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Receptive Language and Cognitive Skills in Preschool-Aged Children with Cerebral Palsy

Susan Elizabeth Panton
Portland State University

THESIS APPROVAL

The abstract and thesis of Susan Elizabeth Panton for the Master of Science in Speech Communication: Speech and Hearing Sciences were presented on July 7, 1997, and accepted by the thesis committee and the department.

COMMITTEE APPROVALS:

[redacted]
Rhea Paul, Chair

[redacted]
Ellen Reuler

[redacted]
Dave Krug
Representative of the Office of
Graduate Studies

DEPARTMENT APPROVAL:

[redacted]
Stephen A. Kosokoff, Chair
Department of Speech Communication

****

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ABSTRACT

An abstract of the thesis of Susan Elizabeth Panton for the Master of Science in Speech Communication: Speech and Hearing Sciences presented July 7, 1997.

Title: Receptive Language and Cognitive Skills in Preschool-Aged Children with Cerebral Palsy

The purpose of this study was to examine the relationship between receptive language skills and nonverbal cognitive skills in preschool children with cerebral palsy and a mild to severe motor speech impairment. In addition, the relationship between the severity of motor impairment and receptive communication and nonverbal cognitive skills was also examined. Fifteen subjects, 10 males and 5 females, were included in this study. The subjects are part of a larger longitudinal study being completed within Portland State University's Speech and Hearing Sciences Program. All of the subjects participated in two in-home assessment sessions, which were approximately 2 hours long. Two research assistants completed the assessments along with a physical therapy student from Oregon Health Sciences University, who assisted in determining optimal positioning for each subject. The *Peabody Picture Vocabulary Test-Revised, Form L* was used to assess the receptive

vocabulary of the subjects and the *Miller and Paul Comprehension Assessment* was used to assess the subjects' comprehension of spoken language. The *Uzgiris and Hunt Scales of Infant Psychological Development* and the *Leiter International Performance Scales* were used to assess nonverbal cognition.

Results of the study indicate that there is a moderately low correlation between receptive vocabulary at the word level and specific nonverbal cognitive skills (i.e., vocal and gestural imitation). This correlation suggests that a lack of motor experience adversely affects receptive language and nonverbal cognitive development in children with motor speech impairments. Clinical implications include a focus on strengthening symbolic representation abilities by providing opportunities to map language onto motor experiences.

RECEPTIVE LANGUAGE AND COGNITIVE SKILLS IN PRESCHOOL-AGED CHILDREN WITH CEREBRAL PALSY

by

SUSAN ELIZABETH PANTON

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TABLE OF CONTENTS

APPENDIXES

LIST OF TABLES

PAGE

TABLE

CHAPTER I

INTRODUCTION AND STATEMENT OF PURPOSE

Introduction

A variety of theories exist in the literature regarding the relationship between language and cognition. Much of the current research follows the *local homologies* theory, which suggests that specific relationships exist between language and cognition at certain periods in time during normal development (Thal, 1991). Little research has been done to determine the relationship between language skills and nonlinguistic cognitive skills in individuals with cerebral palsy.

Current research (Letto, Bedrosian, & Skarakis-Doyle, 1994) reports improved communicative skills in children with cerebral palsy when scaffolded interactions were employed. Adults provide scaffolding as they adjust their speech in order to allow a child to participate communicatively at a level which the child could not participate at independently. This guided interaction in the child's Zone of Proximal Development (ZPD) assists the child in acquiring new communicative forms (Vygotsky, 1978). An understanding of a child's cognitive and comprehension abilities is critical in determining the ZPD.

Little research exists in the literature examining the relationship between receptive language skills and nonlinguistic cognitive skills in children with cerebral palsy. Assessing this relationship would provide additional information regarding the appropriate and optimal level of interaction for children with cerebral palsy. Given that specific relationships are understood to exist in normal development between nonlinguistic ability and receptive language skills, once abilities are assessed in either domain (e.g., cognitive or linguistic), the corresponding level in the other domain can be inferred. This would allow for scaffolding of linguistic input, which is particularly critical for children with cerebral palsy whose communicative interactions are restricted by motor and speech limitations.

Johnson-Martin, Wolters, and Stowers (1987) discuss the difficulties associated with assessing nonvocal, physically handicapped children. The authors indicate that direct assessment of a child with cerebral palsy is often complicated by motor and speech impairments. Most of the tests designed to assess cognitive ability require an ability to manipulate objects and to speak. As a result, assessments completed on children with severe motor limitations are more likely to reflect the child's physical disability rather than his cognitive ability. Children with severe physical impairments may be unable to use pointing or eye gaze to accurately select stimulus items if they are placed too closely together. For these reasons, tests are often modified to accommodate the child's optimal mode of response and/or range of motion. The authors suggest that examiners interpret results from modified

assessments with caution (e.g., as approximations of a child's ability), as these modifications may invalidate the results.

While research in the literature addresses the nonlinguistic cognitive abilities and the language abilities of children with cerebral palsy, little research exists regarding the relationship between the two. Research on normal language development suggests a relationship between object permanence, tool use, gestural imitation and the development of specific language skills. This research indicates that certain comprehension skills reflect certain cognitive abilities at specific points in development. Further research is needed to examine the relationship between nonlinguistic cognitive skills and receptive language skills in children with cerebral palsy.

Statement of Purpose

The purpose of this study was to determine the relationship between nonlinguistic cognitive skills and receptive communication skills in preschool children with cerebral palsy. In addition, the relationship between the severity of impairment and the receptive language and nonverbal cognitive level was examined.

The research questions addressed by the study were:

1. Is there a significant correlation between the *Uzgiris and Hunt Scales of Infant Psychological Development* (Dunst, 1980) scores and the *Peabody Picture Vocabulary Test-Revised (PPVT-R, Form L)* (Dunn & Dunn, 1981) scores of

preschool age children with cerebral palsy and a mild to severe motor speech impairment?

2. Is there a significant correlation between the *Uzgiris and Hunt Scales of Infant Psychological Development* scores and the *Miller and Paul Comprehension Assessment* (Miller & Paul, 1995) scores of preschool age children with cerebral palsy and a mild to severe motor speech impairment?

3. Is there a significant correlation between the *Leiter International Performance Scale* (Leiter, 1969) scores and the *PPVT-R, Form L* scores of preschool age children with cerebral palsy and a mild to severe motor speech impairment?

4. Is there a significant correlation between the *Leiter International Performance Scale* scores and the *Miller and Paul Comprehension Assessment* scores of preschool age children with cerebral palsy and a mild to severe motor speech impairment?

5. Are there significant differences between the mean scores for receptive vocabulary (e.g., *PPVT-R, Form L*) for the motor severity groups (see Tables 1 and 2) of preschool age children with cerebral palsy?

6. Are there significant differences between the mean scores for receptive comprehension of spoken language (e.g., *Miller and Paul Comprehension Assessment*) for the motor severity groups (see Tables 1 and 2) of preschool age children with cerebral palsy?

TABLE 1

SUMMARY OF RUSK'S CRITERIA FOR SEVERITY OF MOTOR IMPAIRMENT

Mild	A person with self-help skills adequate for carrying out daily personal needs, who ambulates without appliances and has no speech problems.
Moderate	Self-help skills are inadequate and the person may need special equipment for ambulation. Speech may be impaired.
Severe	The prognosis for developing self-help skills, ambulation, and functional speech is poor, even with therapy and adaptive equipment (McDonald, 1987, p. 7).

TABLE 2

SUMMARY OF ASSIGNMENT ACCORDING TO SEVERITY OF MOTOR IMPAIRMENT

Subject #	Age in Months	Gender	Severity
3	68	Male	Mild
9	68	Female	Mild
6	37	Male	Moderate
4	62	Male	Moderate
12	62	Male	Moderate
7	52	Male	Moderate
11	47	Female	Moderate
2	56	Female	Moderate
13	41	Female	Moderate
8	72	Male	Severe
1	44	Male	Severe
10	50	Male	Severe
14	71	Male	Severe
15	43	Male	Severe
5	37	Female	Severe

7. Are there significant differences between the mean scores of nonverbal cognition (e.g., *Leiter International Performance Scales* and *Uzgiris and Hunt Scales of Infant Psychological Development*) for the motor severity groups (see Tables 1 and 2) of preschool age children with cerebral palsy?

The null hypothesis for question one is that there will be no correlation between the *Uzgiris and Hunt Scales of Infant Psychological Development* scores and the *PPVT-R, Form L* scores for preschool age children with cerebral palsy and a mild to severe motor speech impairment.

The null hypothesis for question two is that there will be no correlation between the *Uzgiris and Hunt Scales of Infant Psychological Development* scores and the *Miller and Paul Comprehension Assessment* scores of preschool age children with cerebral palsy and a mild to severe motor speech impairment.

The null hypothesis for question three is that there will be no correlation between the *Leiter International Performance Scale* score and the *PPVT-R, Form L* scores of preschool age children with cerebral palsy and a mild to severe motor speech impairment.

The null hypothesis for questions four is that there will be no correlation between the *Leiter International Performance Scale* score and the *Miller and Paul Comprehension Assessment* scores of preschool age children with cerebral palsy and a mild to severe motor speech impairment.

The null hypothesis for question five is that there will be no significant difference between the mean scores for receptive vocabulary (e.g., *PPVT-R, Form L*) for the motor severity groups (see Tables 1 and 2) of preschool age children with cerebral palsy.

The null hypothesis for question six is that there will be no significant difference between the mean scores for receptive comprehension of spoken language (e.g., *Miller and Paul Comprehension Assessment*) for the motor severity groups (see Tables 1 and 2) of preschool age children with cerebral palsy.

The null hypothesis for question seven is that there will be no significant difference between the mean scores of nonverbal cognition (e.g., *Leiter International Performance Scales* and *Uzgiris and Hunt Scales of Infant Psychological Development*) for the motor severity groups (see Tables 1 and 2) of preschool age children with cerebral palsy.

Definition of Terms

The following are descriptions of specific terms used in this study:

Anoxia: lack of oxygen to the fetus (Shames, Wiig, & Secord, 1994).

Anticipatory imagery tasks: Tasks that require a subject to anticipate and imagine physical states of a substance as it changes from one position to another (e.g., water as it tilts in a glass) (Johnston & Ramstad, 1983, p. 52).

Cerebral palsy: A multiply handicapping condition caused by brain abnormality resulting from maldevelopment or damage occurring before, during, or shortly after birth and characterized by motor dysfunction and a variety of associated problems (McDonald, 1987, p. 3).

Causality: An individual's understanding of cause and effect (e.g., certain events cause other events) (Hulit & Howard, 1993, p. 92).

Cognition: A general concept of embracing all of the various modes of knowing: perceiving, remembering, imagining, conceiving, judging, and reasoning (Nicolosi, Harryman, & Kresheck, 1989).

Eye gaze: An individual gazes directly at an object, or symbol to communicate a choice selection or a message.

Gestural imitation: An individual's ability to produce a gesture which has been modeled.

Horizontal/vertical axis tasks: Tasks requiring a subject to draw a line on a picture to predict the orientation of water in a tipped jar (Johnston & Ramstad, 1983).

Hypothesis testing abilities: An individual's ability to formulate and test predictive outcomes.

Invisible gesture: A motor movement which an individual cannot see him/herself doing without a mirror (e.g., pulling ear lobe) (Dunst, 1980).

Linguistic: Of or relating to language (Woolf, 1976, p. 669).

