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Receptive Language Development in Nonverbal Children with Cerebral Palsy: Research Review of Patterns and Predictor Variables

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Receptive Language Development in Nonverbal Children with Cerebral Palsy: Research Review of Patterns and Predictor Variables

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Abstract

Receptive Language Development in Nonverbal Children with Cerebral Palsy: Research Review of Patterns and Predictor Variables

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A research review of eleven studies pertaining to receptive language performance among nonverbal, school-age children with cerebral palsy was completed. The purpose of this review was to identify components and predictor variables of receptive language growth among the target population. The studies were analyzed to further explore how limited verbal output related to comprehension level and to determine appropriate expectations for receptive abilities within the target population. Results suggested that language performances within the domains of verbal and written comprehension were generally lower compared to children matched for chronological age. However, performances were also highly variable among the target population, indicating the potential for typical receptive language development despite impaired expressive abilities. In addition, the following variables demonstrated predictive patterns across subjects: type of cerebral palsy, home literacy environment, and reading status. Clinical implications, including assessment and treatment planning considerations that are

sensitive to unique developmental patterns demonstrated in the target population, are discussed. The empirical focus on language output and the use of mixed age groups in current studies on cerebral palsy warrant future research. Additional investigations of receptive language growth as it relates to specific age groups within this clinical population are needed.

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INTRODUCTION

OVERVIEW OF CEREBRAL PALSY

Cerebral palsy is defined as a non-progressive neurological disorder that is characterized by deficits in movement, posture, physical growth, sensory perception, and communication ability (Hegde, 2001). Deficits range from mild to severe disturbances in cognitive, perceptual, and motor functions (Bottcher, 2010; Pennington, Goldbart, and Marshall, 2005). Cerebral palsy affects approximately 3 out of every 1,000 children in developed countries around the world (Bottcher, 2010; CDC, 2011). The disorder results from lesions that impair the developing brain before birth, during delivery, or in early childhood, particularly within the first two years of life (Geytenbeek, Heim, Vermeulen, & Oostrom, 2010; Hegde, 2001). Such lesions damage the areas of the brain responsible for voluntary and coordinated muscle movements throughout the body, often resulting in dyskinesia, spasticity, ataxia, and/or athetosis (Geytenbeek et al., 2010b; Hegde, 2001). Dyskinesia, or difficulty with voluntary movements, may be observed in various forms. Spasticity is often seen in this population, where increased muscle tone creates tight or rigid muscles and exaggerated reflexes (Dugdale III, 2011). Approximately 60-82% of children with cerebral palsy display spastic symptoms, making this the most common form of the disorder (Bottcher, 2010; Hegde, 2001). Spasticity results from injury to the pyramidal motor pathways, or the areas of the cortex that regulate motor control (Hegde, 2001). Ataxia is common as well, as damage or degeneration of the cerebellum causes decreased muscle control and interrupted movement patterns in the arms and legs. (NINDS, 2011; Sanger, Chen, Delgado, Gaebler-Spira, Hallett, & Mink, 2006). Children may also display athetoid symptoms of cerebral palsy (Hegde, 2001). Voluntary movements are limited due to slow, involuntary writhing of the muscles. Athetosis is

caused by injury to the extrapyramidal motor pathways, particularly the basal ganglia (Hegde, 2001). In addition to type of motor symptoms, cerebral palsy is also classified according to the physical location of impairment (Bottcher, 2010). Hemiplegia results when only the left or right half of the body is afflicted with abnormal movement patterns; diplegia occurs when only the legs or the arms are impaired; quadriplegia involves all four limbs (Hegde, 2001). Table 1 provides a review of the major types of cerebral palsy according to the area of damage to the brain and the resulting movement patterns.

Table 1. The major types of cerebral palsy.

Type of motor impairment	Area of brain lesion	Physical symptoms
Spastic	Pyramidal motor pathways	Tight or rigid muscles and exaggerated reflexes; increased muscle tone leads to stiff and jerky movements.
Ataxic	Cerebellum	Decreased muscle control and interrupted movement patterns; decreased muscle tone leads to decreased balance and uncoordinated movements. Unable to monitor body position, as well as direction, force, and rate of movements.
Athetoid	Extrapyramidal motor pathways, basal ganglia	Slow, involuntary writhing of the muscles that prevents voluntary, organized movements.

Dugdale III, 2011; Hegde, 2001; "NINDS, 2011; Sanger, Chen, Delgado, Gaebler-Spira, Hallett, & Mink, 2006.

Those with cerebral palsy not only have trouble walking and establishing normal body postures, but they may also have difficulty controlling the articulators for speech production. These severe speech disorders are known as dysarthria or anarthria (Geytenbeek, Harlaar, Stam, Ket, Becher, Oostrom, & Vermeulen, 2010; Redmond &

Johnston, 2001). Dysarthria is generally caused by damage to the nerves, brain tissue, or muscles that help control and coordinate the anatomical structures supporting speech production (Hoch & Zieve, 2010). Such damage results in weakened or paralyzed muscles that can greatly reduce speech intelligibility. Anarthria is a condition in which the individual completely lacks control of the articulators due to a lesion located specifically in the anterior portion of the frontal operculum, which is found in the posterior portion of the frontal inferior gyrus (Lucchelli & Papagno, 2005). The individual may produce inconsistent and infrequent verbalizations, but is mainly mute or without any speech. In addition, at least half of all children with cerebral palsy present with deficits in cognition and language such as low intelligence quotient (IQ) scores, learning disabilities, and developmental language disorders (Asbell, Donders, Tubbergen, & Warschausky, 2010; Binger & Light, 2008; Dorman, Laatsch, & Hurley, 1984; Geytenbeek et al., 2010b; Hustad, Gorton, & Lee, 2010; Lepage, Noreau, Bernard, & Fougeyrollas, 1998).

COMMUNICATION DIFFERENCES IN CHILDREN WITH CEREBRAL PALSY

When a child lacks verbal output for communication, he or she is unable to initiate conversation and provide feedback to a communicative partner using symbolic spoken language. Furthermore, when a child has deficits in language development and cognition, he or she will have difficulty processing linguistic information and devising appropriate and clear responses (Binger & Light, 2008). Given the motor impairments that define cerebral palsy, children with this etiology also have trouble producing nonverbal communicative gestures. Nonverbal gestures range from very direct and iconic hand movements to complex systems of sign language that involve fine motor control. Nonverbal communication also involves eye gaze, posture, body position, facial expressions, and nodding of the head. Nonverbal strategies help reinforce the speaker's

intent, while communicating attention and understanding in the listener. Lack of gross and fine motor control in children with cerebral palsy creates many obstacles, not only for expression but also in terms of signaling comprehension to communicative partners.

Given the difficulties children with cerebral palsy have when coordinating responses to others, those interacting with the child may assume that he or she is not engaged or does not require the level of verbal and environmental stimulation needed by typically developing children (Geytenbeek et al., 2010b). Also, the communication partner may not have the necessary preparation and training to help an impaired child during moments of communication breakdowns (Snell, Chen, Allaire, & Park, 2008). Often, there is a considerable misunderstanding of comprehension level and linguistic capability in this population, and it is difficult to determine whether perceived impairments are the result of structural damage to the brain, fewer opportunities for interaction, or a combination of both factors (Berninger & Gans, 1986a; Cauley, Micnick-Golinkoff, Hirsh-Pasek, & Gordon, 1989). In addition, clinical treatment and investigations concerning communication in children with severe disabilities tend to focus primarily on speech deficits and expressive abilities (Geytenbeek et al., 2010a; Geytenbeek et al., 2010b; Hustad et al., 2010). Given that cognitive impairment is commonly associated with cerebral palsy, along with the tendency among professionals and caregivers to focus on verbal output as opposed to comprehension and stimulation, information concerning receptive language development in this population is not well established.

Previous research involving children with severe speech and physical impairments (SSPI), including those with cerebral palsy, shows evidence for development of receptive language in this population, with comprehension greatly surpassing expressive abilities in a few cases (Bishop, Byers Brown, & Robson, 1990 and

Roth & Cassat-James, 1989, as cited in Geytenbeek et al., 2010b, p. 98; Geytenbeek et al., 2010a). Furthermore, use of augmentative and alternative communication (AAC) in combination with modified testing reveals the presence of receptive language abilities to varying degrees in this population. AAC methods such as speech generating devices (SGDs), gestures, eye gaze, head switches, chin switches, communication boards, and partner assisted communication have been successfully implemented to complete measures of receptive language, generate estimates of comprehension levels, and teach language systems that support receptive vocabulary growth and increased spontaneous responding (Hurlbut, Iwata, & Green, 1982; Lund & Light, 2006). In particular, the *Peabody Picture Vocabulary Test, Revised* (PPVT-R) and the *Test of Auditory Comprehension of Language, Revised* (TACL-R) have been adapted to assess receptive vocabulary (or semantic knowledge) and comprehension of morphology and syntax in both adults and children with severe cerebral palsy and very limited verbalizations (Carrow-Woolfolk, 1973; Dunn & Dunn, 1981; Geytenbeek et al., 2010a; Lund & Light, 2006). In most cases, such participants tend to score below what is considered average; however, quality of life measures indicate that even if comprehension does not reach expected levels for chronological and mental age, the capabilities that are present may allow for adequate functional communication (Lund & Light, 2006).

