁶

The literature is less clear regarding pragmatic language skills in children with DS. Pragmatic language skills may vary across developmental levels.³ For example, preschool children with and without DS were reported to display similar levels of pragmatic language

skills by their parents.¹⁷ On the other hand, compared with mental age-matched, typically developing children, youth with DS demonstrated deficits in referential communication (i.e., exchange of communication on a referent) characterized by failing to fully define the referent.¹⁸ This area of need, which draws upon cognitive, linguistic, and social skills, is expected to impact pragmatic skills in a negative manner due to unclear communication.

Cognitive

Individuals with DS present with mild to severe intellectual disabilities (ID) with relative strengths and weaknesses.³ Compared with deficits in verbal skills, visuospatial processing is relatively stronger and often commensurate with mental age.³ In addition to working memory deficits, long-term memory deficits have been reported in children with DS compared with other children with ID without DS.¹⁹

Social

Many children with DS demonstrate relative strengths in social skills compared with their skills in other areas,³ as well as compared with children and adolescents with ID from other etiologies.^{20,21} Strengths in social skills emerge early in development for children with DS, including interest in face-to-face social interactions in infancy and greater attention to adults during social songs than objects during object play.^{14,22} However, this relative strength may not always be advantageous. The behavior phenotype for individuals with DS includes the “personality-motivation orientation that involves an over-reliance on social strategies.”³ We describe how the personality-motivation orientation can limit learning in more detail when considering motivation and temperament characteristics.

Temperament, which can be defined as “constitutional differences in reactivity and self-regulation,” is expected to play a role in social interactions across the life span for individuals with DS.²³ A limited body of evidence suggests that children with DS as a group may be more likely to display particular

temperament characteristics compared with peers without DS. For example, infants with DS were described as showing lower levels of distress to limitations and higher levels of low-intensity pleasure and cuddliness/affiliation based on parent report on the Infant Behavior Questionnaire–Revised.^{24,25} In addition, individuals with DS in middle childhood to early adolescence were rated as having a more positive mood, being less persistent, and being more distractible by their parents and teachers.²⁶ The themes of less persistence, “stubbornness,” and a positive mood appear as common trends in discussions of children with DS.^{3,27} However, additional evidence is warranted not only for which traits individuals with DS are more likely to display but also how these traits impact development and response to treatment. Furthermore, substantial individual differences and co-occurring diagnoses (e.g., autism spectrum disorder) that may influence their temperament and/or social interactions cannot be ignored.²⁸

Summary

As a group, children with DS present with particular areas of need that include speech comprehensibility, expressive language, and verbal working memory and relative strengths that include receptive language, visuospatial processing, and social skills. Interactions among these different components of the behavioral phenotype of DS are expected to influence how children with DS respond to speech and language interventions. However, specific evidence for these interactions is limited, at least in part due to research on characteristics continuing to outpace research on intervention.²

NEEDS AND PRIMARY CHALLENGES FOR PROVIDING PRECISE SPEECH-LANGUAGE THERAPY SERVICES

Moving Effective Interventions from Research to Practice

The research-practice gap continues to receive considerable attention from clinicians and researchers, not only in speech-language pathol-

ogy, but also in medicine and education.^{29,30} Spanning the research-practice gap is no easy task. Green and colleagues describe the “17-year odyssey” from research discovery to patient care.³¹ Seventeen years is nearly an entire childhood! Interventions with empirical support must move more rapidly from research laboratories to clinical and educational settings to benefit more children with DS and their families.

Evidence for effective interventions for specific areas of need for children with DS, including expressive language and speech comprehensibility, is available. For instance, multiple studies have reported gains in communication and language skills following Milieu Communication Teaching (MCT) for young children with developmental disabilities, including DS.^{32–34} MCT comprises responsivity education, prelinguistic milieu teaching, and milieu teaching as described in Table 1.^{33,35,36} School-aged children with DS demonstrated gains in generalized speech comprehensibility following Broad Target Speech Recasts (BTSR) intervention in a recent study.³⁷ During BTSR intervention, the clinician provides speech recasts (i.e., accurate models) of the child’s misarticulated words in close temporal proximity to the child’s platform utterance without eliciting imitations from the child.^{38,39} In addition, researchers are beginning to attend more to the language and literacy needs of older children and adults with DS.⁴⁰ Demonstrating positive effects of an intervention within a controlled research study is a starting point, not the end point. Effective interventions must move to clinical settings, recognizing that they will be adapted through this process.⁴¹ Researchers, speech-language pathologists, and related professionals must collaborate to develop and tailor interventions that yield optimal outcomes for children with DS.