Means-end: An individuals knowledge of different ways to achieve a goal (James, 1990).

Nonlinguistic cognitive skills: Skills which demonstrate an individual's symbolic representation abilities, but do not require oral language in order to demonstrate.

Nonvocal: Used to describe an individual with no intelligible speech (Johnson-Martin, Wolters, & Stowers, 1987, p.24).

Object permanence: Awareness that an object exists when it is not present in the immediate visual field.

Phoneme discrimination: An ability to differentiate one sound from another.

Phonology: Knowledge of how sounds can be sequenced into syllables and words (Hulit & Howard, 1993, p. 270).

Pragmatics: Knowledge of how to use language to communicate.

Probable event strategy: Using background knowledge to predict who is the agent of an action and who is the object of an action in order to decode the meaning of a sentence.

Receptive language skills: An individual's ability to understand what they hear or read (Boone, 1987, p. 32).

Scaffolding: Adjusting the complexity of language used during interactions with a child in order to allow the child to participate at a communicative level which s/he could not participate at independently.

Semantics: Word and sentence meaning (Hulit & Howard, 1993).

Sensorimotor: A stage of cognitive development in which a child interacts with his/her environment in a physical, reflexive or unlearned manner (Hulit & Howard, 1993, p. 88).

Syntax: Grammatical rules regarding word order.

Tool use: An ability to use tools to complete a task which could not be completed otherwise.

Toxemia: An abnormal condition associated with the presence of toxic substances in the blood (Woolf, 1976, p. 1236).

CHAPTER II

REVIEW OF THE LITERATURE

Characteristics of Cerebral Palsy

One of the earliest descriptions of the specific condition presently known as cerebral palsy was made by an English physician in 1843. Dr. W. J. Little used the term "spastic rigidity" to describe a condition in children who incurred brain damage before or during birth (McDonald, 1987; Shames, Wiig, & Secord, 1994). Sigmund Freud provided a broader definition of the term cerebral palsy in 1868 by characterizing cerebral palsy as a neuromotor disorder, which results from damage before or at birth (Shames, Wiig, & Secord, 1994). Current definitions of cerebral palsy vary, though the following three characteristics remain constant: (a) cerebral palsy is a nonprogressive disorder characterized by motor dysfunction; (b) it is secondary to damage to the central nervous system; and (c) it results from damage incurred before, during, or shortly after birth.

Motor Characteristics

Seven types of cerebral palsy are outlined by the American Academy of Cerebral Palsy (AACP): spastic, athetoid, rigid, ataxic, tremor, atonia, and mixed (McDonald, 1987). The most common form of cerebral palsy is spasticity, which is

characterized by an exaggerated stretch reflex (Boone, 1972; McDonald, 1987). Approximately 60% to 63% of individuals with cerebral palsy are diagnosed with spasticity (Healy, 1990; McDonald, 1987). Spasticity is marked by extremely strong contractions which persist beyond the normal stretch. The second most common type of cerebral palsy is athetosis. Approximately 12% of individuals with cerebral palsy are diagnosed with athetosis (McDonald, 1987). Athetosis is characterized by irregular, involuntary muscle movement which accompanies voluntary muscle movement. The third type of cerebral palsy is rigidity. Approximately 7% of individuals with cerebral palsy are diagnosed with rigidity (McDonald, 1987). This rigidity is the result of antagonist and agonist muscle groups contracting simultaneously. Ataxia is the fourth type of cerebral palsy and is characterized by difficulties with balance. Approximately 5% of individuals with cerebral palsy are diagnosed with ataxia (McDonald, 1987). Involuntary contraction of the flexor and extensor muscles characterizes the fifth group, tremor. Atonia refers to a lack of muscle tone and may coexist with other neuromuscular characteristics present in cerebral palsy; any combination of coexisting neuromuscular characteristics is referred to as mixed.

Typography

The typographical distribution of cerebral palsy is evidence by six categories: hemiplegia, paraplegia, quadriplegia, diplegia, monoplegia, and triplegia. Hemiplegia indicates that one side of the body is involved, while with paraplegia

only the legs are involved. Approximately 25% of individuals diagnosed with cerebral palsy are hemiplegic and 18% are paraplegic (Lewis, 1987). Quadriplegia refers the to involvement of all four limbs, while diplegia refers to the primary involvement of the legs. Approximately 33% of individuals with cerebral palsy are quadriplegic, while 20% are diplegic (Lewis, 1987). Monoplegia indicates that one limb is involved, and triplegia indicates that three limbs are involved (McDonald, 1987). Less than 2% are monoplegic or triplegic (Lewis, 1987).

Severity

Rusk (1977) provides a classification for severity which is based on an individual's ability to complete activities of daily living. His severity criteria are noted in Table 1.

Incidence and Etiology

Recent studies estimate the incidence of cerebral palsy to be approximately 2 per 1,000 births (Shapiro & Capute, 1994). The causes of cerebral palsy are divided into three groups, according to onset: prenatal, perinatal, and postnatal (i.e., before, during, and after birth). The prenatal causes of cerebral palsy include: maternal infection, anoxia, prematurity, and maternal toxemia. The perinatal causes include prolonged labor and anoxia. Anoxia, or asphyxia at time of birth, is the most common cause of cerebral palsy. Postnatal causes include traumatic head injury,

infections, toxins, cerebral vascular accidents, and cerebral anoxia (Keats, 1965, McDonald, 1987).

Effects on Communication

Speech

The effects of cerebral palsy on communication include developmental dysarthria, respiratory, laryngeal, and velopharyngeal dysfunction, and apraxia. Developmental dysarthria is the most common speech disorder associated with cerebral palsy and severely affects the intelligibility of speech. Dysarthria is a motor speech disorder resulting from peripheral or central nervous system damage (McDonald, 1987; Shames, Wiig, & Secord, 1994). Among the types of cerebral palsy, dysarthria is most common in individuals with athetosis (Feldman, 1994). The primary deficit associated with respiratory dysfunction in individuals with cerebral palsy is difficulty with prolonged, controlled exhalation (McDonald, 1987). Laryngeal dysfunction in individuals with cerebral palsy includes hyperadduction of the vocal folds and inappropriate abduction of the vocal folds during exhalation (McDonald, 1987; Shames, Wiig, & Secord, 1994). Velopharyngeal dysfunction in individuals with cerebral palsy leads to hypernasality and taxes the respiratory system (Shames, Wiig, & Secord, 1994). While not as prevalent as developmental dysarthria, apraxia of speech may be noted in individuals with cerebral palsy. Apraxia is a speech disorder which is characterized by difficulties in motor

programming of the speech mechanism. Apraxia affects volitional movement or positioning of the articulators (McDonald, 1987).

Cognition

Mental retardation and language or learning disabilities are often present in individuals with cerebral palsy (McDonald, 1987; Shames, Wiig, & Secord, 1994). Mental retardation exists in 50% to 60% of individuals with cerebral palsy, though determining the exact extent of impairment is complicated by the motor difficulties associated with cerebral palsy (Kurtz, 1992; Shames, Wiig, & Secord, 1994). Generally, the more limbs involved motorically, the greater the degree of mental retardation. Accordingly, the least amount of intellectual impairment is associated with hemiplegia, and the greatest degree of intellectual impairment is associated with spastic quadriplegia (Robinson, 1973). While cerebral palsy does not cause mental retardation and learning or language difficulties, it may result from the same damage which caused the cerebral palsy (McDonald, 1987).

Language

Depending of the type and severity of cerebral palsy, a children's limited motor experience may preclude him or her from uncovering concepts relating to language development (Carlson, 1987). The child may also have limited opportunity to discover the function of language. Motor related impairments such as facial expression, visual tracking ability and visual fixation abilities may also affect social

communication. These impairments may affect a child's perception that he or she can affect others and his or her environment through the use of language. Communicative attempts may be misinterpreted or ignored, and as a result, children with cerebral palsy are more likely to respond rather than initiate communication (Yoder & Kraat, 1983). Light, Collier, and Parnes (1985) assessed communicative functions used by nonspeaking physically disabled children and their care givers during freeplay interactions. They found that the caregivers produced three times as many communicative functions during a social interchange. They also found that the range of communicative functions used by the children were fairly limited. Confirmations or denials constituted an average of 39% of the children's conversational turns, while providing information requested by the caregiver constituted 18%. Ten percent of the children's turns consisted of requests for objects and actions.

Relationship Between Cognition and Language

The relationship between cognition and language has been extensively debated in the literature. A variety of theoretical constructs exist attempting to explain this relationship. Thal (1991) stresses the importance of these underlying theoretical assumptions in understanding the way children learn to use language. As language interventionists, we need to know if linguistic skills are mapped onto underlying cognitive skills, if cognitive skills are mapped onto existing linguistic

skills, or if these skills develop in tandem. Five major theories are discussed in the literature regarding this relationship: the cognition hypothesis, weak cognition hypothesis, local homologies hypothesis, interactional hypothesis, and the whorfian hypothesis.

The cognition hypothesis (or strong cognition hypothesis) states that cognition precedes and accounts for language function. With respect to language development, specific milestones in the domains of phonology, pragmatics, syntax, and semantics are thought to vary in the speed with which they are acquired, but not in the order with which they are attained. Certain cognitive prerequisites are necessary but not sufficient in acquiring specific language skills (Chapman & Miller, 1980). Piaget's notion that intelligence precedes language defines the underlying premise of the cognitive hypothesis (Wadsworth, 1979). According to this construct, cognitive development leads language development. Accordingly, a child's language skills would not be expected to be delayed or advanced in comparison to his/her mental age (Miller, 1981).

In direct opposition to the cognitive hypothesis is the whorfian hypothesis, which states that language leads cognition. Another variation is the weak cognition hypothesis, which states that cognition accounts for some, but not for all language function. According to this theory, cognition is necessary but not sufficient for language acquisition. The interactional hypothesis suggests that language and cognition are mutually influenced by each other's development.

The local homologies hypothesis suggests that language and cognition emerge simultaneously, and that language may lead cognition at certain points, while cognition may lead language during other periods (Miller, 1981). Currently, the local homologies theory is the most widely accepted theoretical construct explaining the relationship between cognition and language. According to this theory, certain relationships exist between language and cognition at specific points in development. These relationships are not static; they exist during a certain developmental windows (Thal, 1991).

The Relationship Between Reception Language and Cognition in Children with Specific Language Impairment

Miller, Chapman, Branston, & Reichle (1980) found that language comprehension correlates with sensorimotor performance, although sensorimotor measures do not predict language comprehension in normal language development. The researchers assessed the receptive language and cognitive skills of 48 children from the ages of 10 to 21 months. They examined the relationship between five sensorimotor subscales and comprehension of the following: one word representing people or objects present, one word representing actions, and one word representing people or objects absent. They also examined the same relationship for two words representing action-object or agent-action and three words for agent-action-object. The authors found a significant correlation between language comprehension and cognition when the sensorimotor tasks assessed required attainment of several skills

which are hypothesized as requirements for language comprehension. These skills include: representational thought, object permanence, background knowledge that people can act as agent of actions, and an ability to use new means to attain known ends.

Thal (1991) reports that receptive language correlates with single and multiple gesture production using conventional schemes (e.g., putting a doll to bed). Children evidence correct sequencing of events within a familiar script (e.g., putting a doll to bed) by 28 to 33 months of age. Additional parallels between symbolic play and language acquisition are noted by several authors, though these correlations specifically relate to expressive language production (Corrigan, 1982; Gopnik & Meltzoff, 1986; Kelly & Dale, 1989; McCune-Nicolich, 1981; Rescorla & Goosens, 1992).