LANGUAGE DEVELOPMENT IN TYPICAL SCHOOL-AGE CHILDREN

In order to create a context for understanding the variables involved with language development in children with cerebral palsy, it is necessary to first consider the course of typical development in school-age children. Typical language milestones must be examined in order to compare discrepancies between expressive and receptive behaviors in children with cerebral palsy. In addition, a clear picture of typical development allows for more appropriate expectations of language skills among impaired

populations.

Typical language development for school-age children ages seven and older involves increasing complexity of expressive and receptive abilities, as well as the emergence of literacy skills. Specifically, the child should have highly intelligible speech and should be able to carry out adult-like conversations utilizing appropriate social routines and complex sentences. Complex grammatical structures such as embedded clauses, relative clauses, coordinating and subordinating conjunctions, and the perfective aspect and passive voice begin to appear more frequently in the child's speech (Eisenberg, 2006). In addition to more accurate and varied grammatical structures, sentences should also contain more detailed descriptions of events, observations, and objects. The child can easily retell past events and correctly sequence thoughts into a complete story (Ukrainetz, 2006). Importantly, the child should be able to distinguish between grammatical correctness and semantics beginning at the age of eight years old (Owens, 2008a). Such awareness allows the child to evaluate the domains of syntax and morphology apart from the domain of word meaning.

In terms of receptive language, the child will have an extensive vocabulary that allows him or her to comprehend more abstract concepts such as time, numbers, and opposites. Also, a well developed vocabulary will help the child follow lengthy conversations, complete multi-step directions, and establish strong reading comprehension skills (Biemiller & Boote, 2006). Generally, children begin to recognize non-literal meanings around eight years old, and they will acquire skills for identifying and exploring abstract topics by eleven years old (Owens, 2008a). Finally, reading and writing begin to develop and will continue to become more fluent and advanced with practice. As phonological awareness matures, word reading typically emerges between the second and fourth grade levels of early education (Owens, 2008b).

Receptive communication specifically involves awareness and comprehension of an incoming message. Such a message may take the form of speech, gestures, signs, or text. In order to process and decode incoming spoken and written messages, as well as encode information in order to form an appropriate response, certain linguistic abilities must be accessible to the developing child. He or she must learn to implement phonemic analysis in order to segment spoken words into phonemes. Not only does this allow the child to process speech sounds, but phonemic analysis also supports learning of letter-phoneme correspondence (Berninger & Gans, 1986a). In addition, vocabulary knowledge is crucial for allowing recognition of whole word units and comprehension of word meaning in both speech and writing (Berninger & Gans, 1986a).

PREDICTING THE IMPACT OF LANGUAGE DIFFICULTIES

In addition to addressing current communication difficulties within the home or school environment, adults need to assess any variables that may strongly predict such problems among children with cerebral palsy. Focusing on key pieces of background information could help caregivers and professionals predict the domains or severity of language impairment. Moreover, anticipating communication breakdowns and their causes could improve quality of daily living and treatment design.

A retrospective study of thirty-six prematurely born children with cerebral palsy investigated early predictor variables for later language impairments (Pirila, van de Meere, Pentikainen, Ruusu-Neimi, Korpela, Kilpinen, & Nieminen, 2007). The study revealed that severity of motor impairments was positively correlated with deficits in expression and comprehension. In addition, more subjects that presented with an IQ below 70 demonstrated problems with phonological development, as compared to those with an IQ of 70 or above. However, other variables such as early ultrasound findings, birth weight, and socio-economic status did not relate to later speech, language, or

intellectual abilities. Such distinctions are highly valuable for speech-language pathologists with similar clients on their caseloads. When collecting background information on a client, the clinician can utilize previous measures of motor impairment and intellectual performance as initial indicators of receptive language ability.

Lepage et al. (1998) developed a handicap profile using ninety-eight single case studies of children and adolescents with varying forms of cerebral palsy. The profile looked at the connections between life habits of the participants and the following four variables: impairment type (hemiplegia, diplegia, and quadriplegia), severity of the impairment, speech and language disorders, and comprehension difficulties. Life habits included the following basic necessities and aspects that contribute to quality of life: nutrition, fitness, personal care, communication, housing, mobility, responsibility, family relations, interpersonal relations, community, education, and recreation (Lepage et al., 1998). Results showed that impairment type and severity were associated with accomplishment of life habits. Disruptions in daily activities and routines increased if impairment type and severity were more extreme. For example, children with quadriplegia had the most difficulty completing daily routines and life habits. Similarly, those with speech and language disorders and cognitive issues leading to comprehension difficulties also had disrupted daily activities.

The results indicate that language deficits in school-age children with cerebral palsy have a serious impact upon quality of life. Specifically, children that fit this particular profile not only require more direct assistance, but they also have limited opportunities to develop and maintain personal relationships. If caregivers and clinicians have a better understanding of receptive language deficits in these individuals, they can anticipate communication breakdowns and provide the support needed to increase the quality and consistency of daily activities and social interactions for this population.

SPECIFIC AIMS

The primary goals of this paper are to (1) identify the type and complexity of receptive language components seen in nonverbal, school-age children with severe cerebral palsy and (2) highlight common variables among the target population that may predict receptive language growth and performance. The current data will help answer the following questions: how does limited verbal output relate to comprehension, and what levels of understanding and linguistic mastery can be expected of the target population? The hypothesis is that nonverbal, school-age children with a diagnosis of severe cerebral palsy can develop appropriate receptive language skills despite an inability to produce intelligible speech.

Information on receptive language development would be of great benefit to caregivers, teachers, and clinical professionals because knowing a child's level of comprehension has a significant impact on type and quality of social and communicative interactions. Also, understanding the child's level of comprehension will allow caregivers, educators, and clinicians to more easily identify the child's needs and interests. In addition, having specific data on language deficits in children with cerebral palsy will help professionals develop more effective assessment tools and treatment programs for this population.

The research presented in this paper highlights specific receptive abilities that have been noted in children with cerebral palsy. The data reflect comparisons made between the target population and typically developing children, as well as children with other cognitive and motor impairments.

Specifically, receptive language components will encompass the skills needed in order to comprehend both spoken and written language. Comprehension of spoken language will include understanding a single spoken word (receptive vocabulary),

understanding a spoken sentence (receptive grammar and syntax), and understanding spoken conversation (discourse comprehension) (Geytenbeek et al., 2010a). In addition, the emergent literacy abilities, such as phonological awareness, phonemic analysis, and letter knowledge, will be investigated along with word decoding and reading comprehension among the target population.

METHODS

CRITERIA FOR INCLUSION AND EXCLUSION OF STUDIES

In order to evaluate the questions about receptive language development in children with cerebral palsy, a review of the available literature was conducted. Studies were included when the following criteria were met: (1) the studies were published in peer-reviewed journals; (2) subjects had a diagnosis of cerebral palsy; (3) the studies specifically reported data on subjects with severe speech impairments, either unintelligible speech (dysarthria) or no speech (anarthria); (4) the studies specifically reported data on school-aged subjects within the range of 7-17 years old, and (5) the studies focused on receptive language abilities, specifically comprehension of spoken and written language.

Studies were excluded when (1) they did not specify the diagnoses of impaired subjects; (2) subjects had mild speech impairments or were able to use speech as their main mode of communication; (3) specific data was not reported for subjects that met inclusion criteria for age and impairment; and (4) the main focus was on expressive language or cognitive ability.

SEARCH METHODS

The following search procedures were used to locate studies: (1) a series of computer literature database searches in Academic Search Complete, CINAHL, ERIC, MEDLINE, PsycARTICLES, and PsycINFO, using combinations of the terms *cerebral palsy, comprehension, language development, language review, nonverbal, nonvocal, receptive language, reading comprehension, receptive language development, review, school-age, severe speech and physical impairment, verbal comprehension*; (2) a hand search of the following peer-reviewed journals: *American Journal on Mental*

Retardation, Augmentative and Alternative Communication, International Journal of Clinical Neuropsychology, Journal of Speech and Hearing Research, and *Perceptual and Motor Skills*; and (3) searches of the reference lists of each study meeting any of the above inclusion criteria. Searches were limited to the English language. A variety of databases focused on different areas of research were utilized to ensure a broad and thorough search of the literature.