Primary challenges include the following. Narrowing the research-practice gap will require a multifaceted approach with collaboration among numerous stakeholders while acknowledging individual differences and providing access to intervention resources. First, individual children respond differently to specific speech and language interventions for a variety of reasons—some known, others unknown.

Table 1 Milieu Communication Teaching Components

Component	Description
Responsivity education	Sessions with goals to increase specific parent behaviors such as: <ol style="list-style-type: none"> 1. Responsiveness to child's play actions and communicative attempts 2. Use of linguistic mapping (i.e., putting child's nonverbal communication acts into words) 3. Use of follow-in comments (i.e., semantically adding to child's focus of attention) 4. Recasts (i.e., repeating child's words and adding structure and meaning)
Prelinguistic milieu teaching	Clinician arranges the environment to elicit opportunities for the child to communicate and uses prompts to increase the frequency, clarity, and complexity of the child's nonverbal communication acts
Milieu teaching	Clinician aims to establish and/or increase the frequency and/or complexity of the child's verbal communication acts

Adapted from Warren et al,³³ Fey et al,³⁵ and Hancock and Kaiser.³⁶

Differences in individuals' responses to treatment can hinder evaluation of an intervention's effectiveness and slow the implementation process. With minimal evidence for which particular interventions or intervention characteristics are likely to help a specific child, clinicians may have little incentive or support to trial new interventions. Furthermore, without clear expectations for the type or degree of progress, how can clinicians know whether a given child is responding in the expected manner? Additionally, even if we did have normative progress rates for children with DS, individuals vary from the mean in ways that might be predicted by other characteristics of the children. Offering clinicians more specific, empirically based recommendations could increase their confidence in making and advocating for their treatment decisions, including implementing novel, evidence-based interventions.

Second, interventions may be stalled from leaving the laboratory and reaching clinical practice because of the lack of availability of resources for implementing interventions and measuring progress.⁴¹ Although interventions will be modified as they are implemented across providers and settings, clinicians need a starting point for transferring an intervention from an article or presentation to their therapy rooms. Without having access to the assessments used either to determine whether a child is likely to benefit from the intervention or to document the child's progress, where is a clinician to begin?

Evidence-Based, Child-Specific Treatment Intensity Decisions

Speech-language pathologists are asked treatment intensity questions on a near daily basis. How many times per week should he have speech therapy? If he comes twice a week, will he make more progress? Should she have 30-minute or 45-minute sessions? With the growing focus on efficiency in educational and health care settings, the frequency of these types of questions is expected only to increase. Despite calls for greater attention to treatment intensity research, progress remains slow.⁴²⁻⁴⁴ Consequently, many children receive the same frequency and form of services regardless of their specific strengths and needs. School-aged children most often receive group therapy outside of the classroom one to two times per week for 20 to 30 minutes. Furthermore, caseload size and years of practice more strongly influence treatment intensity decisions than child characteristics.⁴⁵ Using child characteristics to appropriately match treatment intensity to specific children may result in improved progress toward treatment goals for individual children, more effective caseload management for speech-language pathologists, and improved utilization of limited resources by educational and clinical systems.

Primary challenges include the following. Inconsistencies in the way we communicate about treatment intensity and the severely limited empirical evidence specifically related to

treatment intensity impede evidence-based, child-specific treatment decisions. Although *intensity* is often treated as a singular entity, it is a product of multiple factors. One must consider the cumulative intensity based on the dose, dose frequency, and duration of the intervention, as described in Table 2.⁴⁶ Implicit within the concept of *dose* is the concept of spacing effects. *Distributed practice* refers to trials or sessions being provided over a long period. In contrast, trials or sessions during massed practice are provided over a short period.⁴⁷ Spacing effects can be viewed across sessions (e.g., five trials per day across 3 days versus 15 trials on a single day) and within sessions (e.g., one trial per minute across a 20-minute session versus 20 trials in the first 5 minutes of a 20-minute session). The few studies that have specifically compared distributed versus massed practice for language tasks suggest a benefit of distributed practice.^{48–50} Nonetheless, issues of treatment intensity remain understudied for speech-language therapy.