The Relationship Between Receptive Language and Cognition in Children with Specific Language Impairment

Specific Language Impairment is defined as a language impairment which is not the result of sensory deficits, emotional or behavioral difficulties, or global cognitive impairment. Language acquisition in children with SLI follows a normal developmental sequence, though it is delayed and uneven across the domains of language.

Kamhi (1981) reports a significant difference in the haptic recognition skills (e.g., subject feels geometric forms and then picks the shape that matches) of

language-impaired children and normally developing children. Although the language-impaired subjects demonstrated normal nonverbal intelligence, they evidenced symbolic deficits with respect to the haptic recognition tasks. The author suggests that this task may be indicative of nonlinguistic symbolic deficits in language-impaired children and that these symbolic deficits in turn impact language acquisition.

Similarly, Johnston and Ramstad (1983) found that language-impaired children had difficulty with tasks requiring anticipatory imagery. They assessed 7 subjects on several Piagetian tasks and found that although their IQ scores were within the normal range, the subjects performed poorly on "haptic recognition tasks and horizontal and vertical axis tasks" (p.52). The authors suggest that language-impaired children may have cognitive deficits which result in pervasive symbolic dysfunction.

Kamhi, Catts, Koenig, and Lewis (1984) assessed the hypothesis testing abilities and nonlinguistic symbol abilities of ten language-impaired children and found a significantly poorer performance in a haptic recognition task and a discrimination learning task (e.g., subjects had to discriminate which container had a ball inside according to color combinations of circles on top of the containers). A strong correlation was noted between the Peabody Picture Vocabulary Test and the haptic recognition task. The authors suggest that an underlying deficit in symbolic

representational skills may be more closely correlated to receptive language skills than expressive language skills.

Conti-Ramsden, Donlan, and Grove (1992) examined 15 children with SLI and found that although they did evidence difficulty with symbolic representation (as measured by a counting efficiency task) in children with SLI, this difference was only found in the amount of time needed to complete the task. Children with SLI took a significantly longer amount of time to count dots than did the control group of children with normally developing language.

Tallal (1988) reiterates this caution in interpreting data regarding symbolic representation deficits in children with SLI. She suggests that a deficit in timing may be the underlying reason for difficulties with these tasks.

While research in the literature has not directly assessed the relationship between receptive language skills and cognitive skills in children with SLI, several researchers have assessed these skills independently. Viewed together these studies suggest that the receptive language skills of children with SLI follow the same developmental pattern as children with normally developing language although this development is delayed. A clear determination has not been made whether the deficits associated with SLI relate to an underlying problem in symbolic representation or delayed processing time.

The Relationship Between Cognition and Receptive Language in Children with Cerebral Palsy

Bishop, Brown and Robson (1990) compared phoneme discrimination, speech production, and receptive language skills in children with cerebral palsy and dysarthria and children with cerebral palsy (CP) without dysarthria. The subjects ranged in age from 10 to 18 years of age and had IQs in the low average to average range. The authors report poorer receptive vocabulary language skills in individuals with CP and dysarthria compared to individuals with CP without dysarthria. They found that understanding of grammatical structure was not impaired for either group. The authors conclude that speech impairment in individuals with cerebral palsy may retard vocabulary acquisition, though it does not prevent it.

In a 3-subject study (i.e., 3 males aged 40, 16, and 9 years), Berninger and Gans (1986) found that individuals with cerebral palsy and normal intelligence had better receptive oral language at the discourse level than at any other level (i.e., phonemic analysis, vocabulary knowledge, sentence interpretation). Evaluation of discourse comprehension was assessed by oral reading comprehension. The subjects listened to a paragraph read aloud and answered questions regarding the paragraph. The phonemic analysis was assessed using auditory discrimination tasks; vocabulary knowledge was assessed using the *Peabody Picture Vocabulary Test-Revised* (Dunn & Dunn, 1981); and sentence interpretation was assessed using a subtest of the *Clinical Evaluation of Language Functions* (Semel & Wiig, 1980). Each subject was also given the *Wechsler Adult Intelligence Scale-Revised (WAIS-R)* (Weschler, 1981)

to assess their verbal IQ. Two of the subjects scored in the low average range, and one scored in the average range. The authors argue that the results of their study indicate that the linguistic abilities of nonspeaking individuals with severe cerebral palsy may be relatively superior to their nonlinguistic cognitive skills.

Eagle (1985) assessed object permanence skills in 34 children with cerebral palsy with ages ranging from 9 months to 12 years. Thirty-five percent ($n = 12$) of the subjects did not demonstrate a level of object permanence equivalent to a normally developed 12 month old infant (even though all but 3 subjects were 2 years old or older), although 47% ($n = 16$) demonstrated high levels of object permanence. Only 15% of the variation in scores was related to the severity of impairment. Given that some subjects with motor impairment demonstrated the highest levels of object permanence, the author argues that early cognitive development occurs even when sensorimotor experiences are profoundly, motorically affected.

Cioni, Paolicelli, Sordi, and Vinter (1993) assessed sensorimotor development in 89 infants aged 6 to 24 months with cerebral palsy using the Uzgiris-Hunt Scales. The authors reported poorer performance in children with cerebral palsy with respect to object permanence, gestural imitation, and schemes for relating objects in comparison to a control group of normally developing children. The authors indicate that acquisition of sensorimotor skills follows a normal developmental pattern, though this development is delayed. They also suggest that

while sensorimotor experiences are beneficial to cognitive development, they are not essential requirements of early cognitive development.

Dammann et al. (1996) assessed the cognitive development of 298 children who were born with a very low birth weight. Of these subjects, 33 had cerebral palsy. Four additional groupings were made according to neurological diagnosis. These included: children with no symptoms, children with minimal symptoms, children with ADHD, and children who were clumsy (e.g., daily activities were affected by motor coordination). An assessment of intelligence, visuomotor skills, word completion, grammar, object detection, digit recall, and symbol recall was completed on each subject. Results indicated that the children with cerebral palsy, ADHD, and clumsiness demonstrated deficits with respect to intelligence, visuomotor skills, and visual memory. Among these three groups, the children with cerebral palsy had the lowest scores in each of these areas. The authors point out that the deficits noted with respect to symbol recall maybe more indicative of a deficit in the visuomotor domain than an ability to recall digits.

Summary

While little research exists in the literature regarding the relationship between cognition and receptive language skills in children with cerebral palsy, several researchers have examined the receptive language skills and cognitive skills of individuals with cerebral palsy independently. Lower receptive vocabulary skills

were reported for individuals with cerebral palsy and severe speech impairments, though comprehension of grammatical structures was relatively unimpaired. Studies examining the nonlinguistic cognitive skills of children with cerebral palsy suggest that nonverbal intelligence in these children is developmentally delayed. Research on normally developing children suggests that certain cognitive skills correlate to certain language skills at specific points in time. Receptive language skills correlate with use of single and multiple gestures during conventional schemes (e.g., putting a doll to bed). Children evidence correct sequencing of events within a familiar script (e.g., putting a doll to bed) by 28 to 33 months of age (Thal, 1991). An understanding of this relationship in children with cerebral palsy at the same developmental level has useful academic, functional, and clinical applications. Once skills in either domain have been determined, a parallel level of competence in the other domain can be assumed. This information would assist educators, parents, and language clinicians in determining the appropriate level of interaction necessary to facilitate optimal communicative performance in children with cerebral palsy.

CHAPTER III

METHODS AND PROCEDURES

Subjects

Fifteen subjects, 10 males and 5 females, were recruited from local hospitals and early intervention programs. The subjects are part of a larger study currently being conducted at Portland State University's Speech and Hearing Sciences Program (see Appendix A for Human Subjects Committee Approval and Appendix B for Consent Form). Subjects met the following criteria:

1. Between 3 and 6 years of age.
2. Diagnosis of cerebral palsy by medical professional.
3. Mild to severe motor speech impairment (i.e., precluding use of speech as a primary mode of communication).
4. Ability to use hand pointing or eye gaze as reliable mode of response.
5. English is the primary language spoken in the home.
6. Absence of uncorrected hearing or vision impairments.
7. Absence of autism, Down syndrome, or genetic/metabolic disorder which could interfere with cognitive development.
8. Presence of an adult in the home who could complete questionnaires.

The subjects were grouped according to severity of motor impairment (mild, moderate, and severe) using the criteria set forth in Rusk (1977) (see Table 1). Two of the subjects were mildly impaired (13.3%), 7 were moderately impaired (46.7%), and 6 were severely impaired (40%). A summary of the severity grouping for the subjects included in the study is shown in Table 2.

Instruments

The *Peabody Picture Vocabulary Test - Revised (PPVT-R)* (Dunn & Dunn, 1981) was designed to assess receptive vocabulary for Standard American English (Appendix C). The *PPVT-R* was standardized on 4,200 subjects from 2 to 18 years of age (Paul, 1995). The test provides a raw score, age equivalents, percentile rankings, standard scores, and stanines. A ceiling is reached when six errors are made out of eight consecutive responses. Within this study, the standard scores are reported. The concurrent validity of the *PPVT-R* was assessed against the *Stanford-Binet Vocabulary Subtest* (Thorndike, Terman, & Merrill., 1973) in 1981 on 1,849 subjects between 3 and 18 years of age. A positive correlation of .72 was noted between the two tests.

The *Uzgiris and Hunt Scales of Infant Psychological Development* (Dunst, 1980) was designed to be used in conjunction with the *Ordinal Scales of Psychological Development* (Uzgiris & Hunt, 1975) and is based on Piagetian concepts of cognitive development. Six scales are used to assess children from 2

weeks to 2 years of age (see Table 3). These scales measure a child's understanding of causality, spatial relations, symbolic representation, tool use, and vocal & gestural imitation (Appendix D). A ceiling is reached once a subject fails three successive items within a scale. The concurrent validity of the Uzgiris and Hunt (1975) Scales and the *Griffiths Mental Development Scales* (Griffiths, 1954) was assessed in a study of 36 handicapped subjects, with a mean age of 14.42 months. The scores correlated significantly within and across scales. The correlation between mental age (as determined by the Griffith Scales) and estimated mental age (as determined by the Uzgiris and Hunt scales) was positive and high at .83 (e.g., at the .01 significance level) (Dunst, 1980).

TABLE 3

SUMMARY OF UZGIRIS AND HUNT SCALES

Scale	Scale Steps (#)	Experimental Items (#)	Highest Critical Behavior
Object Permanence	14	7	Secures object under 3 screens — object left under first screen, subject searches in reverse order
Means-Ends	13	15	Uses stick to push out a toy inserted in an opaque tube
Vocal Imitation	9	6	Imitates four novel words
Gestural Imitation	9	6	Imitates three invisible gestures
Causality	7	4	Searches for causal mechanism needed to activate toy without demonstration
Objects in Space	11	10	Indicates absence of familiar persons
Schemes for Relating to Objects	10	6	Uses one object to stand for another

The *Leiter International Performance Scale* (Leiter, 1969) was designed to assess the nonlinguistic cognitive abilities of children from 2 to 13 years of age. The instrument consists of four subtests for each year of age (Appendix E). One inch wooden blocks with pictures adhered to them are matched with corresponding pictures on a blotter sheet (e.g., a strip of paper). The test begins at 2 years of age and continues to 13 years of age. A ceiling is reached once the child fails all items at two successive year levels. The *Leiter International Performance Scale* was validated against the *Stanford Binet Scale* (Terman & Merrill, 1937) on a sample of 280 white, middle class American children in 1948. A positive, high correlation was noted at .89 (Leiter, 1969).