CODING PROCEDURES

Data from eleven selected articles were compiled into a table and organized according to the following categories: language components tested; type of study design; diagnosis, age, and number of participants; results of language measures; and predictor variables associated with participant performances. The results, including all descriptive, informal, and standardized measures pertaining to comprehension of spoken and written language, were summarized. Although some studies contained adult participants and children with only mild to moderate speech impairments, as well as measures pertaining more to cognition than language, only information that met inclusion criteria was included in the present review.

RESULTS

An initial search yielded 27 articles that partially met inclusion criteria. Search results were narrowed down to a total of eleven studies that met all established criteria. These studies included a total of 245 participants with limited verbal ability due to cerebral palsy and 85 typically developing children and adults. An additional group of 24 participants with a diagnosis of cerebral palsy but mild to no speech impairment were included for comparison to the target population. Finally, 22 children diagnosed with cognitive impairments were also included as controls. Study methods ranged from within and between group designs, to longitudinal, descriptive, and case study analyses. Among all participants with cerebral palsy, there were 115 males and 106 females ranging in age from 5-40 years old. Bishop et al. (1990) did not provide information on gender for their 48 subjects. Only one out of the eleven studies used solely school-age participants in its research design (Redmond & Johnston, 2001).

Table 2 summarizes the results of the eleven studies involving receptive language skills in school-age children with cerebral palsy found in the literature. The results are described in terms of the two identified questions: an investigation of receptive language abilities and an analysis of predictor variables. The investigation of receptive language abilities is further divided into two subsections that present results for either comprehension of spoken language or reading comprehension.

Table 2. Summary of receptive language studies, including research design, number of participants, age, disability, type of language measure used, and results.

Reference	Design	No.	Age (in years)	Disability	Language Measures	Results
Berninger and Gans (1986)	Case Study	3	40 (Case 1) 16 (Case 2) 9 (Case 3)	All=CP	CT; Discourse; Phonemic analysis; RS; RV; Spelling; WD	Delays in phonemic analysis, spelling, WD, and reading. At or near mastery for SC and discourse comprehension.
Bishop et al. (1990)	Between and within group analyses	Study 1 = 24[a] Study 2 = 21[ab]	Range = 10-18	All=CP[c]	Phoneme discrimination; RS; RV	Study 1 = Lower performances for phoneme discrimination and RV; similar to controls with CP but typical speech for RS. Study 2 = Significant differences when using nonword stimuli.
Dahlgren-Sandberg and Hjelmquist. (1997)	Between and within group analyses	27[a]	Range = 8;6-19;10 Mean = 13	All=CP	CT; LK Phonological awareness; RS; SC; Spelling; WD	Similar to cognitively impaired group for SC. Significant differences for "readers."
Dahlgren-Sandberg et al. (2010)	Within group analyses	28[d]	Range = 5;2-13 Mean = 9;5	All=CP	CT; LK; Phonological awareness; RV; Spelling; WD	Performances related to task type. Significant differences in CA, education, phonological awareness, and spelling for "readers."
Dorman (1987)	Step-wise multiple linear regression analyses	31	Mean=16	All=CP	Phonemic discrimination; RC; WD	Mean scores were more than 1 SD below average for RC and WD.
Peeters et al. (2009)	Longitudinal, group	35	Time 1 mean = 6 Time 2 mean = 7	All=CP	LK; Phonemic awareness; RS; RV; Rhyme; WD	Significant growth in reading precursors from Time 1 to Time 2. Best predictors of early reading were phonemic awareness and literacy activities.

Table 2 Continued

Reference	Design	No.	Age (in years)	Disability	Language Measures	Results
Pueyo et al. (2003)	Within group analyses	30	Range = 16-38	All=CP[e]	AC; RS; RV	Subjects with dyskinetic and mixed forms of CP outperformed those with spastic CP.
Pueyo et al. (2009)	Within group and regression analyses	40	Range = 6-38	All=CP[f]	AC; RS; RV	RV most impaired.
Redmond and Johnston (2001)	Descriptive between group analyses	4[a]	11;2 14;8 12;10 15;9	3=CP 1= brainstem aneurysm	RS	High sensitivity to bare stem aspectual verbs, subject-verb agreement, and overregularization. More difficulty with verb tense-marking errors.
Sabbadini et al. (2001)	Between group analyses	8[ag]	Range = 9-30	All=CP	Phonemic discrimination Phonetic discrimination RS; RV	Similar performances to controls matched for MA. Phonological comprehension stronger than lexical comprehension.
Smith et al. (2009)	Between and within group analyses	16[ah]	Range = 5;5-13 Mean = 8;11	All=CP	CT; LT; Phonological awareness RS; RV; Spelling; WD	Greatest differences on spelling and reading. Significant differences compared to typical peers matched for CA, MA, and RV.

Note: AC, auditory comprehension; CA, chronological age; CP, cerebral palsy; CT, connected text; LK, letter knowledge; MA, mental age; RC, reading comprehension; RS, receptive syntax; RV, receptive vocabulary; SC, semantic comprehension; SD, standard deviation; WD, word decoding.
[a]Controls were included in the study but are not included in this table. [b]Participants in Study 2 were drawn from Study 1. [c]In Study 1, 12 participants were congenitally anarthric and 12 were severely dysarthric; in Study 2, 12 participants were congenitally anarthric and 9 were severely dysarthric. [d]25 participants were school-aged; range = 7;0-13;0. [e]All participants had bilateral CP; 6 had dyskinetic symptoms, 13 had spastic symptoms, and 11 had mixed symptoms. [f]All participants had bilateral CP; 6 had dyskinetic symptoms, 14 had spastic symptoms, 18 had mixed symptoms, and 2 had unknown types of CP. [g]4 participants were school-aged; they were 9, 9, 11, and 13. [h]14 participants were school-aged; range = 7;3-13;0.

COMPREHENSION OF SPOKEN LANGUAGE

The results of receptive language measures assessing comprehension of spoken language are presented in the following three sections. Once again, the components necessary for comprehension of speech are based upon definitions of receptive language provided in the relevant literature (Geytenbeek et al., 2010a). Results for receptive vocabulary are presented first, followed by receptive grammar and syntax, and finally discourse comprehension. The sections progress from comprehending the meaning of a single, spoken word to spoken sentences, and finally information presented in a conversational or discourse type format.

Receptive vocabulary

Six studies examined receptive vocabulary among school-aged participants that met research criteria for diagnosis and speech impairment (Berninger and Gans,1986b; Bishop et al., 1990; Dahlgren Sandberg & Hjelmquist, 1997; Pueyo, Junqué, Vendrell, Narberhaus, & Segarra, 2009; Sabbadini, Bonanni, Carlesimo, & Caltagirone, 2001; Smith, Dahlgren Sandberg, & Larsson, 2009). Two subjects diagnosed with athetoid and spastic cerebral palsy, as well as severe dysarthria, completed measures of vocabulary knowledge and semantic competence in a study conducted by Berninger and Gans (1986b). One child (Subject 3, age 9) was advanced in vocabulary knowledge, according to results from the PPVT-R, as well as at or near mastery for semantic competence (according to the *Buschke Test of Linguistic Competence* for detecting meaning within sentences) (Buschke, 1975, as cited in Berninger and Gans, 1986b). The other child (Subject 2, age 16) demonstrated significantly delayed vocabulary knowledge while showing mastery levels of semantic competence. Both achieved better performances on the semantic portions of the *Buschke Test of Linguistic Competence*. In a study by Sabbadini et al. (2001), performances on a neuropsychological battery for four school-

aged subjects with severe neuromotor and verbal disabilities due to cerebral palsy were compared to typically developing children matched for mental age. Lexical comprehension, as measured by the PPVT, was similar between groups.

Several versions of the PPVT were utilized for assessment of receptive vocabulary. For example, scores on the *British Picture Vocabulary Scales, 2nd Edition* (BPVS) from 16 Irish children with severe motor impairments and congenital dysarthria or anarthria were compared to typically developing peers (Dunn, Whetton, & Pintilie, 1982). Only 50% achieved a standard score within the average range on the BPVS-2 (Smith et al., 2009).