There is little consensus on specific combinations of treatment intensity variables that are most effective for any area in speech-language pathology (e.g., aphasia, emergent literacy, stuttering, and voice).⁴³ The first study of a comprehensive communication and language intervention that specifically isolated the effect on treatment intensity was only recently published in 2013.³² In addition, different outcomes across the limited number of available studies is hard to reconcile.⁴³ Although some studies suggest greater effects with higher in-

tensity, this pattern of results is far from universal even for similar studies. Some of these discrepancies may be due to investigators omitting key treatment intensity variables in their reports. Thus, replication within either clinical or research settings is at best a guess. Clearly, notable gaps persist in our knowledge base for making informed treatment intensity decisions.

Even though any or all of the intensity variables (see Table 2) can be manipulated to influence cumulative frequency, as a field we have not systematically evaluated various intensity levels. Future treatment studies need to evaluate different combinations of treatment implementation variations that alter intensity variables and report them with replicable precision. Because well-controlled treatment studies of sufficient duration require extensive resources, they must be planned wisely. Studies should take into account how speech-language therapy services are currently being provided, supports and challenges to implementation, and how intervention effects can be captured across clinical and research settings to avoid further widening of the research-practice gap.

CONSIDERING CHILD MOTIVATION AND TEMPERAMENT CHARACTERISTICS

Children with DS often demonstrate relative strengths in social skills that can be beneficial for relationships with family members and interacting with peers. Unfortunately, this relative strength can also diminish learning opportunities when used to escape tasks.^{22,51}

Table 2 Treatment Intensity Variables

Variable	Definition
Dose	"Number of properly administrated teaching episodes during a single intervention session" ^{46(p.410)}
Dose frequency	"Number of times a dose of intervention is provided per day and per week" ^{46(p.411)}
Duration of therapy	"Time period over which a specified intervention is presented" ^{46(p.411)}
Cumulative intervention intensity	Dose × dose frequency × duration of therapy
Spacing	Distributed practice: trials or sessions provided over a long time period Massed practice: trials or sessions provided over a short time period

Adapted from Yoder et al⁴⁶ and Kamhi.⁴⁷

Children with DS demonstrate a tendency to be “cognitively avoidant” through use of positive behaviors (e.g., “party tricks,” making silly faces, and blowing raspberries) and negative behaviors (e.g., quitting and crying), even in young preschool children.^{52,53} Wishart also found that children with DS exhibited less willingness to engage in “easy” tasks than children with typical development.⁵² The net result of these avoidant tactics is reduced learning opportunities needed to acquire new skills and to consolidate recently acquired skills when teachers, parents, and other communication partners remove or reduce the demand. In a related manner, certain temperament characteristics may also influence how a child with DS responds to learning situations. For example, children with higher levels of resistance to structure may engage in avoidant tactics more often or more intensely than children with lower levels.

Primary challenges include the following. To facilitate optimal outcomes in individuals with DS, their relative strengths in social skills must be harnessed to maximize, not avoid, learning opportunities. Addressing the personality-motivation orientation and temperament characteristics that are more common in children with DS will require examining how children with DS and their communication partners engage in dyadic interactions. A prevalent stereotype about children with DS appears to be counterproductive to boosting learning across multiple domains. Children with DS “are widely viewed as . . . not too bright but nevertheless happy and docile, who love music and are very affectionate, and who fit easily into family life.”⁵⁴ Wishart asserts that this stereotype of children with DS plays a critical role in reducing learning opportunities for children with DS in the context of these avoidant behaviors.⁵⁴ Response profiles on a questionnaire about individual children with DS were consistent with this stereotype for professionals in a variety of fields including general education teachers, special education teachers, medical students, and psychology students. Surprisingly, even mothers of children with DS exhibited responses consistent with the stereotype, although to a lesser degree.⁵⁵ Certain motivation and temperament characteristics tend to occur at different levels in children with DS than

other children; the degree that they are malleable and specifically how they impact learning are unknown.