The *Miller and Paul Comprehension Assessment* (Miller & Paul, 1995) is a norm referenced instrument which was designed to assess the comprehension of spoken language in children from 8 months to 12 years of age. This informal, nonstandardized test was specifically designed for assessment of children with physical impairments. The test consists of 29 stimulus plates with four line drawings per plate. It is used to assess comprehension of varying levels of syntactic complexity. Four trials are provided per syntactic level. Six syntactic levels of complexity are represented (Appendix F). The initial items assess simple subject-verb sentence comprehension (e.g., Mommy's kissing), progressing to verb-object (e.g., pushing the girl), subject-prepositional phrase (e.g., doll on blanket), subject-verb-object (e.g., Daddy's kissing Mommy), subject-verb-prepositional phrase (e.g.,

the boy climbs on Daddy), and finally to verb-object-prepositional phrase (e.g., touching the water in the cup). The foils included in each stimulus plate include a reversal of word order (e.g., "Mommy's hugging Daddy" for "Daddy's hugging Mommy"), a semantic substitution (e.g., "Daddy's touching Mommy" for "Daddy's hugging Mommy"), or an unrelated choice (e.g., "the girl is hugging the boy" for "Daddy's hugging Mommy"). The test is administered in its entirety once pretest items have been identified correctly.

Procedures

Each of the subjects participated in two assessment sessions in their home, which were approximately 2½ hours in length. The purpose and nature of the study was explained to the parents verbally and in writing. Written consent to participate in the study was obtained for each subject from the subject's parent/s before assessments were initiated (Appendix B). Two research assistants and a physical therapy student from Oregon Health Sciences University (OHSU) assessed the subjects. One research assistant and the physical therapy student attended the initial session. During the initial session, the physical therapy student determined the optimal positioning for each subject in order to minimize the effects of abnormal tone and reflex movement during the assessment procedures.

Four instant Polaroid photographs were taken of objects or people in the subject's home and were used to determine the latency, mode, and reliability of

response for each subject. The examiner instructed the subject to indicate which picture matched the stimulus word. The pictures were placed two by two in a row/column format. They were placed on a table, floor, or laptray, as appropriate for optimal positioning during the assessment. The photographs were rearranged before each succeeding trial was presented. Assessment of the *PPVT-R, Form L* was initiated after this initial assessment had been completed.

The *PPVT-R, Form L* was enlarged in order to provide a larger target for pointing and eye gaze selections (see Appendix G). Subjects were asked to indicate which picture matched the stimulus word given by the examiner. For subjects who were physically unable to point, eye gaze was used in lieu of pointing. Eye gaze was used after it had been determined that it could be reliably and consistently obtained using the Polaroid pictures. Twenty percent ($n = 3$) of the subjects used eye gaze as a mode of response. An additional modification was made for subjects who were unable to use eye gaze reliably with four quadrants. The number of items was reduced from four to two per page. This modification was made for 13% ($n = 2$) of the subjects included in the study. A basal was obtained after eight consecutive correct responses were obtained, and a ceiling was attained after six out of eight consecutive errors were noted. The *PPVT-R, Form L* was used during the initial session for all but one subject.

The *Uzgiris and Hunt Scales of Infant Psychological Development*, the *Leiter International Performance Scales,* and the *Miller and Paul Comprehension*

Assessment were completed during the second assessment session for 14 of the subjects. The *Uzgiris and Hunt Scales of Infant Psychological Development* was administered by giving the subject a toy or object to manipulate. Verbal prompts and demonstrations were given by the examiner in order to elicit specific tasks for each subscale step. A basal was attained once three consecutive correct responses were noted and a ceiling was obtained after three consecutive errors were noted. Modifications were made to the following materials which are noted in the Dunst manual (Dunst, 1980) (see Table 4).

TABLE 4

MODIFICATIONS TO UZGIRIS AND HUNT MATERIALS

Object	Description	Modification	Subscale
Blocks	1" wooden counting cubes	2" plastic blocks	Means-Ends; Gestural Imitation; Space; Schemes
T-stick	18 x 1/2" with a 6 x 1/2" doweling attached as a *T*.	18 by 1" with a 6" x 1" doweling attached as a *T*.	Means-Ends
Sticks	Two dowel sticks - 18" x 1/2" and 10" x 1/2"	Two dowel sticks 18" x 1" and 10 x 1"	Means-Ends
Clear Plastic Tube	5" long by 1" diameter	5" long by 2" diameter	Means-Ends
Opaque Tube	5" long by 1" diameter	5" long by 2" diameter	Means-Ends
Spoon	Adult size	Wooden cooking spoon	Space; Schemes
String Toys	Toys activated by pulling string	Replaced string with cloth rope	Causality
Cup	Small plastic cup 4" high with handle	Measuring cup 5"	Space; Schemes
Small container	4" high by 1" diameter	4" high by 3" diameter	Space; Schemes
Raisins	Small box of raisins	Small bag of Whoppers	Space; Schemes

During the administration of the *Leiter International Performance Scales* subjects were presented with a set of one inch wooden blocks and a corresponding blotter strip for each subtest. The frame used to hold the blocks was not used due to the motor limitations of the subjects in this study. A blotter was presented in front of the subject on the floor, a table, or a laptray, as appropriate for optimal positioning. This modification was used for all of the subjects participating in the study. An additional modification was made for subjects with severe motor limitations. In these instances, the subject was asked to indicate yes or no as to whether a block belonged with each design on the blotter strip. Eye gaze was used to indicate the yes/no response, after the reliability of eye gaze had been established. This modification was used for 13% (n =2) of the subjects. A ceiling was obtained after failure was noted for all tests at two consecutive year levels.

The *Miller and Paul Comprehension Assessment* was modified and administered according to the same procedures noted for the *PPVT-R, Form L* (Appendix H).

Data Analysis

This investigator assessed each subject with the *Uzgiris and Hunt Scales of Infant Psychological Development*, the *Leiter International Performance Scale* and the *Miller and Paul Comprehension Assessment* during the second assessment session. Nine subjects (60%) were assessed using the *Leiter International*

Performance Scales and 10 subjects (67%) were assessed using the *Miller and Paul Comprehension Assessment* during the second session. Administration of these tests was discontinued for subjects who were not able to complete the initial subtest tasks for these two instruments. The assessment and scoring for the *PPVT-R, Form L* was completed for all 15 subjects by another examiner during the initial assessment session. This order was reversed for one subject due to scheduling difficulties.

Standard scores from the *PPVT-R, Form L* , mental age scores from the Leiter International, stage scores for the subscales of the Uzgiris and Hunt Scales, and the percentage scores from the *Miller and Paul Comprehension Assessment* were used to determine if the correlations described in the purpose statement of this study exist (see Appendix I for Raw Data Table).

Reliability

Two of the subjects assessed were randomly selected and independently scored by a certified Speech-Language Pathologist with experience in administering each instrument used in the study. Inter-rater reliability was 100% for the Leiter International, 90% for the Uzgiris and Hunt Scales, and 100% for the *Miller and Paul Comprehension Assessment*.

The severity level assigned to each subject was completed by another examiner who was familiar with the subjects and with the Rusk (1977) guidelines. The severity level of each subject was categorized as mild, moderate, or severe. The

inter-rater reliability score for these assignments was in agreement for 13 (87%) of the subjects.

Statistical Analysis

The data for this study were collected and organized with descriptive statistics. The mean and standard deviation for the dependent variables used in the study (e.g., receptive language scores and nonverbal cognitive scores) were computed. A Spearman correlation coefficient was used to determine if a correlation exists between the cognitive and receptive language scores. This coefficient is a test statistic which determines if two variables are independent of each other. The Spearman correlation coefficient was designed to analyze data sets which are not normally distributed. An alpha level for the study was set at .05 to determine the if any correlations found were statistically significant.

Several one-way analyses of variance (ANOVA) (Mann, 1992) were performed to examine the differences between the mean scores of the severity groups (see Table 2) for the dependent variables (e.g., receptive language and nonverbal cognition). An ANOVA procedure is designed to determine if the mean of two or more populations are equal. A post-hoc test was performed for all differences found in order to determine where the differences exist.

CHAPTER IV

RESULTS AND DISCUSSION

Results

Results of this study were statistically analyzed using a Spearman correlation coefficient and several one-way analyses of variance (ANOVA). These results were analyzed to determine answers to the following research questions:

1. Is there a significant correlation between the *Uzgiris and Hunt Scales of Infant Psychological Development* (Dunst, 1980) scores and the *Peabody Picture Vocabulary Test-Revised (PPVT-R, Form L)* (Dunn & Dunn, 1981) scores of preschool age children with cerebral palsy and a mild to severe motor speech impairment?

2. Is there a significant correlation between the *Uzgiris and Hunt Scales of Infant Psychological Development* scores and the *Miller and Paul Comprehension Assessment* (Miller & Paul, 1995) scores of preschool age children with cerebral palsy and a mild to severe motor speech impairment?

3. Is there a significant correlation between the *Leiter International Performance Scale* (Leiter, 1969) scores and the *PPVT-R, Form L* scores of

preschool age children with cerebral palsy and a mild to severe motor speech impairment?

4. Is there a significant correlation between the *Leiter International Performance Scale* scores and the *Miller and Paul Comprehension Assessment* scores of preschool age children with cerebral palsy and a mild to severe motor speech impairment?

5. Are there significant differences between the mean scores for receptive vocabulary (e.g., *PPVT-R, Form L*) for the motor severity groups (see Tables 1 and 2) of preschool age children with cerebral palsy?

6. Are there significant differences between the mean scores for receptive comprehension of spoken language (e.g., *Miller and Paul Comprehension Assessment*) for the motor severity groups (see Tables 1 and 2) of preschool age children with cerebral palsy?

7. Are there significant differences between the mean scores of nonverbal cognition (e.g., *Leiter International Performance Scales* and *Uzgiris and Hunt Scales of Infant Psychological Development*) for the motor severity groups (see Tables 1 and 2) of preschool age children with cerebral palsy?

Descriptive Statistic Results

The mean and standard deviation of the scores for the *PPVT-R, Form L* the *Uzgiris and Hunt Scales of Infant Psychological Development*, the *Leiter International Performance Scale*, and the *Miller and Paul Comprehension*

Assessment were computed for the group as a whole and for each severity group. These results are listed in Table 5.