In a study focused on establishing cutoff points for clinically significant neuropsychological impairment, 34 out of 40 subjects had below average performances on the PPVT-R, *Spanish version* (Pereda, 1985; Pueyo et al., 2009). In addition, while all subjects had a diagnosis of cerebral palsy, 6 had dyskinetic symptoms, 14 had spastic symptoms, 18 had mixed symptoms, and 2 had unknown subtypes of the disorder. Unlike the other subtypes, all dyskinetic subjects had impaired receptive vocabulary.

Two larger studies obtained results in which the impaired or experimental groups (a total of 54 subjects) had lower performances on receptive vocabulary measures than control groups without speech impairments (Bishop et al., 1990; Dahlgren Sandberg & Hjelmquist, 1997). In particular, Bishop et al. (1990) used a control group matched for chronological age that included children with a diagnosis of cerebral palsy but mild motor impairments and typical speech. Average performances for both groups were below expected age level. The speech impaired group featured in Dahlgren Sandberg and Hjelmquist's (1997) study demonstrated lower levels of verbal comprehension at the semantic level in comparison to younger peers with typical development who were matched for mental age. In contrast, the speech impaired group had similar scores to a

second control group matched for chronological and mental age, but with cognitive disability.

The utility of vocabulary measures was questioned by two studies (Pueyo et al., 2009; Smith et al., 2009). The authors cautioned against using such assessments as indicators of general language ability. Only 47% of cases featured by Pueyo et al. (2009) had impaired comprehension, according to a praxis task during which subjects matched a picture to a gesture, whereas 85% of cases had impaired receptive vocabulary. Similarly, even though the impaired subjects in the Smith et al. (2009) study were matched with speaking peers on the basis of vocabulary, their performances across almost all other language and cognitive measures were significantly lower. Such differences indicate that vocabulary may not be an adequate measure of overall receptive language development.

To summarize, when compared to peers matched for chronological age and with typical speech development, the target population had lower performances on standardized tests of receptive vocabulary. Performances were similar when peers matched for mental age or with cognitive impairment were used as controls for nonverbal children with cerebral palsy. Performances were at or near mastery when researchers used more general tests of semantic knowledge, such as the Buschke Test for semantic competence. Better scores were also obtained by subjects with either spastic or mixed symptoms of cerebral palsy. On the other hand, results from vocabulary tests should be interpreted with more caution, particularly when they are used to evaluate overall language ability.

Receptive grammar and syntax

Eight studies were conducted that included various measures of receptive grammar (Berninger and Gans,1986b; Bishop et al., 1990; Dahlgren Sandberg & Hjelmquist, 1997; Pueyo, Junqué, & Vendrell, 2003; Pueyo et al., 2009; Redmond &

Johnston, 2001; Sabbadini et al, 2001; Smith et al, 2009). The two subjects from the Berninger and Gans (1986b) study completed a Buschke Test of syntactic competence, in addition to the previous vocabulary measures. One child (Subject 3, age 9) was advanced in recognizing syntactic structures and at or near mastery for syntactic competence. The other child (Subject 2, age 16) demonstrated significantly delayed knowledge of syntactic structures and competence. The authors note that while Subject 2 had a low average IQ, Subject 3 had average intelligence.

Several studies tested impaired groups that did not show any significant deficits for receptive grammar (Bishop et al., 1990; Dahlgren Sandberg & Hjelmquist, 1997). When comparing school-aged children with cerebral palsy but intact speech production to a speech impaired group matched for chronological age and diagnosis, Bishop et al. (1990) discovered that children from the speech impaired group scored within one standard deviation of the normative mean on the *Test for Reception of Grammar* (TROG) (Bishop, 1983). Like the results previously described for receptive vocabulary, average performances for both groups were below expected age level. Compared to typically developing peers matched for mental age, impaired subjects had similar performances on the *Nauclér and Magnusson test of identification of syntactic acceptability* (Dahlgren-Sandberg & Hjelmquist, 1997; Nauclér and Magnusson, 1994).

Significant differences were found when examining levels of receptive grammar among groups with varying types of cerebral palsy. Those with mixed symptoms performed better than those with spastic symptoms on the *Screening Test of Spanish Grammar, receptive portion* (STSG), and all dyskinetic subjects received scores within the normal range (Pueyo et al., 2003; Pueyo et al., 2009; Toronto, 1973). The overall best performances among groups were seen on tests of receptive grammar, when compared to outcomes from tests of receptive vocabulary, nonverbal intelligence,

auditory comprehension, working and verbal memory, visual perception, and frontal lobe functioning; receptive grammar was only impaired in 12.5% of 40 subjects with cerebral palsy and limited speech (Pueyo et al., 2009).

Specific areas of strengths and weaknesses relating to receptive grammar were identified in members of the target population by Redmond and Johnston (2001). The experimental group consisted of four children with SSPI, three of which had a diagnosis of cerebral palsy. The subjects were asked to judge whether 45 sentences presented verbally and with visual stimuli in a short story format were grammatically correct. Target grammatical features included the following: agreement between the subject and auxiliary verbs (i.e. she is vs. she are running); marking of aspect/use and omission of aspectual -ing (i.e. she is eat vs. she is eating a cookie); and marking of past tense for regular and irregular verbs (use of stem, correct past tense, and overregularization). Responses from the four experimental subjects were compared to groups of preschool-aged, adolescent, and adult subjects with typical development. The impaired group had levels of sensitivity above chance for verbal morphological errors. Furthermore, there were no significant group differences regarding the marking of subject-verb agreement or the marking of aspectual –ing. The impaired group also did well with marking past tense with irregular verbs. Subjects appeared to recognize that irregular verbs must also be marked for tense and that –ed is not used with irregular verb stems (Redmond & Johnston, 2001). Among the impaired group, one of the three subjects with cerebral palsy had high sensitivity to all ungrammatical items.

The impaired subjects were most challenged when trying to identify bare stem regular verbs as errors. They demonstrated a limited understanding of regular verb inflections and regular past tense. Also, detection of tense marking errors, especially overregularization, was more difficult than detection of non-tense marking errors. One of

the three children with cerebral palsy had a low rate of accepting grammatically correct sentences and rejected most sentences with regular verbs, whether they were correctly inflected or not. Another child with cerebral palsy accepted all bare stem errors as correct and preferred bare stem regular verbs over correctly inflected verbs.

Four typically developing participants from the preschool and adolescent groups were matched to the 4 children in the impaired group on the basis of PPVT-III raw scores (Redmond & Johnston, 2001). The purpose of this was to look at the sensitivity of the impaired group to morphological errors in comparison to developmental expectations based on vocabulary knowledge (Redmond & Johnston, 2001). The impaired and vocabulary-matched groups were similar in their levels of sensitivity to most error types. All had high sensitivity to ungrammatical sentences with subject-verb agreement errors and bare stem aspectual verbs. Also, three out of the four children in the impaired group had higher sensitivity than the vocabulary-matched group for sentences containing over-regularization errors. On the other hand, the impaired group showed less sensitivity to ungrammatical sentences containing bare stem irregular verb errors, and they were more willing to accept ungrammatical sentences containing bare stem regular verbs.

Two other studies, with a total of 20 subjects, obtained results showing significantly lower mean performances of impaired groups compared to typically developing children matched for either chronological or mental age (Sabbadini et al, 2001; Smith et al, 2009). Grammatical comprehension and receptive syntax were measured using the *Grammatical Comprehension Test for Children* (TCGB) and the TROG-2 (Chilosi & Cipriani, 1997). Among the twelve children in the impaired group in the Smith et al (2009) study, only half achieved a standard score within the average range on the TROG-2; of those six children, one child obtained a score one standard deviation above the mean.

To summarize, results for grammatical assessments varied throughout the target population. Generally, nonverbal children with cerebral palsy scored below age-appropriate levels for receptive syntax. However, the degree of deviation from typical performance levels was not always significant. In regards to specific grammatical errors, there were no significant differences for the marking of subject-verb agreement or the marking of aspectual –ing. The target population also did well with marking past tense with irregular verbs. They had more difficulty with regular verb inflections and regular past tense. Also, they were not as adept at detecting tense marking errors, as compared to identification of non-tense marking errors. Finally, children with spastic symptoms of cerebral palsy had significantly lower performances on grammatical measures than those with other forms of the disorder.

Discourse comprehension

Oral discourse comprehension was directly examined in only one of the qualifying studies. Berninger and Gans (1986b) used Subtest 6 of the *Clinical Evaluation of Language Fundamentals* (CELF) to assess this particular area of receptive language (Semel & Wilg, 1980). Subjects listened to a paragraph that was read out loud, and then they answered 3-7 questions about the paragraph. Subject 2 (age 16) demonstrated age and grade appropriate discourse comprehension, while Subject 3 (age 9) received an advanced rating for this skill. Both subjects had average or better factual recall for information presented during oral discourse.