OPPORTUNITIES FOR FACILITATING PRECISE SPEECH-LANGUAGE THERAPY SERVICES

For Moving Effective Interventions from Research to Practice

INDIVIDUAL DIFFERENCES

Because some children are expected to benefit more from certain interventions than other children, offering guidance on which children are more likely to benefit from a specific intervention could narrow the research-practice gap. Individual differences in a variety of domains (e.g., speech, language, cognitive, social, and temperamental) are suspected to influence how different children respond to different characteristics (e.g., intensity) of the same intervention. Carefully selecting the general intervention as well as specific details of that intervention offer the potential to tailor speech-language therapy for a specific child to maximize growth.

Yoder and colleagues showed how individual differences on one variable can affect how children with DS differentially respond to interventions.³⁷ They compared the effectiveness of two interventions for speech comprehensibility in school-aged children with DS: BTSR intervention and Easy Does It (EDI) intervention.⁵⁶ During BTSR intervention the clinician provides accurate models of misarticulated words without eliciting imitations from the child. In contrast, during EDI the clinician elicits imitations from the child to target specific phonological patterns. Overall, participants in both conditions demonstrated significant gains in speech comprehensibility at the conversational level following 6 months of individual, 1-hour intervention sessions two times per week. For children with DS who exhibited relatively high verbal imitation skills prior to treatment, those randomly assigned to BTSR intervention demonstrated greater rates of speech comprehensibility growth than those assigned to EDI. These findings suggest that

clinicians should consider assessing verbal imitation skills prior to selecting a specific speech comprehensibility intervention for children with DS.

ACCESS TO INTERVENTION RESOURCES

Providing access to the materials and/or assessments needed for the evaluation and/or implementation of interventions will be essential to moving them from research to practice. Adaptations of interventions, which can be positive, are expected as they transfer from research to clinical practice.⁴¹ Clinicians face different challenges and opportunities implementing interventions than those faced in research settings. Beginning with an empirically supported intervention provides a foundation for further tailoring the treatment to specific children. Modifications could influence future research studies regarding for whom and under what conditions specific interventions result in meaningful change. The field of speech-language pathology should take advantage of technological advances that permit communication across wide distances when disseminating materials and tools and when soliciting input from clinicians who work daily with children with DS.

Continuing with our earlier example, BTSR intervention exemplifies how these tools can be made available to clinicians. For children with DS who scored at least 15.5 or higher on the Dynamic Assessment of Verbal Imitation (DAVI),⁵⁷ those who received BTSR intervention demonstrated greater speech comprehensibility growth than those who received EDI intervention. Clinicians can now use the benchmark of 15.5 on the DAVI to inform their decisions regarding whether to use BTSR intervention with children with DS to increase speech comprehensibility. The DAVI is available through the Vanderbilt Kennedy Center Web site (<http://vkc.mc.vanderbilt.edu/vkc/>). No materials beyond the printed instructions and data collection page are required. The DAVI is simple and efficient—two needed qualities for clinical measures.

Other useful materials and tools must also move from research settings to clinical practice. For example, the clinical utility of automated

vocal analysis tools is becoming more viable. Automated vocal analysis through the Language ENvironment Analysis system permits the collection of daylong samples in the child's naturalistic language environment, including the language to which the child is exposed and the vocalizations (some of which is language) that the child produces.^{58,59} Throughout the day, the child wears the recording device in specially designed clothing. Computer software analyzes certain aspects of the data for clinicians to interpret and apply. Even though this technology has only recently been used with children with DS,⁶⁰ it has been used to a greater degree with other populations, such as children with autism spectrum disorder, hearing loss, or low socioeconomic status.⁶¹⁻⁶³ Automated vocal analysis could be particularly useful for children with DS in the early stages of spoken language development. As the analysis component of the Language ENvironment Analysis system is refined to create more stable estimates of clinically useful variables, such as vocalization complexity and vocal reciprocity, clinicians may be able to add automated vocal analysis to their tool set when these indices and scores become commercially available.⁶⁴ Presently, software to derive some indices and scores are being developed still or are available only for research purposes. In sum, we strongly encourage researchers to grant access to intervention resources used with their tested interventions and service providers to trial these resources and provide feedback on their clinical utility.

For Making Evidence-Based, Child-Specific Treatment Intensity Decisions

We have the opportunity to build upon the emerging evidence base for making treatment intensity decisions. Because of the current focus on efficient, effective interventions, there may be stronger motivation across stakeholders to address this important clinical question head-on now and in the near future. Understanding individual differences and offering clear descriptions of disciplined manipulations of treatment intensity components are two opportunities for advancing toward evidence-based, child-specific treatment intensity decisions.