Table 5

Descriptive Statistics

Dependent Variables	All Subjects (N = 15)	Mild (n = 2)	Moderate (n = 7)	Severe (n = 6)
Age (months)				
Mean	54.00	68.00	51.00	52.83
(SD)	(12.46)	(0)	(9.83)	(15.04)
Peabody Picture Vocabulary Test -	69.93	83.00	74.43	60.33
Revised, Form L (Dunn, 1981) -	(21.03)	(1.41)	(24.30)	(17.95)
Standard Score	N = 15	n = 2	n = 7	n = 6
Miller and Paul Comprehension	53.40	83.50	46.70	44.50
Assessment (Miller & Paul, 1995) -	(24.80)	(23.33)	(17.09)	(27.83)
Percentage Correct Score	*n = 10*	n = 2	n = 5	n = 3
Uzgiris and Hunt Scales of Infant	5.87	6.00	6.00	5.67
Psychological Development (Dunst,	(.35)	(0)	(0)	(.52)
1980): Causality — Stage Score	N = 15	n = 2	n = 7	n = 6
Means/Ends — Stage Score	5.53	6.00	5.71	5.17
	(.83)	(0)	(.49)	(1.17)
	N = 15	n = 2	n = 7	n = 6
Object Permanence — Stage Score	5.87	6.00	6.00	5.67
	(.52)	(0)	(0)	(.82)
	N = 15	n = 2	n = 7	n = 6
Vocal Imitation — Stage Score	5.13	6.00	5.43	4.50
	(1.25)	(0)	(.98)	(1.52)
	N = 15	n = 2	n = 7	n = 6
Gestural Imitation — Stage Score	5.13	6.00	5.57	4.33
	(.92)	(0)	(.53)	(.82)
	N = 15	n = 2	n = 7	n = 6
Schemes for Relating to Objects — Stage	5.80	6.00	6.00	5.50
Score	(.56)	(0)	(0)	(.84)
	N = 15	n = 2	n = 7	n = 6
Objects in Space — Stage Score	5.73	6.00	6.00	5.33
	(.59)	(0)	(0)	(.82)
	N = 15	n = 2	n = 7	n = 6
Leiter International Performance Scale	32.67	43.50	34.20	18.00
(Leiter, 1969) — Mental Age (Months)	(10.55)	(6.36)	(6.57)	(0)
	n = 9	n = 2	n = 5	n = 2

Spearman Correlation Results

The strength of the relationship between the domains outlined in research questions one, two, three, and four (e.g., receptive language and cognition) was analyzed using a Spearman correlation coefficient. With respect to question one, the relationship between each Uzgiris and Hunt subscale stage scores was assessed against the *PPVT-R, Form L* standard scores. The correlation results are listed in Table 6.

TABLE 6

CORRELATIONS BETWEEN UZGIRIS AND HUNT SCALES, AND PPVT-R, FORM L

Uzgiris and Hunt Scales of Psychological Development (Dunst, 1980) — Stage Score	Peabody Picture Vocabulary Test-Revised, Form L (Dunn, 1981) — Standard Score	
	Correlation	*p*-value
Operational Causality	-.02	.94
Means/Ends	.33	.23
Objective Permanence	.00	1.00
Vocal Imitation	.65	.01*
Gestural Imitation	.69	.01*
Schemes for Relating to Objects	.24	.39
Objects in Space	.36	.19

*Significance level at $p < .05$.

As noted in Table 6, two of the subscales reflected a moderately low correlation with receptive vocabulary. Both vocal and gestural imitation correlated with the *PPVT-R, Form L* below the .05 significance level. Accordingly, the null hypothesis was rejected for vocal and gestural imitation and was not rejected for the remaining Uzgiris and Hunt subscales for research question one.

Statistical analysis for research question two required a comparison of each Uzgiris and Hunt subscale score with each subsection score and the total score for the *Miller and Paul Comprehension Assessment*. Results of these analyses are listed in Table 7. None of these analyses reflected a significant correlation. Accordingly, the null hypothesis was not rejected for research question two.

The standard scores of the *PPVT-R, Form L* and the mental age derived from the *Leiter International Performance Scale* were compared to answer research question three. Results of these analyses are listed in Table 8. No significant correlations were noted between these measures, therefore, the null hypothesis was not rejected for research question three.

TABLE 7

CORRELATIONS BETWEEN UZGIRIS AND HUNT SCALES, AND MILLER AND PAUL COMPREHENSION ASSESSMENT

Miller and Paul Comprehension Assessment	Subject-Verb	Verb-Object	Subject-Prep. Phrase	Subject-Verb-Object	Verb-Object-Prep. Phrase	Subject-Verb-Prep. Phrase	Total Percent Correct
Uzgiris and Hunt Scales Stage Scores							
Causality Correlation (p-value)	.04 (.90) $n = 10$	.32 (.41) $n = 9$	-.22 (.65) $n = 7$	.09 (.84) $n = 8$	.43 (.34) $n = 7$	-.54 (.21) $n = 7$	.26 (.47) $n = 10$
Means/Ends	.59 (.07) $n = 10$	-.05 (.88) $n = 9$	.08 (.86) $n = 7$	.13 (.76) $n = 8$	.66 (.11) $n = 7$	-.08 (.86) $n = 7$	.04 (.91) $n = 10$
Object Permanence	—	—	—	—	—	—	—
Vocal Imitation	-.18 (.61) $n = 10$	—	—	—	—	—	.52 (.12) $n = 10$
Gestural Imitation	.02 (.95) $n = 10$	.16 (.69) $n = 9$	.53 (.22) $n = 7$	.46 (.25) $n = 8$	.25 (.59) $n = 7$	-.08 (.86) $n = 7$	.50 (.14) $n = 10$
Schemes for Relating to Objects	—	—	—	—	—	—	—
Objects in Space	-.18 (.61) $n = 10$	-.18 (.61) $n = 10$	.32 (.48) $n = 7$	.51 (.19) $n = 8$	-.11 (.82) $n = 7$	.43 (.33) $n = 7$	-.06 (.87) $n = 10$

— Correlation coefficient could not be computed.

TABLE 8

CORRELATIONS BETWEEN PPVT-R, FORM L AND LEITER INTERNATIONAL PERFORMANCE SCALES

	Leiter International Performance Scales (Leiter, 1969) — Mental Age Score		
	Correlation	*p*-value	*N* of Subjects
Peabody Picture Vocabulary Test-Revised, Form L (Dunn & Dunn, 1980) — Standard Score	.30	.43	9

With respect to research question four, the *Leiter International Performance Scale* scores were compared to the subsection scores and to the total score of the *Miller and Paul Comprehension Assessment*. Results of these analyses are listed in Table 9. No significant correlations were found between these measures, therefore, the null hypothesis was not rejected for research question four.

TABLE 9

CORRELATIONS BETWEEN MILLER AND PAUL COMPREHENSION ASSESSMENT, AND LEITER INTERNATIONAL PERFORMANCE SCALES

Miller and Paul Comprehension Assessment Subscores (Miller & Paul, 1995) — Percent Correct Score	Leiter International Performance Scales (Leiter, 1969) — Mental Age Score		
	Correlation	*p*-value	*n* of Subjects
Subject-Verb	.06	.89	8
Verb-Object	.45	.26	8
Subject-Prepositional Phrase	.18	.73	6
Subject-Verb-Object	.07	.87	7
Subject-Verb-Prepositional Phrase	-.12	.82	6
Verb-Object-Prepositional Phrase	.15	.77	6
Total Percent Correct	.03	.94	8

One-Way Analysis of Variance Results

Several ANOVAs were completed to determine if a statistically significant difference existed between the mean scores for each severity group (see Tables 1 and 2) for receptive language and cognition. No statistically significant differences were noted between the mean scores for the three severity groups with respect to receptive vocabulary (e.g., *PPVT-R, Form L*) and receptive comprehension of spoken language (e.g., *Miller and Paul Comprehension Assessment*) (see Table 10). Accordingly, the null hypothesis was not rejected for research questions five and six.

TABLE 10

ANALYSIS OF VARIANCE BETWEEN MOTOR SEVERITY GROUPS FOR PPVT-R, FORM L, AND MILLER AND PAUL COMPREHENSION ASSESSMENT

Instrument	df	*f*	*p*-value
Peabody Picture Vocabulary Test-Revised, Form L (Dunn & Dunn, 1980) — Standard Score	14	1.21	.33
Miller and Paul Comprehension Assessment (Miller & Paul, 1995) — Total Percentage Correct	9	2.44	.16
Subject-Verb	9	.24	.80
Verb-Object	8	.03	.97
Subject-Prepositional Phrase	6	1.81	.28
Subject-Verb-Object	7	1.79	.26
Subject-Verb-Prepositional Phrase	6	1.07	.43
Verb-Object-Prepositional Phrase	6	1.10	.42

With respect to research question seven, a statistically significant difference was noted for two measures of nonverbal cognition. A difference was detected for the Leiter mental age scores and for the gestural imitation stage scores of the Uzgiris and Hunt Scales, although no statistically significant differences were noted for the other Uzgiris and Hunt subscales. Accordingly, the null hypothesis was rejected for gestural imitation and the Leiter scores, while it was not rejected for the remaining the Uzgiris and Hunt subscales. The results of these analyses are listed in Table 11.

TABLE 11

ANALYSIS OF VARIANCE BETWEEN MOTOR SEVERITY GROUPS FOR LEITER INTERNATIONAL PERFORMANCE SCALES, AND UZGIRIS AND HUNT SCALES

Instrument	df	*f*	*p*-value
Leiter International Performance Scale (Leiter, 1969) — Mental Age (Months)	8	9.52	.01*
Uzgiris and Hunt Scales of Psychological Development (Dunst, 1980) — Stage Score — Operational Causality	14	1.80	.21
Means/End	14	1.07	.37
Object Permanence	14	.72	.51
Vocal Imitation	14	1.58	.25
Gestural Imitation	14	7.95	.01*
Schemes for Relating to Objects	14	1.54	.25
Objects in Space	14	2.88	.10

*Significance level at $p < .05$.

A post-hoc Bonferroni test was used to determine where these differences existed. With respect to gestural imitation, the difference was detected between the mild and moderate groups in comparison to the severe group. With respect to the Leiter scores, the difference was detected between the mild and severe groups.

Discussion

The results of this study indicate that a moderately low positive correlation exists between the specific nonverbal cognitive skills of vocal and gestural imitation and receptive vocabulary at the word level. This correlation suggests that motor experience, or lack of motor experience, significantly affects receptive language skills in children with motor speech impairments. McNaughton (1993) suggests that a lack of motor experiences contributes to a weaker language base and to reduced symbolic representational abilities. She outlines a system of symbolic representation which is interdependent with external experiences and cognitive, sensory, and motor processes. This interdependence allows language to be mapped onto experiences and perceptions. A child with severe motor impairment is limited in his/her motor experiences and therefore receives limited feedback on these experiences. McNaughton points out that although a child with a severe motor impairment may be exposed to feedback given to a nondisabled child, the level of this feedback may not be at a level the child with severe motor impairments can understand. In addition, normally developing children receive feedback regarding the speech and language

they use during motor experiences. Due to their difficulties in speech production, children with motor speech impairment are further impacted by their lack of opportunities to map language onto experiences within their environment.

Significant differences were noted within this study with respect to severity of motor impairment for nonverbal cognitive skills. These differences were detected between the mild and moderate groups in comparison to the severe group for the gestural imitation scores of the Uzgiris and Hunt Subscales and between the mild and severe groups for the Leiter scores. Generally, these differences reflect higher mean scores for subjects with lower levels of motor impairment. Accordingly, these scores may reflect the difficulties children with severe motor impairment experience in manipulating objects or in executing purposeful movement rather than their true nonverbal cognitive ability.

The uneven distribution of subjects within each motor severity group (see Table 2) may have affected the strength of the statistical analysis relating to severity of motor impairment. The subjects included in the mild severity group were the oldest subjects included in the study (both were 68 months old). This uneven distribution would not have impacted the diagnostic results obtained from the *PPVT-R, Form L* which accounts for the age of a subject in assigning a standard score, although it may have impacted the stage score results obtained from the Uzgiris and Hunt scales and the percentage scores obtained from the *Miller and Paul Comprehension Assessment*. Given the uneven distribution noted with respect to the

mean age of the subjects included in each motor severity group and with respect to the number of subjects included within each motor severity group, the results of the analysis of variance among these severity groups should be interpreted with caution.