Comprehension of spoken language included data for receptive vocabulary, receptive grammar and syntax, and discourse comprehension. Performances were highly variable for vocabulary and grammar. Participants tended to achieve higher ratings if their performances on formal and informal measures were compared to children matched

for mental age. Trends were noted when assessing the relationship between type of motor impairment and grammatical deficits. Children with spastic symptoms of cerebral palsy had significantly lower performances on grammatical measures than those with dyskinetic or mixed forms of the disorder. Consistent error patterns for specific grammatical concepts were noted as well. Subjects had more difficulty with regular verb inflections, regular past tense, and detection of tense marking errors. Only one study assessed oral discourse comprehension, and results were at or above appropriate age and grade levels (Berninger & Gans, 1986b).

EMERGENT LITERACY SKILLS AND READING COMPREHENSION

The results of receptive language measures assessing comprehension of written material are presented in the following four sections. Results for phonological awareness are presented first, followed by letter knowledge, single word decoding, and comprehension of connected text. The sections progress from sound discrimination ability and letter knowledge, to reading at the word and sentence levels.

Phonological awareness

Phonological awareness is integral to reading development and comprehension. It relates to a child's ability to identify the sound segments that constitute words and to divide words into their individual phonemes. Such skills have been shown to be the strongest predictors of later reading abilities in school-age children (Muter, 1998; Muter, Hulme, Snowling, and Taylor, 1996; Nation and Hulme, 1997; as cited in Apel and Swank, 1999, p. 232). Phonological awareness has even been found to support word decoding skills in children who struggle with reading (Hatcher, Hulme, & Ellis, 1994; van Kleeck, Gillam, & McFadden, 1998; Warrick, Rubin, & Rowe-Walsh, 1993, as cited

in Apel and Swank, 1999, p. 232-233). The relationship between phonological awareness, word reading, and reading comprehension is of a dynamic nature and is crucial to understanding written language (Hogan, Catts, & Little, 2005; Sutherland & Gillon, 2005, as cited in Owens, 2008b, p. 358). For these reasons, phonological awareness was included among the components of receptive language explored in this review.

Seven studies that met criteria included various measures of phonological awareness (Berninger and Gans, 1986b; Bishop et al, 1990; Dahlgren-Sandberg & Hjelmquist., 1997; Dahlgren Sandberg, Smith, & Larsson, 2010; Dorman, 1987; Sabbadini et al., 2001; Smith et al, 2009). Berninger and Gans (1986b) used the *Auditory Discrimination Subtest* of the *Stanford Diagnostic Reading Test (Red Level)* as a measure of phonemic analysis ability (Karlsen, Madden, & Gardner, 1976). Subjects 2 and 3 had to determine if a pair of spoken words began or ended with the same sound. Phonemic analysis was significantly delayed for both participants. Twenty speech impaired subjects with cerebral palsy had similar results on two trials of a phonemic discrimination task (Task 1) that involved identifying non-word pairs as same or different (Bishop et al, 1990). The impaired group had significantly lower performances during both trials, compared to the control group containing children with cerebral palsy but typical speech. One specific phoneme contrast was consistently difficult for the impaired group-initial /b/ and /v/. A second phonemic discrimination task was administered for only one trial. Task 2 was a word judgment task based on procedures by Locke (1980); subjects determined whether a name spoken by the examiner matched a picture and whether it was pronounced correctly. Task 2 assessed the phonemic discriminations used in Task 1.

There were no significant differences between groups for Task 2. After a one-year interval, different items were used to assess the same phoneme contrasts, and there was still a highly significant difference between groups on the same-different phoneme task (Task 1).

Factor analysis showed significantly lower performances for 16 impaired subjects on a battery of phonological awareness tasks, compared to typically developing peers matched for chronological age (Smith et al, 2009). However, half or more of the impaired subjects achieved ceiling scores on the following phonological awareness tasks: phoneme deletion (12 subjects), phoneme blending (7 subjects), and two rhyming tasks (10 subjects).

Four studies reported no significant differences between control groups and impaired groups (Dahlgren Sandberg & Hjelmquist, 1997; Dahlgren Sandberg et al., 2010; Dorman, 1987; Sabbadini et al., 2001). Dorman (1987) analyzed phonological analysis using the Phonemic Discrimination factor scale from the *Luria-Nebraska Neuropsychological Battery* (Golden, Hammeke, & Purisch, 1978). Subjects had to repeat and write simple and blended phonemes in isolation and in combination. None of the 31 adolescents with varying types of cerebral palsy (18 were spastic quadriparetic; 5 were spastic diplegic; 5 were athetoid with some spastic symptoms; 3 were hemiplegic) showed severe impairments in phonemic discrimination. In fact, mean scores for each group (based on the type of CP) were above the standard mean of 100, except for the athetoid group. Among the many phonological subtests administered to 55 subjects by Dahlgren Sandberg and Hjelmquist (1997) and Dahlgren Sandberg et al., (2010), sound identification (deciding if a particular sound was in a word) and word length analysis

(identifying which word among four choices contained the most sounds) were consistently more difficult than rhyme recognition and phoneme synthesis for impaired subjects. Phoneme blending and phoneme deletion were reported as the easiest phonological tasks for school-age children with cerebral palsy and severely impaired speech.

Eight subjects were assessed by Sabbadini et al. (2001) for level of phonological comprehension, phonetic discrimination ability, and minimal pair detection. Subjects had to discriminate between 60 pairs of syllables with similar sounds, match a picture to the name of figure said out loud by the examiner, and distinguish between minimal pairs. Phonemic discrimination skills were similar between the impaired subjects and the typically developing subjects.

To summarize, mixed results were found for phonological awareness skills. Significant deficits were identified in the target population when assessments involved non-word stimuli. Performances were also poorer for sound identification and word length analysis. Less severe deficits were noted when tasks involved rhyme recognition, phoneme blending, and phoneme deletion. Typical performances were obtained on tests using minimal pairs.

Letter knowledge and spelling

Four studies assessed letter knowledge and spelling ability (Berninger and Gans, 1986b; Dahlgren Sandberg & Hjelmquist, 1997; Dahlgren Sandberg et al., 2010; Smith et al., 2009). Subjects 2 (age 16) and 3 (age 9) in Berninger and Gans' (1986b) study completed the Spelling Subtest of the *Wide Range Achievement Test* (WRAT); subjects

selected letters that spelled a dictated word (Jastak, Bijou, & Jastak, 1978). Responses determined that Subject 2 was at a 4th grade spelling level, while Subject 3 was at a 2nd grade spelling level. After completing a battery of standardized tests to assess receptive oral language, processing of written language, and production of written language, Berninger and Gans (1986b) determined that both subjects were better at selecting letters for spelling rather than matching a printed word to a picture. The authors suggested that this could be explained by exposure to electronic or AAC devices.

Fifty-five impaired subjects were tested for letter knowledge and spelling ability using the following informal tasks: naming letters, correctly associating phonemes with letters, dictated spelling, pseudoword spelling, and visual spelling (only a picture of a noun was presented, without any label) (Dahlgren Sandberg & Hjelmquist, 1997; Dahlgren Sandberg et al., 2010). Significant differences were found in letter knowledge between an impaired group and a cognitively impaired group matched for mental and chronological age (Dahlgren Sandberg & Hjelmquist, 1997). The cognitively impaired group knew approximately 3 more letters than the speech impaired group. No significant differences were found between the two groups or the typically developing control group for spelling of orally presented words; however, the speech impaired group had lower scores than the other two. The speech impaired group also had lower scores than the typically developing group for spelling of nonsense words. In addition, the speech impaired group performed at a lower but not significantly different level than other two groups when words were presented via pictures. Such a finding was later reinforced by Dahlgren Sandberg et al. (2010), as spelling real words presented orally was the easiest spelling task for the 28 impaired subjects included in the study.

Factor analysis showed significant differences between groups for spelling (Smith et al., 2009). Sixteen speech impaired subjects achieved lower mean scores on measures

of letter identification and spelling, despite the fact that they were older, had more experience in literacy instruction, and were matched for receptive vocabulary age and non-verbal cognition to the control group. Furthermore, some of the greatest mean score differences obtained throughout the Smith et al. (2009) study were found on spelling tasks. In addition to letter identification, spelling tasks included the following activities: dictated spelling; visually presented words (subjects had to spell names of common nouns seen in pictures); and pseudo-word spelling (consonant pairs were changed in real words to create pseudo-words). All subjects met the criterion of identifying at least ten letters correctly; however, three in the impaired group were unable to identify all 26 letters of the alphabet and only seven correctly identified each phoneme–grapheme correspondence (scores ranged from 13 to 26 matches). One of the subjects who had correctly identified all the letters of the alphabet identified only 13 phoneme–grapheme correspondences. A majority of the impaired group achieved low scores on visual spelling. However, the mode of presentation for spelling tasks (either spoken word or picture) did not significantly affect scores in either group. The authors suggested that members of the impaired group were able to easily access and retrieve internal phonological representations in order to spell a word, despite the nature of the spelling task (Smith et al., 2009).