UNDERSTANDING INDIVIDUAL DIFFERENCES

One must keep in mind that the behavioral phenotype of individuals with DS is probabilistic, not deterministic. Because we expect individual differences to influence how children with DS respond to interventions, we must look for those interactions within the DS population. The following example emphasizes the value of the behavioral phenotype in guiding research on possible differential effects of intervention characteristics as well as the need to consider individual differences. Fey and colleagues evaluated the effect of treatment intensity of MCT on intentional communication growth for young children with ID, including children with DS.³²⁻³⁵ Unexpectedly, the full sample of children with ID did not demonstrate a significant difference in gains in expressive language based on whether they received 1-hour MCT sessions one time per week or five times per week. However, children with DS did respond differentially. For the participants with DS, those who received MCT five times per week (i.e., daily) demonstrated greater gains in spoken vocabulary growth than those who received MCT one time per week (i.e., weekly).⁶⁴ Follow-up analyses found that children with DS who had high object interest were particularly likely to benefit from higher-intensity MCT. These results suggest that DS-specific characteristics as well as other characteristics that vary in children with and without DS are contributing factors to treatment intensity effects.

CLEAR DESCRIPTIONS OF DISCIPLINED MANIPULATIONS OF TREATMENT INTENSITY COMPONENTS

Greater creativity in testing the effects of altering single or clinically relevant combinations of intensity components might optimize outcomes in children with DS. Most components have only been manipulated to a minimal degree in research and clinical settings.⁴⁴ Thus, there are many opportunities for exploration. Possible factors to be manipulated include session frequency (dose frequency), session length (dose), duration of therapy, and spacing of trials (see Table 2). Although practical constraints must be acknowledged, such as having a limited number of hours in a day, we could

explore use of more frequent, shorter sessions with distributed trials or try varying lengths for the duration of therapy, while carefully tracking progress.

These explorations should occur within clinical practice and research settings. As researchers share findings regarding when and for whom different treatment intensities are more effective, many stakeholders will need to determine how the information will be applied. Clear communication as to exactly which intensity components were manipulated and the impact of those changes will be necessary. If clinicians see similar gains as those observed in research settings, the case for changes to service provision models and funding mechanisms will be strengthened. For children with DS, this process could begin in several places. In keeping with the examples already presented, daily rather than weekly speech-language therapy services using MCT could be trialed for children with DS in early intervention services.⁶⁵ School-aged children with DS could participate in speech-language therapy services focusing on speech intelligibility 2 hours per week using BTSR intervention.³⁷ Future research is needed to test whether adding verbal imitation training is necessary for BTSR to work with children with DS who begin treatment with low verbal imitation skills. While implementing these empirically based recommendations, adaptations and variations due to practical constraints are expected and likely necessary.^{41,43}

For Considering Child Motivation and Temperament Characteristics

ADDRESSING COMMUNICATION PARTNERS' RESPONSES

One way to address the negative impact of the personality-motivation orientation and avoidant behaviors is to change the learning environment of children with DS by targeting the stereotype of children with DS. By changing the way others respond to the avoidant tactics of children with DS, the number of learning opportunities could be increased, which in turn could lead to greater learning. For example, very early reinforcement for persistence in the face of difficult tasks might have long-term

effects on treatment response. Maximizing learning opportunities is important for all individuals, but especially for children with DS because of their need for increased repetitions to master and retain information. A growing body of literature offers practical ways to reduce implicit biases and stereotype threats. Even though the recommendations may not specifically discuss the stereotype of children with DS, the underlying principles apply. Example strategies include increased awareness of biases and stereotypes, increasing opportunities for contact, and obtaining information about specific group members (i.e., individuation).⁶⁶

ADDRESSING CHILD BEHAVIORS

Another option would be to address the personality-motivation orientation and avoidant behaviors of children with DS more directly. It is not yet known the degree to which the tendencies described in the behavioral phenotype of individuals with DS are malleable versus fixed. More is known about the characteristics of the behavioral phenotype than interventions related to it. Now we have the opportunity to direct more attention to interventions related to motivation and temperament characteristics. Children with DS may be able to learn more adaptive ways to manage challenging situations.