CHAPTER V

SUMMARY AND IMPLICATIONS

Summary

The purpose of this study was to examine the relationship between receptive language skills and nonverbal cognitive skills in preschool children with cerebral palsy and a mild to severe motor speech impairment. In addition, the relationship between the severity of motor impairment and receptive communication and nonverbal cognitive skills was also examined. Fifteen subjects, 10 males and 5 females, were included in this study. The subjects are part of a larger longitudinal study being completed within Portland State University's Speech and Hearing Sciences Program. All of the subjects participated in two in-home assessment sessions, which were approximately 2 hours long. Two research assistants completed the assessments along with a physical therapy student from OHSU, who assisted in determining optimal positioning for each subject. The *Peabody Picture Vocabulary Test-Revised, Form L* (Dunn & Dunn, 1981) and the *Uzgiris and Hunt Scales of Infant Psychological Development* (Dunst, 1980) were administered to each subject who participated in the study. The *Miller and Paul Comprehension Assessment*

(Miller & Paul, 1995) was administered to ten subjects and the *Leiter International Performance Scale* (Leiter, 1969) was administered to 9 subjects.

Results of the study indicate that there is a moderately low correlation between receptive vocabulary at the word level and specific nonverbal cognitive skills (i.e., vocal and gestural imitation). Significant differences were noted with respect to severity of motor impairment for nonverbal cognition. This relationship may reflect motor disability rather than cognitive ability.

Clinical Implications

A correlation between receptive vocabulary skills and specific nonverbal cognitive skills was found among one of the four comparisons made in this study. Both vocal and gestural imitation correlated with receptive vocabulary skills in preschool children with cerebral palsy and a mild to severe motor speech impairment.

This correlation has useful clinical implications. Understanding the developmental level in either the cognitive or receptive language domain will assist clinicians, educators, and caregivers in providing an appropriate level of interaction for a child with cerebral palsy. Letto, Bedrosian, and Skarakis-Doyle (1994) reported that scaffolded interactions result in improved communication skills in children with cerebral palsy. Accordingly, we can assist in providing a richer

language environment for a child with cerebral palsy once their receptive language or specific nonverbal cognitive skill level has been determined.

This correlation also suggests that a lack of motor experience adversely affects receptive language and nonverbal cognitive development in children with motor speech impairments. Accordingly, as language interventionists, we can focus on strengthening a child's symbolic representation abilities by providing opportunities to map language onto motor experiences. Games which accompany language with motor movement, such as patty-cake, can be adapted to suit a child's needs. Other activities might involve the use of a switch to substitute for direct manipulation of an object which a child is physically unable to manipulate independently. Modifications can also be made to toys and objects in the child's everyday environment in order to encourage and increase a child's repertoire of motor experiences. Once these modifications have been incorporated, caregivers, educators, and clinicians can use scaffolding techniques to map language onto motor experiences in an attempt to broaden a child's language and representational base.

Differences were noted between the severity groups for both measures of nonverbal cognitive development used within this study. The greatest differences noted were among the measures which were the most difficult to modify clinically and the most difficult to manipulate motorically (i.e., gestural imitation and the Leiter). Correlations were not found among the remaining Uzgiris and Hunt Scales, which were more readily modified to fit the subjects' motoric needs. Accordingly,

these results should be interpreted with caution. Before accepting a causal relationship between severity level and language and/or cognitive skills, additional research is needed with a larger sample size. Increasing the sample size would allow for equal distribution of subjects within each severity group. Only 2 subjects were included in the mild severity group, while 7 were included in the moderate group and 6 were included in the severe group.

The fact that significant differences were not noted among the remaining subscales of the Uzgiris and Hunt Scales suggests that these specific aspects of nonverbal cognition develop despite the presence of motor impairment. Future research with an increased sample size may validate and strengthen these findings.

Research Implications

Current research suggests that receptive vocabulary and cognitive development in children with cerebral palsy is developmentally delayed. Results of this study support the view that motor impairment may contribute to this delay. The correlation found between receptive vocabulary and nonverbal cognitive skills parallels current research regarding the relationship between cognition and language in normally developing children. According to the local homologies theory, certain cognitive skills correlate with certain language skills at specific points in time during normal development. Results of this study indicate that certain relationships exist between language and cognition in children with cerebral palsy as well. Future

research in this area may look at changes overtime in this relationship. Longitudinal research could provide additional information regarding changes in the receptive language and cognitive skills of individuals with cerebral palsy as they continue to develop physically and intellectually.

The effects of severity of motor impairment on this development also has useful clinical and educational applications. Analysis of the relationship between levels of severity can be strengthened by including a larger subject pool, which would allow for subjects to be equally distributed between severity groups. This would provide us with an ability to detect distinct differences between the motor severity groups and to account for the affects of the age on variances noted among the groups. Further research regarding the relationship between language and cognitive skills in individuals with cerebral palsy will continue to broaden our understanding of appropriate assessment and intervention approaches for individuals with cerebral palsy.

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APPENDIX A

HUMAN SUBJECTS COMMITTEE APPROVAL

OFFICE OF GRADUATE STUDIES AND RESEARCH
Research and Sponsored Projects

DATE: December 2, 1996

TO: Susan Panton SSN#: 541-86-6062

FROM: for Vikki Vandiver, Chair, HSRRC, 1996-97

RE: HSRRC Waived Review of Your Application titled, "First Language Acquisition in Children with Severe Speech Production Impairments Using Alternative Communication Systems."

Your proposal is exempt from further HSRRC review, and you may proceed with the study.

Even with the exemption above, it was necessary by University policy for you to notify this Committee of the Proposed research and we appreciate your timely attention to this matter. If you make changes in your research protocol, the Committee must be notified. This approval is valid for one year from date of issue.

c: Maureen Orr Eldred
Rhea Paul, Project Advisor

APPENDIX B

CONSENT FORM

PORTLAND STATE UNIVERSITY

CONSENT FORM: FOR PARTICIPATING IN A STUDY OF COGNITIVE AND LANGUAGE CHARACTERISTICS OF CHILDREN WITH SEVERE SPEECH IMPAIRMENTS

I _____ agree to allow my child _____ to take part in the research conducted by Dr. Rhea Paul on the development of language in children with severe speech production impairments. I understand that the study involves giving standard tests and clinical assessments, including parent interviews, designed to evaluate the hearing and understanding, vocal abilities, motor abilities, play, cognitive, social and adaptive skills of young children with severe speech impairments and compare them to those of normally developing peers. I also understand that the study may involve videotaping me and my child to look at how mothers interact with children with speech impairments and compare these interactions to those of mothers with normally speaking children. If my child is involved in an intervention program, the study may also involve videotaping my child with the clinician to look at the way that clinicians talk to children with severe speech impairments.

I understand that the study will take several hours of my and my child's time, some of which will take place in our home, and some may take place in my child's clinical setting or at PSU. Dr. Paul has told me that the purpose of the study is to learn more about how children who cannot talk learn to understand and communicate, and that this knowledge can help develop better ways to teach language skills to these children. I understand that my child may not receive any direct benefit from participating in the study, however.

Dr. Paul has agreed to answer any questions I have about the study and what I am expected to do. I understand that all information collected about my child in the study will remain confidential to the extent permitted by law, and that the names of all the people in the study will be kept confidential. I understand that I do not have to take part in this study, and my decision will not affect any services my child receives. If I choose to participate, I may withdraw at anytime.

I have read and understand the above information and agree to allow my child to take part in this study.

Date:_____ Signature: _____

Please keep one copy of this permission form yourself and return one to Susan. If you have concerns or questions about the study please contact Dr. Paul at 725-3142 or the Chair of the Human Subjects Research Review Committee, Office of Research and Sponsored Projects, 105 Neuberger Hall, Portland State University, 503/725-3417.

APPENDIX C

PEABODY PICTURE VOCABULARY TEST-REVISED, FORM L

Peabody Picture Vocabulary Test—Revised

INDIVIDUAL TEST RECORD

by LLOYD M. DUNN & LEOTA M. DUNN

FORM L

NAME _____ SEX: M ___ F
(last) (first) (middle name) (gender)

HOME ADDRESS _____ HOME PHONE _____

SCHOOL _____ GRADE PLACEMENT _____
(or agency) (or classroom)

TEACHER _____ EXAMINER _____
(or classroom)

LANGUAGE OF THE HOME: ☐ Standard English; ☐ Other _____
(specify: foreign language, or type of English dialect spoken)

Date & Age Data

	Year	Month	Day
Date of testing.....	_____	_____	_____
Date of birth.....	_____	_____	_____
Chronological age.....	_____	_____	_____*

*If the number of days exceeds 15, add a month to the age (see Part I of the Manual).

Notice to Users

The PPVT—R is not intended for use in situations where truth-in-testing legislation stipulates that copies of test items and correct responses be distributed to subjects, parents, or the general public. Such disclosures may make the norms meaningless in future testing.

Reason for Testing (may include referral source and person authorizing testing)

_____

_____

_____

_____

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Obtained Test Scores

Raw score . . . . . (from page 4)

Standard score equivalent . . . (from Table 1, Appendix A)

Percentile rank . . . (from Table 3, Appendix A)

Stanine (from Table 3, Appendix A)

Age equivalent . . . . (from Table 4, Appendix A)

TRUE SCORE CONFIDENCE BAND

Mark the obtained standard score equivalent on the top scale. Then draw a heavy, straight, vertical line through it, and across the three scales. This line will extend through the three obtained deviation-type test scores. Depending upon the obtained standard score, shade in a band on both sides of the vertical line, using the schedule to the right. An example is given in Figure 1.4 of the Manual.

Obtained Standard Score	AREA TO SHADE: 1 Left of Line	AREA TO SHADE: Right of Line	Obtained Standard Score	AREA TO SHADE: 1 Left of Line	AREA TO SHADE: Right of Line
Below 55	0	14	100-109	7	7
55-74	2	12	110-114	8	6
75-84	4	10	115-124	10	4
85-99	6	8	125-134	12	2
90-99	7	7	135 & above	14	0

This shaded area provides a confidence band; the range of scores within which the subject's true scores can be expected to fall 68 times in 100. (These band width values are based on a median standard error of measurement (SEM) of ± 7, with the band widths made increasingly asymmetrical toward the extremes to allow for regression to the mean.) See Part I of the Manual and the Technical Supplement for more precise values and a discussion of SEM confidence bands. Also see the Manual for a discussion of how to calculate the true score confidence band for the age equivalent.

EXTREMELY LOW SCORE | MODERATELY LOW SCORE | LOW AVERAGE | HIGH AVERAGE SCORE | MODERATELY HIGH SCORE | EXTREMELY HIGH SCORE

Data from Other Tests

Test		Date	Results
PPVT-R	FORM M		

Performance Evaluation

This standardized test provides an estimate only of this individual's hearing vocabulary in Standard English, as compared with a cross-section of U.S.A. persons of the same age. Do you believe the performance of this subject represents fairly her or his true ability in this area? _____ Yes _____ No If not, cite reasons such as rapport problems, poor testing situation, hearing or vision loss, visual-perceptual disorder, test too easy or too hard (automatic basal or ceiling used), etc.