Overall, the target population had significantly lower performances for tests of letter knowledge and spelling. Such a trend was noted when comparing nonverbal children with cerebral palsy to both typically developing and cognitively impaired peers. However, better performances were seen when tasks involved spelling real words presented orally.

Decoding single words

Impairments for decoding single words were reported in four studies (Berninger and Gans, 1986b; Dahlgren-Sandberg & Hjelmquist, 1997; Dahlgren Sandberg et al., 2010; Smith et al., 2009). Not only did speech impaired subjects have below grade level performances, but they also had lower mean scores than both typically developing and cognitively disabled control groups. Two subjects completed a measure of decoding ability using the Vocabulary subtest of the *Gates-MacGinitie Reading Tests* (Berninger and Gans, 1986b; MacGinitie, 1978). Subjects had to match the correct word among four similar choices to a picture representing its meaning. Subject 2 (age 16) performed at a 4th grade level for decoding words, while Subject 3 (age 9) performed at a 1st grade level.

Dahlgren Sandberg and Hjelmquist (1997) found that the speech impaired group performed significantly worse than the cognitively impaired group on the OS400 test for word comprehension; subjects had to match a written word to a picture (Søegård and Bording Petersen, 1974). Dahlgren Sandberg et al. (2010) also tested word comprehension in the same manner, along with other single-word reading tasks such as lexical decision (deciding if a written word is a real word), pseudo-word reading (matching the correct written word to a spoken word), and proofreading. Overall, single word decoding and pseudo-word reading were the easiest decoding tasks for the speech impaired group.

Factor analysis also showed significant differences between groups for single word reading skills (Smith et al., 2009). Tasks included pseudo-word reading (the examiner reads a pseudo-word out loud, and the subject identifies the word from a written list of three pseudo-words) and word decoding (the subject decides which picture matches a written word; the words become more and more similar). The impaired group

had lower mean scores for decoding tasks than the typically developing group, again despite the fact that they were older, had more experience in literacy instruction, and were matched for receptive vocabulary age and non-verbal cognition to the control group. In general, the greatest mean score differences among groups were obtained on the reading tasks.

Comprehension of connected text

Five studies analyzed comprehension of connected text among target subjects (Berninger and Gans, 1986b; Dahlgren Sandberg & Hjelmquist, 1997; Dahlgren Sandberg et al., 2010; Dorman, 1987; Smith et al., 2009). The Reading Comprehension Subtest of the *Peabody Individualized Achievement Test* (PIAT) and the Comprehension Subtest of the *Gates-MacGinitie Reading Tests* were administered to two school-aged subjects with cerebral palsy and impaired speech (Berninger and Gans, 1986b; Dunn and Markwardt, 1970). Subjects read a sentence and chose a picture that matched the sentence subject; they also read a passage and then selected a picture that represented the passage or answered multiple choice questions about it. Subject 2 (age 16) performed at a 3rd grade level for sentence comprehension and at a 2nd grade level for paragraph comprehension. Subject 3 (age 9) performed at a 2nd grade level for sentence comprehension and at a 1st grade level for paragraph comprehension.

Reading achievement and reading comprehension were assessed among 31 adolescents with varying types of cerebral palsy (18 were spastic quadriparetic; 5 were spastic diplegic; 5 were athetoid with some spastic symptoms; 3 were hemiplegic) (Dorman, 1987). Assessment included the Reading Subtest from the WRAT and the Reading Comprehension subtest from the PIAT. Mean scores for all subjects were below the standard means for both reading recognition and reading comprehension.

Overall performances of speech impaired groups for reading connected text were lower than control groups (Dahlgren Sandberg & Hjelmquist, 1997; Dahlgren Sandberg et al, 2010; Smith et al., 2009). Once again, factor analysis showed significant differences between groups for reading abilities (Smith et al., 2009). Measures included sentence cloze (the subject chose the best word that completed a sentence); sentence reading (the subject chose which picture matched a written sentence among seven picture choices; sentences had increasing length and complexity); and the *Word Chains Test* (the subject indicated by pointing word boundaries of three words written out with no spaces in between) (Guron, 1999). Most of the speech impaired subjects achieved low scores on sentence cloze (Smith et al., 2009). Overall, there were substantial mean score differences recorded for reading tasks.

In this section, emergent literacy and reading comprehension skills in the target population were reviewed. The review included data on phonological awareness, letter knowledge and spelling, word decoding, and comprehension of connected text. Similar to measures of receptive vocabulary and grammar, assessments of phonological awareness yielded highly variable results. Performance levels generally differed according to the type of task in the assessment. Sound identification and word length analysis were more difficult tasks for impaired children. Phoneme blending and phoneme deletion were among the easier phonological tasks that produced typical results in the experimental groups. Phonemic discrimination tasks produced mixed results. A majority of participants had significantly lower mean scores for a variety of spelling, word decoding, and reading tasks. Lower performances were seen even when impaired participants were matched to typically developing children for vocabulary knowledge and mental age.

Taken together, variable performances were seen for receptive vocabulary, grammar, and the emergent literacy skill of phonological awareness. Furthermore, performances in these areas were influenced by type of cerebral palsy and language task. Only one study with two school-aged subjects assessed oral discourse comprehension (Berninger & Gans, 1986b). Both subjects met or exceeded age and grade level expectations for recalling information from a paragraph read out loud.

VARIABLES PREDICTING RECEPTIVE LANGUAGE PERFORMANCE

In addition to analyzing the eleven selected articles for data on language abilities in the target population, variables that could potentially predict language performance were also explored. While many correlations were calculated in the studies, several significant relationships emerged among participants and their physiological, developmental, and environmental characteristics. The following variables demonstrated predictive patterns across subjects: type of cerebral palsy, home literacy environment, and reading status.

Type of cerebral palsy and associated language impairments

Three studies directly examined diagnostic variables that may predict receptive language growth and performance (Bishop et al., 1990; Pueyo et al., 2003; Pueyo et al, 2009). No significant differences were found between anarthric and dysarthric subjects on measures of phonemic discrimination, receptive vocabulary, and receptive grammar (Bishop et al., 1990). However, significant differences in mean performances on language measures were found when comparing children with either dyskinetic, spastic, or mixed symptoms of cerebral palsy. Generally, those with dyskinetic and mixed types of cerebral palsy tended to obtain higher scores than those with spastic characteristics. Major differences were seen specifically on measures of auditory comprehension,

receptive grammar, and working verbal memory (Pueyo et al., 2003). Understanding the main symptoms the child presents with may help determine his or her skill levels for auditory comprehension, receptive grammar, working verbal memory, and even receptive vocabulary (Pueyo et al, 2009).

Home literacy environment

Peeters, Verhoeven, de Moor, van Balkom, & van Leeuwe (2009) conducted a longitudinal study that examined the relationships between literacy interests in parents and development of reading abilities in their children. A total of 35 children with spastic and ataxic cerebral palsy were included in the study. While 17 had no difficulty speaking, 12 had mild to moderate dysarthria, 2 had dyspraxia, and 4 were unable to speak. Literacy interest was labeled as Home Literacy Environment (HLE), and it was qualified by self administered parent questionnaires. Reading abilities were divided into two categories: Reading Precursors (Rhyme Recognition, Phonemic Awareness, Receptive Vocabulary, and Receptive Grammar) and Early Reading Tasks (Letter Knowledge and Word Recognition). Tests for the Reading Precursors were administered to the children at the end of kindergarten (Time 1) and one year later at the end of first grade (Time 2). The Early Reading Tasks were completed only at the end of first grade.

Three HLE variables had highly significant correlations with the Reading Precursors at Times 1 and 2, and the Early Reading Skills at Time 2: Parent Literacy Mediation (playing rhyme games, reading labels to children, involving children in own reading/writing tasks), Child Story Orientation Activities (asking questions about the story, retelling and relating the story to daily life experiences), and Child Word Orientation Activities (naming pictures, reading and pointing at letters and words). Parent Literacy Mediation was positively related to all four Reading Precursors and both of the Early Reading Tasks. In addition, Parent Literacy Mediation strongly predicted almost

all Reading Precursors at both Times 1 and 2, and was a good predictor of Phonemic Awareness at Grade 1 (Time 2). Specifically, parent involvement strongly predicted early reading success through the development of the Reading Precursors Rhyme Recognition and Phonemic Awareness. Rhyme and Phonemic Awareness further predicted Letter Knowledge and Word Recognition; Receptive Grammar also predicted Letter Knowledge ability at Grade 1 (Time 2).