Findings from studies of typically developing infants suggest that very young children may engage in goal-directed behavior more frequently following training tasks. For example, typically developing 3-month-old infants who wore “sticky mittens” during play with objects exhibited increased reaching and grasping 2 weeks after the 2-week intervention as well as increased attention and focus 12 months after the intervention (i.e., at 15 months of age).⁶⁷ Typically developing 3-month-old infants also exhibited increased reaching movements when provided with contingent reinforcement.⁶⁸ It is unknown whether these mechanisms will operate in a similar fashion for children with DS. Pending future evidence, early intervention services may be able to shape how children with DS respond to therapeutic tasks to increase their growth trajectory across multiple domains.

Future research efforts should explore other aspects of the behavioral phenotype and how those characteristics may be related to the effects of speech-language intervention, including the intensity with which interventions are implemented. It is plausible that differences in motivation and temperament could impact the manner and degree to which children with DS participate in and benefit from educational and

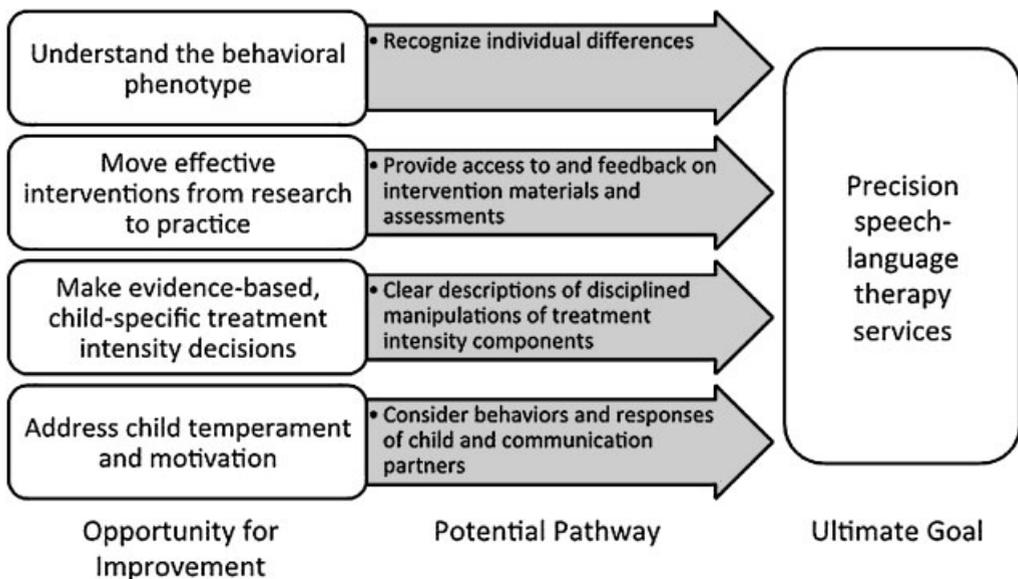


Figure 1 Development of precision speech-language therapy services for children with Down syndrome.

therapeutic services. Because these interactions may change across the life span, different intervention approaches may be required at different stages of development.

CONCLUSION

Developing precision speech-language therapy services for children with DS calls for increased collaboration among clinicians and researchers to take advantages of opportunities to address the needs and challenges of (1) moving effective interventions from research to practice, (2) making evidence-based, child-specific treatment intensity decisions, and (3) considering child motivation and temperament characteristics. Researchers and clinicians can draw upon the deepening understanding of the behavioral phenotypic of individuals with DS in the quest for more individualized and more effective speech-language therapy services for children with DS. Fig. 1 depicts how understanding the behavioral phenotype of individuals with DS and these key themes could lead to the development of precision speech-language therapy services. Tailoring services to child characteristics that affect treatment response could substantially improve the effectiveness of these services and the long-term outcomes for individuals with DS. The behavioral phenotype exposes individual differences that may be particularly important for predicting responses to intervention and intensity. These individual differences then color the way we evaluate and adapt new interventions, trial different intervention intensities and respond to child behaviors. Consequently, we can move research to practice, make intervention intensity decisions, and address motivation and temperament characteristics in a more targeted manner in the hopes of optimizing outcomes for each child with DS. Achieving the goal of precision speech-language therapy services will require increasing the flow of information to and from clinicians and researchers. Collaborations, either through formal programs or less formal means, could yield dramatic, positive changes for children with DS and their families in the coming decade by facilitating precision speech-language therapy services.

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