Observations

Briefly describe the subject's test behavior, such as interest in task, quickness of response, signs of perseveration, work habits, etc.:

Recommendations

Examiner's signature

FORM L — TEST ITEMS AND ABBREVIATED INSTRUCTIONS

Administering the TRAINING ITEMS

For most subjects under age 8: Use Plates A, B, and C. Administer as many training item series as necessary to secure three consecutive correct responses. For most subjects age 8 and over: Use Plates D and E. Administer as many training item series as necessary to secure two consecutive correct responses.

Starting Plate	INITIAL PRACTICE SERIES WORDS & KEYS	ADDITIONAL PRACTICE WORDS & KEYS: Alternate Series X	Alternate Series Y	Alternate Series Z
A	doll (4)	fork (1)	table (2)	car (3)
B	man (2)	comb (3)	sock (4)	mouth (1)
C	swinging (3)	drinking (4)	walking (1)	climbing (2)
D	wheel (4)	zipper (2)	rope (1)	rake (3)
E	giant (1)	bride (3)	witch (4)	royal (2)

(Complete directions are given in Part I of the Manual.)

Administering the TEST ITEMS

Basal: Highest 8 consecutive correct responses
Ceiling: Lowest 8 consecutive responses containing 8 errors
Starting Point: For a subject assumed to be of average ability, find the person's age circled in the margin, and begin the test with that item. Otherwise consult Part I of the Manual for further instructions.
Recording Responses and Errors: Record the subject's response (1, 2, 3, or 4) for each item administered. For each error, draw an oblique line either through the plate number of the item missed, or through the geometric figure, as illustrated below:

32 envelope .... (2) 4 Ω or 32 envelope .... (2) 4 ♡

Every eighth figure is identical to help determine the basal and ceiling.

NOTE:
Ages in circles refer to the lowest age in a 6- or 12-month interval. For example, item 1 is the starting item for ages 2-6 through 3-5, and item 30 for ages 5-0 through 5-5. Use item 110 for ages 18-0 and over.

Plate Number		Word	Key	Response	Error
2½	2	1 bus ..... (4)			○
		2 hand ..... (1)			□
		3 bed ..... (3)			△
		4 tractor ..... (2)			Ω
		5 closet ..... (1)			♡
		6 snake ..... (4)			☆
		7 boat ..... (2)			◇
		8 tire ..... (3)			○
		9 cow ..... (1)			□
3½		10 lamp ..... (4)			△
		11 drum ..... (3)			Ω
		12 knee ..... (4)			♡
		13 helicopter ..... (2)			☆
		14 elbow ..... (4)			◇
4		15 bandage ..... (4)			○
		16 feather ..... (1)			□
		17 empty ..... (3)			△
		18 fence ..... (4)			Ω
		19 accident ..... (2)			♡
4½		20 net ..... (2)			☆
		21 tearing ..... (4)			◇
		22 sail ..... (1)			○
		23 measuring ..... (2)			□
		24 peeling ..... (3)			△
		25 cage ..... (1)			Ω
		26 tool ..... (4)			♡
		27 square ..... (4)			☆
		28 stretching ..... (1)			◇
		29 arrow ..... (2)			○
5		30 tying ..... (2)			□
		31 nest ..... (1)			△
		32 envelope ..... (2)			Ω
		33 hook ..... (3)			♡
		34 pasting ..... (4)			☆
5½		35 patting ..... (1)			◇
		36 penguin ..... (1)			○
		37 sewing ..... (2)			□
		38 delivering ..... (1)			△
		39 diving ..... (2)			Ω
6		40 parachute ..... (3)			♡
		41 furry ..... (4)			☆
		42 vegetable ..... (4)			◇
		43 shoulder ..... (3)			○
		44 dripping ..... (2)			□
		45 claw ..... (4)			△
		46 decorated ..... (3)			Ω
		47 frame ..... (1)			♡
		48 forest ..... (3)			☆
		49 faucet ..... (2)			◇
6½		50 group ..... (3)			○
		51 stem ..... (3)			□
		52 vase ..... (3)			△
		53 pedal ..... (1)			Ω
		54 capsule ..... (2)			♡
7		55 surprised ..... (4)			☆
		56 bark ..... (2)			◇
		57 mechanic ..... (2)			○
		58 tambourine .... (1)			□
		59 disappointment . (4)			△
		60 awarding ..... (3)			Ω
		61 pitcher ..... (3)			♡
		62 reel ..... (1)			☆
		63 signal ..... (1)			◇
		64 trunk ..... (2)			○
8		65 human ..... (2)			□
		66 nostril ..... (1)			△
		67 disagreement .. (1)			Ω
		68 exhausted ..... (2)			♡
		69 vine ..... (4)			☆
8½		70 ceremony ..... (4)			◇
		71 casserole ..... (2)			○
		72 vehicle ..... (4)			□
		73 globe ..... (3)			△
		74 filing ..... (3)			Ω
		75 clamp ..... (2)			♡
		76 reptile ..... (2)			☆
		77 island ..... (1)			◇

Plate Number	Word	Key	Response	Error
	78 spatula	(3)	____	○
	79 cooperation....	(4)	____	□
(3)	80 scalp.....	(4)	____	△
	81 twig.....	(2)	____	∩
	82 weasel	(2)	____	♡
	83 demolishing ...	(4)	____	☆
	84 balcony.....	(1)	____	◇
(1)	85 locket	(1)	____	○
	86 amazed.....	(3)	____	□
	87 tubular.....	(1)	____	△
	88 tusk.....	(1)	____	∩
	89 bolt	(3)	____	♡
(3)	90 communication .	(4)	____	☆
	91 carpenter	(2)	____	◇
	92 isolation	(1)	____	○
	93 inflated	(3)	____	□
	94 coast.....	(3)	____	△
(3)	95 adjustable.....	(2)	____	∩
	96 fragile	(3)	____	♡
	97 assaulting.....	(1)	____	☆
	98 appliance	(1)	____	◇
	99 pyramid.....	(4)	____	○
(3)	100 blazing	(1)	____	□
	101 hoisting.....	(1)	____	△
	102 arch.....	(4)	____	∩
	103 lecturing	(4)	____	♡
	104 dilapidated	(4)	____	☆
(1)	105 contemplating..	(2)	____	◇
	106 canister.....	(1)	____	○
	107 dissecting	(3)	____	□
	108 link	(4)	____	△
	109 solemn	(3)	____	∩
(1)	110 archery	(2)	____	♡
	111 transparent....	(3)	____	☆

Plate Number	Word	Key	Response	Error
	112 husk	(1)	____	◇
	113 utensil.....	(2)	____	○
	114 citrus.....	(3)	____	□
	115 pedestrian.....	(2)	____	△
	116 parallelogram ..	(1)	____	∩
	117 slumbering	(3)	____	♡
	118 peninsula	(4)	____	☆
	119 upholstery.....	(2)	____	◇
	120 barricade.....	(4)	____	○
	121 quartet	(4)	____	□
	122 tranquil	(3)	____	△
	123 abrasive	(1)	____	∩
	124 fatigued.....	(3)	____	♡
	125 spherical.....	(2)	____	☆
	126 syringe	(2)	____	◇
	127 feline.....	(2)	____	○
	128 arid	(4)	____	□
	129 exterior	(1)	____	△
	130 constellation ...	(4)	____	∩
	131 cornea.....	(2)	____	♡
	132 mercantile.....	(1)	____	☆
	133 ascending.....	(3)	____	◇
	134 filtration.....	(1)	____	○
	135 consuming	(4)	____	□
	136 cascade	(4)	____	△
	137 perpendicular ..	(3)	____	∩
	138 replenishing ...	(1)	____	♡
	139 emission.....	(3)	____	☆
	140 talon	(3)	____	◇
	141 wrath.....	(3)	____	○
	142 incandescent ..	(4)	____	□
	143 arrogant	(2)	____	△
	144 confiding.....	(3)	____	∩
	145 rhombus	(3)	____	♡

Plate Number	Word	Key	Response	Error
	146 nautical.....	(3)	____	☆
	147 tangent	(1)	____	◇
	148 inclement	(4)	____	○
	149 trajectory.....	(1)	____	□
	150 fettered	(1)	____	△
	151 waif.....	(3)	____	∩
	152 jubilant	(2)	____	♡
	153 pilfering.....	(4)	____	☆
	154 repose.....	(2)	____	◇
	155 carrion.....	(3)	____	○
	156 indigent.....	(2)	____	□
	157 convex	(1)	____	△
	158 emaciated.....	(2)	____	∩
	159 divergence	(4)	____	♡
	160 dromedary	(2)	____	☆
	161 embellishing ...	(2)	____	◇
	162 entomologist...	(3)	____	○
	163 constrain.....	(1)	____	□
	164 infirm.....	(1)	____	△
	165 anthropoid.....	(3)	____	∩
	166 specter	(4)	____	♡
	167 incertitude.....	(2)	____	☆
	168 vitreous.....	(1)	____	◇
	169 obelisk	(1)	____	○
	170 embossed.....	(4)	____	□
	171 ambulation	(2)	____	△
	172 calyx.....	(2)	____	∩
	173 osculation.....	(3)	____	♡
	174 cupola.....	(4)	____	☆
	175 homunculus ...	(4)	____	◇

Calculating Raw Score

Ceiling Item ..... ____

minus errors* ..... ____

Raw score ..... ⌒

*Count errors between highest basal and lowest ceiling only

APPENDIX D

UZGIRIS AND HUNT SCALES OF INFANT PSYCHOLOGICAL DEVELOPMENT

IV: DEVELOPMENT OF OPERATIONAL CAUSALITY Child's Name _____ Date of Birth _____ Date of Test _____

SCALE STEP	AGE PLACEMENT (Months)	DEVELOP-MENTAL STAGE	ELICITING CONTEXT	CRITICAL ACTION CODE	CRITICAL BEHAVIORS	SCORING 1	2	3	4	5	OBSERVATIONS
E_{IV}	.2	I	Social Responsiveness	—	Vocalizes and/or smiles in response to adult talking						
1	2	II	Hand Watching	1b	Engages in hand watching						
2	3	III	Secondary Circular Reaction	2c	Repeats arm movements to keep a toy activated						
3a	5	III	Response to Interesting Spectacle	3c	Uses procedure as causal action in response to adult producing a repetitious action with toy (jumping jack, pinwheel, any string activated toy)						Action Presented _____ Procedure Used _____
3b	5	III	Familiar Game	4c	Uses procedure as causal action in familiar game situations (pulls to sit, pat a cake, tickling tummy)						Game _____ Procedure Used _____ Other Causal Action _____
3c	5	III	Spectacle Created by Agent	5c	Uses procedure as causal action in response to behavior created by an agent (no toy) (snapping fingers, mouth sound, "beeping" the nose)						Action Presented _____ Procedure Used _____ Other Causal Action _____
3d	5	III	Spectacle Created Using Toy	6b	Uses procedure as causal action in response to behavior created by an agent using a toy (Slinky, Farmer Says whistling sound using a pop bead)						Action Presented _____ Procedure Used _____ Other Causal Action _____
4a	10	IV	Spectacle Created by Agent	5d	Touches adult's hands as causal action - behavior created by agent - no toy						
4b	10	IV	Spectacle Created Using Toy	6c	Touches adult's hands or object as causal action - behavior by agent - using a toy						
4c	10	IV	Spectacle Created by Toy	7c	Touches adult's hands or object as causal action in response to adult activating a mechanical toy						
E_{IV}	12	V	Engages Adult		Pushes or pulls an adult's hands to have a behavior instigated or repeated						
E_{IV}	12	V	Repeats Behavior		Repeats behavior (shows off) to maintain adult attention						Behaviors Used:
5	14	V	Engages Adult	6d 7d	Gives object to adult as causal action to have it activated						
E_{IV}	15	V	Gestural Vocal Causal Behavior		Uses gestural plus visual/vocal behaviors to have an adult repeat or instigate a desired action						Gestures Used _____ Vocalization _____
6	18	V	Spectacle Created by Toy	7e	Attempts to activate mechanical toy following demonstration						
7	21	VI	Spectacle Created by Toy	7f	Searches for causal mechanism to activate wind up toy (no demonstration)						

d1 DEVELOPMENT OF MEANS FOR OBTAINING DESIRED ENVIRONMENTAL EVENTS Child's Name _____ Date of Birth _____ Date of Test _____