The amount of child involvement in storybook reading and word orientation activities had a high, positive correlation with Rhyme Recognition, Phonemic Awareness, and the two Early Reading skills. In addition, Child Story Orientation activities predicted Rhyme Recognition skills at Time 1 and Receptive Grammar abilities at Time 2. Following trends in previous research on reading development, Phonemic Awareness was the best predictor of early reading skills among the four Reading Precursors (Dahlgren Sandberg & Hjelmquist, 1997; Peeters et al., 2009).

The level of engagement during storybook reading is crucial to literacy development (Peeters et al., 2009). Furthermore, children must understand the activity and have a way of interacting with adults during storybook reading. Overall, the quality of an impaired child's initial literacy experiences has a significant impact on early literacy development. While Reading Precursors such as Rhyme Recognition and Phonemic Awareness determine the level of influence of HLE, all HLE variables are defined by caregiver efforts to encourage language and reading development.

Readers versus nonreaders

Three studies analyzed potential linguistic and cognitive variables that may predict reading ability and comprehension (Dorman, 1987; Dahlgren Sandberg & Hjelmquist, 1997; Dahlgren Sandberg et al., 2010). Reading skills were found to be more highly related to verbal and auditory skills, compared to other cognitive measures.

Nonverbal auditory perception had the highest correlation with both word recognition and reading comprehension; there was a moderate correlation between verbal IQ and word recognition (Dorman, 1987). No significant relationship was found between visuo-spatial perception and reading measures, indicating that visual deficits may not always predict reading abilities (Dorman, 1985, as cited in Dorman, 1987, p. 676).

Twenty-seven children with cerebral palsy and either severe dysarthria or anarthria were divided into two groups: readers (ten children) and nonreaders (seventeen children) (Dahlgren Sandberg & Hjelmquist, 1997). Assignment to one of the groups depended on performances on reading tests that measured lexical decision making (identifying words from non-words), proofreading for spelling, decoding single words, and comprehension of connected text.

Researchers discovered several major trends. First, the reading group had a significantly higher mental age than the non-reading group. Second, there were no significant differences between the groups regarding degree of disability (either motor or speech). Third, researchers discovered that the readers had the following educational advantages: there was a significant difference in how instructors used speech synthesis (use of an SGD or artificial speech) in reading and spelling training; speech synthesis was used more often with readers; readers overall had more training in spelling and reading; and more of the readers were included in mainstream classrooms than nonreaders (Dahlgren Sandberg & Hjelmquist, 1997).

Similar procedures were carried out for the Dahlgren Sandberg et al. (2010) study; however, impaired subjects were divided into three groups: good readers (achieved a score above 25% on decoding tasks and above 33% on connected text tasks), decoders (scored more than 25% correct on decoding tasks but less than 33% on connected text tasks), and non-readers (scored less than 25% on tasks). The good readers were

significantly older than the decoders and non-readers. They also had more school experience than the two lower performing groups; they had four to eight years of educational training.

Significant differences were found between the groups for particular receptive language abilities. The good readers significantly outperformed the decoders and non-readers on rhyme awareness and spelling, but not on phonemic awareness. Tests of phonemic awareness included informal measures for phoneme identification, phoneme blending, phoneme segmentation, phoneme deletion, and word length analysis.

The decoders and nonreaders had similar performances for spelling. The differences in phonological awareness were no longer significant when age was controlled for, but differences remained the same for spelling among the three groups. The same pattern of results was obtained when the authors controlled for number of school years completed. The good readers appeared to have stronger connections between reading and spelling knowledge than the other two groups. Such a connection typically indicates proficiency in reading and writing (Dahlgren Sandberg et al., 2010). The significant differences in chronological age and education may have explained the differences between groups for phonological skills. However, the authors were not able to establish any clear relationships between speech impairment, type of schooling or reading proficiency. In addition, there was not a statistically significant relationship between the number of years of school completed and reading ability.

SUMMARY OF FINDINGS

Comprehension of spoken language included data for receptive vocabulary, receptive grammar and syntax, and discourse comprehension. Performances were highly variable for vocabulary and grammar. Participants tended to achieve higher ratings if their performances on formal and informal measures were compared to children matched

for mental age. Trends were noted when assessing the relationship between type of motor impairment and grammatical deficits. Specifically, children with spastic symptoms of cerebral palsy had significantly lower performances on grammatical measures than those with dyskinetic or mixed forms of the disorder.

Moreover, consistent error patterns for certain grammatical concepts were recorded among the target population. There were no significant differences between the target population and typically developing peers for the marking of subject-verb agreement, aspectual –ing, and past tense with irregular verbs. Subjects had more difficulty with regular verb inflections and regular past tense. Also, they were not as adept at detecting tense marking errors, such as overregularization, as compared to identification of non-tense marking errors. Only one study assessed oral discourse comprehension, and results were at or above appropriate age and grade levels for understanding information conveyed in a paragraph read out loud (Berninger & Gans, 1986b).

Emergent literacy skills and reading comprehension included data on phonological awareness, letter knowledge and spelling, word decoding, and comprehension of connected text. The target population had significantly lower performances than typically developing control groups on both formal and informal measures of reading comprehension. Performances were generally below age and grade level expectations across studies. In addition to comprehension of connected text, letter knowledge, spelling, and word decoding showed consistent developmental delays among nonverbal children with cerebral palsy.

Finally, the analysis of predictive variables included data demonstrating the predictive value of developmental and environmental factors for receptive language performance. Factors analyzed within the review included type of speech and motor

impairment, the extent to which a child's home environment supported literacy development, and the characteristics associated with children who read versus children who struggle to process written information. Children with spastic cerebral palsy appeared more likely to have significant language impairments. Conversely, children had better chances of developing foundational skills for reading if they were provided with a literacy-rich home environment. Such an environment depended upon caregiver emphasis on daily literacy activities and the degree to which children were involved in storybook reading. Lastly, average reading abilities were predicted by age, skills such as nonverbal auditory perception, phonological awareness, and spelling, as well as extent and quality of formal education.

DISCUSSION

CLINICAL IMPLICATIONS

Overview of receptive language performance

The findings of this review indicate that nonverbal school-age children with a diagnosis of severe cerebral palsy can develop appropriate skills for certain components of receptive language. However, language development in this specific population appears highly variable, despite the use of limiting inclusion criteria. In regards to receptive vocabulary, a majority of subjects performed below average on a standard measure. Scores were significantly lower when the impaired subjects were compared to typically developing children matched for chronological age. On the other hand, performances were quite similar when subjects were matched for mental age, or nonverbal intelligence. Also, a mastery level performance was obtained by one subject when a test of broader semantic meaning was administered, as compared to his poor performance on a standardized receptive naming task (Berninger and Gans, 1986b). In addition, two studies noted an apparent discrepancy between vocabulary knowledge and performances on other tests of language and cognition (Pueyo et al., 2009; Smith et al., 2009). Two conclusions may be drawn from these data. First, while below average vocabulary knowledge and naming ability is expected among the target population, these children may still have adequate lexical representations that allow them to recognize broader meanings in communication. Second, while cognitive delays in the child must be considered when trying to determine receptive vocabulary ability, knowledge in this particular area of comprehension may not be an accurate reflection of overall development. Clinicians must utilize a variety of assessments and not rely upon a single normative measure to determine actual ability.

Similar to receptive vocabulary, receptive grammar abilities appear to be somewhat variable among the target population. Children had low to significantly lower performances for their ages on standardized measures of grammar and syntax. However, informal measures produced more comparable results between the impaired groups and control groups with typical development and speaking abilities. Importantly, these informal grammatical measures provided data on specific areas of strengths and weaknesses in the target population. Impaired subjects demonstrated understanding and even mastery of subject-verb agreement, use of aspectual –ing, and past tense forms for irregular verbs. On the other hand, they showed limited ability to identify bare stem regular and irregular verbs, regular past tense verbs, and tense marking errors. During intervention, clinicians can focus upon these areas of weakness to help increase use and understanding of verb tense. In addition, while many clinicians would assume that regular verb inflections are easier for young students to comprehend, such a pattern of acquisition is not necessarily true for nonverbal students with cerebral palsy.

Unfortunately, only one study assessed oral discourse comprehension. Thus, it would be inappropriate to draw any general conclusions about this particular ability in the target population. However, the lack of research on this topic made evident by this review reveals an area in need of future investigation.

Performance levels for measures of phonological awareness generally differed according to the type of task in the assessment. Once again, sound identification and word length analysis were more difficult tasks for impaired children. Phoneme blending and phoneme deletion were among the easier phonological tasks that produced typical results in the experimental groups. Phonemic discrimination tasks had mixed results. When children had to determine if pairs of nonsense words were the same or different, they produced significantly lower scores than typical peers. However, when they had to

complete similar same-different tasks with individual phonemes, syllables, or with visual cues (such as a picture representing a word), they had much higher levels of accurate responses and smaller between group differences. When creating intervention goals and materials for treatment within this language domain, clinicians must remember that nonsense words are potentially too challenging for this population. However, focusing on individual sounds or simple blends of consonants and vowels would be an appropriate starting point for therapy. Also, visual cues that correspond to target sounds would provide the child with the extra support needed for success during such activities.

Overall, letter knowledge and spelling ability were less well developed compared to peers matched for either chronological or mental age. Significant differences were found for letter knowledge, even when the impaired groups were tested against the performances of cognitively impaired children. Moreover, a majority of the speaking impaired subjects struggled to identify all twenty six letters of the alphabet and phoneme-grapheme correspondences. Spelling words presented either orally or through a picture yielded low accuracy, but there were no significant differences according to results or test type. Interestingly, the children's similar performances for both types of spelling tasks indicate flexibility and expanding connections within their phonological representations (Smith et al., 2009).

Given the delayed development of letter knowledge within the target population, reading at the single word and sentence level was also impaired. The experimental groups were below grade level on various tests of word decoding and sentence comprehension. Furthermore, obtained scores were not only lower than those of age-matched peers, but also poorer than those of peers with intellectual deficits. In a clinical setting, it is crucial for speech-language pathologists to first establish strong, stable skills in phoneme and letter identification before any reading is attempted by the child.

Establishing sound and letter knowledge will prevent frustration, ease any future learning of an AAC device, and provide the child a basis for proper literacy development. No gains will be made in reading if the child continually struggles with phoneme and grapheme identification as he or she progress through the school-age years.

Overview of predictor variables

In addition to the preceding treatment suggestions, it is also important to consider variables which may predict a client's performance in therapy. First, the type of cerebral palsy present in a school-aged client with limited speech may provide clues about his or her level of language impairment. In the review, children with spastic symptoms tended to have the lowest performances compared to those with several other types of motor impairments associated with cerebral palsy. As stated in the introduction, the spastic form of this disorder is currently the most common. Thus, clinicians are highly likely to come across such clients. They should prepare to provide increased levels of support through carefully adapted goals and interaction styles.

If a clinician is working on reading with a nonverbal child with cerebral palsy, he or she should collect background and baseline information on several factors. The following factors had strong and positive predictive associations with reading ability in the target population: nonverbal auditory perception; mental age; more exposure to reading and spelling training; use of speech synthesis in reading and spelling training; inclusion in mainstream classrooms; chronological age; and higher levels of phonological awareness and spelling ability (Dorman, 1987; Dahlgren Sandberg & Hjelmquist 1997; Dahlgren Sandberg et al., 2010). Using information from case history forms and parent interviews, it is important for the clinician to first uncover the length and type of formal education and intervention previously provided for the child. If the child has received several years of training and has been exposed to either SGDs and/or mainstream

curriculum, he or she is more likely to demonstrate reading comprehension skills. Next, the clinician may want to refer the child for neuropsychological testing that can help determine mental age or nonverbal intelligence. A higher mental age (along with a higher chronological age) may also indicate success with learning to read. Finally, the clinician should arrange to test the child's auditory perception, phonological awareness, and spelling skills. Greater perceptual and phonological skills will likely predict greater success with literacy, including reading comprehension. Thus, it is crucial that the clinician initially gathers enough information to form a complete representation of the child. Based on the child's development within cognitive, linguistic, and educational domains, the clinician can determine appropriate goals for literacy treatment.

The final, but perhaps most important, predictor variable revolves around the quality of support children receive from their caregivers. Increased parent-directed child involvement in literacy activities positively predicted acquisition of reading precursors (such as phonemic awareness) as well as letter knowledge and word decoding during the early school-age years (Peeters et al., 2009). The results from this study are in line with previous research emphasizing the importance of caregivers on an impaired individual's quality of life (Lepage et al., 1998; Snell et al., 2008). Not only should parents read to their nonverbal children, but they should discuss what is read to the child and create a rich literacy environment where reading and writing are common activities. Berninger and Gans (1986b) further argue that nonverbal children still have the capacity to use language as a learning tool, even if they have severe expressive deficits. However, learning to use language in such a manner depends upon the child's level of language development. If parents can provide early literacy experiences for the impaired child, they have the opportunity to foster growth of essential receptive skills. It is the clinician's responsibility to educate families about establishing healthy home literacy

environments and using strategies for engaging a nonverbal child in language activities. Clinicians should directly involve caregivers in treatment and provide increased opportunities for language centered interactions during therapy and within the home.

Given the wide variety of ages (i.e. early school-age children versus adolescents), cognitive levels, types of cerebral palsy (i.e. spastic versus ataxic symptoms), educational experiences, and assessment protocols (i.e. the PPVT versus the Buschke test of semantic competence; cognitive measures versus linguistic measures) included in the selected articles, it was difficult to establish consistent patterns of receptive language development. Small sample sizes also limited the statistical power and generalization of results. Future studies on receptive language abilities in nonverbal school-age children would benefit from more rigorous and focused inclusion criteria, as well as larger experimental groups.

DIRECTIONS FOR FUTURE RESEARCH

The results of this review indicate unique and variable patterns of receptive language growth among nonverbal school-age children diagnosed with cerebral palsy. However, a majority of the included studies relied upon performance data from mixed age groups. In order to fully illustrate the possible developmental profiles within the target population, future studies need to apply more stringent inclusion criteria to research populations. Focusing solely on school-age children with the specified communicative and neurological impairments will strengthen research findings and further clarify appropriate expectations regarding receptive language proficiency.

Based upon the limited findings in this review, comprehension of spoken discourse among the target population is an area in need of future research. It is necessary to determine how well nonverbal children follow along in typical conversations and what types of support they might require to encourage understanding and more fluent

communicative exchanges. Additionally, one area of research noticeably missing from the literature search on children with cerebral palsy is comprehension of metalinguistic and figurative language. As children progress to the later school-age years, they are expected to not only understand such abstract concepts but also use them regularly in conversation (Owens, 2008b). It would be interesting to investigate how these advanced concepts develop in nonverbal children and adolescents.

Future research should also examine the influences of AAC use on receptive language and literacy development. While the use of AAC and synthetic speech in educational settings was briefly mentioned in the selected articles, their exact influences on receptive language were not discussed. Similarly, nonverbal intelligence and cognitive measures appeared throughout the articles, yet more in depth exploration of how these abilities interact with receptive language in nonverbal children is needed. As cognitive and linguistic skills are undoubtedly linked together, studies focusing on these factors could provide better models of language development, particularly for impaired individuals.

Yet another area in need of more research involves looking at the relationship between receptive language development, particularly phonological awareness, and lack of vocal rehearsal in nonverbal children. How would phonemic discriminations and phonological representations fully develop without the ability to verbally practice novel sounds and words? Finally, continued research on caregiver and child relationships in cases of cerebral palsy could help strengthen the clinician's argument for increased family involvement in daily communication with a nonverbal child.

CONCLUSION

The goals of this review were to (1) identify the type and complexity of receptive language components seen in nonverbal, school-age children with severe cerebral palsy

and (2) highlight common variables among the target population that may predict receptive language growth and performance. The results of this review partially met the primary goal and fully met the secondary goal. The data indicate that receptive language indeed develops in children with severe motor and speech impairments. However, limited verbal output appears to hinder use and mastery of language comprehension components, particularly receptive vocabulary, grammar, and early literacy skills expected at the school-age level of development. Furthermore, while factors such as type of motor impairment, education, and literacy experiences appear to strongly relate to receptive language in the target population, actual abilities vary greatly. In general, performances on both formal and informal measures of receptive language were below age and grade level expectations. However, children that fit into this population need thorough testing of individual comprehension abilities. As shown in the review, a portion of nonverbal school-age children with cerebral palsy have the potential to meet or even exceed normative standards and performances of typical peers. While some factors that prevent receptive language growth cannot be controlled for (e.g. type of cerebral palsy), there are other emerging predictor variables that must be acknowledged and pursued by caregivers and clinicians.

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