SCALE STEP	AGE PLACEMENT (Months)	DEVELOPMENTAL STAGE	ELICITING CONTEXT	CRITICAL ACTION CODE	CRITICAL BEHAVIORS	SCORING 1	2	3	4	5	OBSERVATIONS
E_0	2	I	Visual Awareness	--	Activity level increases or decreases on seeing a visually presented object						
1	2	II	Hand Watching	1b	Child engages in hand watching						
2	3	III	Secondary Circular Reaction	3c	Repeats arm movements to keep a toy activated						
3	4	III	Visually Directed Reaching	2b	Visually directed reaching - hand and object both in view						
4	5	III	Visual Directed Reaching	2c	Visually directed reaching - brings closed hand up to object						
E_0	5	III	Visually Directed Reaching	2d	Visually directed reaching--shapes hand in anticipation of securing object						
5	7	IV	Multiple Objects	4c	Drops one or both objects held in hands to obtain a third object						
E_{10}	8	IV	Barrier		Pushes obstruction (e.g., pillow or Plexiglas) out of the way to obtain an object						
6	8	IV	Support	6d 6e	Pulls support to obtain an object placed on it						
7	9	IV	Locomotion	5c	Uses some form of locomotion as a means to obtain an out of reach object						
8	10	V	Support	7c	Does not pull support with object held above it						
E_{11}	10	V	Support		Does not pull either of two supports with object placed between them						
9	11	V	String (horizontal)	8- 8d	Pulls string along a horizontal surface to obtain an object attached to it						
E_{12}	12	V	String (horizontal)		Pulls the correct one of two strings to obtain an object attached to one string						
10	13	V	String (vertical)	9c 9d	Uses string vertically - pulls object up from floor						
E_{13}	18	V	T Stick		Uses T stick as a tool to obtain an out of reach object						
11	19	V	Stick	10d 10e	Uses a stick as a tool to obtain an out of reach object						
E_{14}	19	V	Matchbox		Opens and removes the contents of a small matchbox						
E_{15}	19	V	Necklace (container)	11d	Invents method to place the necklace into the container						
E_{16}	19	V	Solid Ring	12c	Solid ring - attempts to stack - avoids subsequently						
12	20	VI	Necklace (container)	11c	Shows foresight in placing the necklace into the container						
E_{17}	20	VI	Matchbox		Shows foresight in placing a chain into a matchbox						
13	24	VI	Solid Ring	12d	Shows foresight by not stacking the solid ring						
E_{18}	24	VI	Tube (clear)		Uses stick to push out a toy inserted in a clear tube						
E_{19}	26	VI	Tube (opaque)		Uses stick to push out a toy inserted in an opaque tube						

I: VISUAL PURSUIT AND THE PERMANENCE OF OBJECTS Child's Name _____ Date of Birth _____ Date of Test _____

SCALE STEP	AGE PLACEMENT (Months)	DEVELOPMENTAL STAGE	ELICITING CONTEXT	CRITICAL ACTION CODE	CRITICAL BEHAVIORS	SCORING 1	2	3	4	5	OBSERVATIONS
E_1	1	I	Visual Fixation	—	Fixates on object held 8 to 10 inches above the eyes						
1	2	II	Visual Tracking	1d	Tracks object through a 180° arc						
2	3	II	Visual Tracking	2c	Lingers at point of object's disappearance—child in supine position or in an infant seat						
E_2	4	III	Visual Tracking	—	Searches for object at point of disappearance—child seated on parent's lap						
3	5	III	Visible Displacement	3c	Secures partially hidden object						
4	6	III	Visual Tracking	2d	Returns glance to position above the head after object moves out of visual field						
E_3	7	IV	Visual Tracking	—	Reverses searching for object in anticipation of reappearance—child seated on parent's lap						
E_4	7	IV	Visible Displacement	—	Withdraws object held in hand following covering of hand and object with cloth						
5	8	IV	Visible Displacement	4d	Secures object hidden under a single screen						
E_5	9	IV	Visible Displacement	5b	Secures object hidden with two screens (A & B)—hidden under A twice then B—searches under A only						
6	9	V	Visible Displacement	6c	Secures object hidden under one of two screens—hidden alternately						
7	9	V	Visible Displacement	7c	Secures object hidden under one of three screens—hidden alternately						
E_6	10	V	Successive Visible Displacement	8e	Secures object hidden through a series of successive visible displacements with three screens						
8	10	V	Superimposed Screens	9c	Secures object under three superimposed screens						
9	13	V	Invisible Displacement	10d 10e	Secures object hidden with a single screen	+					
10	14	VI	Invisible Displacement	11c	Secures object hidden with two screens (A & B)—hidden under A twice then B						
11	14	VI	Invisible Displacement	12c	Secures object hidden under one of two screens—hidden alternately						
12	15	VI	Invisible Displacement	13c	Secures object hidden under one of three screens—hidden alternately						
13	18	VI	Successive Invisible Displacement	14c	Secures object hidden with three screens—object left under last screen—child searches along pathway						
E_7	22	VI	Successive Invisible Displacement	14d	Secures object hidden with three screens—object left under last screen—child searches directly under last screen						
14	23	VI	Successive Invisible Displacement	15c	Secures object hidden with three screens—object left under first screen—child searches in reverse order						

IIIA: DEVELOPMENT OF VOCAL IMITATION Child's Name _____ Date of Birth _____ Date of Test _____

SCALE STEP	AGE PLACEMENT (Months)	DEVELOP MENTAL STAGE	ELICITING CONTEXT	CRITICAL ACTION CODE	CRITICAL BEHAVIORS	SCORING 1	2	3	4	5	OBSERVATIONS
E_{1a}	1	I	Vocal Responsiveness		Responds to voice						
1	1	II	Spontaneous Vocalizations	1b	Vocalizes other than crying						Observed ____ ____ ____ ____ Reported ____ ____ ____ ____
2a	2	II	Cooing Sounds	2c	Shows positive response to familiar cooing sounds						Presented / Positive Response / Vocalizes / Imitates
2b	3	II	Babbling Sounds	3c	Shows positive response to familiar babbling sounds						Presented / Positive Response / Vocalizes / Imitates
3	3	II	Cooing Sounds	2d	Vocalizes in response to cooing sounds						
E_{2a}	3	II	Cooing Sounds	2e	Vocalizes similar sounds in response to cooing sounds						
E_{2b}	1	III	Cooing Sounds	2f	Imitates cooing sounds						
4a	4	III	Babbling Sounds	3d	Vocalizes in response to babbling sounds						
4b	6	III	Babbling Sounds	3e	Vocalizes similar sounds in response to babbling sounds						
4c	9	III	Words (familiar)	4b	Vocalizes in response to familiar words						Presented / Positive Response / Vocalizes / Imitates
E_{3a}	9	III	Words (familiar)		Vocalizes similar sounds in response to familiar words						
5a	12	IV	Babbling Sounds	3f	Imitates babbling sounds						
5b	12	IV	Words (familiar)	4c	Imitates familiar words						
6	12	IV	Unfamiliar Sound Patterns	5d	Vocalizes in response to unfamiliar sound patterns (examples: room room, ree ree, ding dong, brr, tsss zzz)						Presented / Vocalizes / ImitatesGA / Imitates
7a	14	IV	Unfamiliar Sound Patterns	5e	Imitates unfamiliar sound patterns by gradual approximation (GA)						

IIIA: DEVELOPMENT OF VOCAL IMITATION – *continued* Child's Name _____ Date of Birth _____ Date of Test _____

SCALE STEP	AGE PLACEMENT (Months)	DEVELOP-MENTAL STAGE	ELICITING CONTEXT	CRITICAL ACTION CODE	CRITICAL BEHAVIORS	SCORING 1	2	3	4	5	OBSERVATIONS
7b	15	IV	Novel Words	6c	Imitates novel words by gradual approximation (GA) (examples: pretty, bounce, uppity, bottle, box; flower, bunny, lish, beadle)						Presented Vocalizes ImitatesGA Imitates
8	17	V	Unfamiliar Sound Patterns	5l	Imitates unfamiliar sound patterns						
E_{18}	18	V	Novel Words		Imitates one novel word						
E_{19}	20	V	Novel Words	6d	Imitates two novel words						
9	23	VI	Novel Words	6e	Imitates at least four novel words						

IIIb. DEVELOPMENT OF GESTURAL IMITATION Child's Name____ ate of Birth_____ ____ ____Date of Test____

SCALE STEP	AGE PLACEMENT (Months)	DEVELOP-MENTAL STAGE	ELICITING CONTEXT	CRITICAL ACTION CODE	CRITICAL BEHAVIORS	SCORING 1	2	3	4	5	OBSERVATIONS
E_{2a}	2	I	Visual Attention	--	Attends to gestures performed by an adult						
1a	6	II	Simple Gestures	1b	Performs consistent act in response to familiar, simple gestures (examples: patting table, squeezing a toy, shaking a rattle, banging a table with a spoon)						Presented / Positive Response / Imitates GA / Imitates
1b	7	II	Complex Gestures	2b	Performs consistent act in response to complex gestures composed of familiar schemes (examples: crumples paper, slides beads, pat a cake, hitting blocks together, opening and closing a Slinky)						Presented / Positive Response / Imitates GA / Imitates
E_{2b}	8	III	Simple Gestures		Imitates familiar, simple gestures by gradual approximation (GA)						
2	8	III	Simple Gestures	1c	Imitates simple, familiar gestures						
3	8	III	Complex Gestures	2c	Attempts to imitate complex gestures composed of familiar schemes						
4a	9	IV	Complex Gestures	2d	Imitates complex gestures composed of familiar schemes by gradual approximation (GA)						
4b	11	IV	Visible Gestures (unfamiliar)	3	Imitates unfamiliar, visible gestures by gradual approximation (GA) (examples: snapping fingers, bending index finger, playing "so big," using the hand as a puppet)						Presented / Positive Response / Imitates GA / Imitates
5	12	IV	Complex Gestures	2e	Imitates complex gestures composed of familiar schemes						
6	15	IV	Visible Gestures (unfamiliar)	3d	Imitates unfamiliar, visible gestures						
7	18	V	Invisible Gestures	4b	Attempts to imitate unfamiliar, invisible gestures (examples: hat on head, tap head, wrinkle nose, pat heads behind the neck, bonk over ears, pull earlobe)						Presented / Positive Response / Imitates GA / Imitates
E_{2c}	18	V	Invisible Gesture (object)	4c	Imitates invisible gesture with object by gradual approximation (GA)						
E_{2d}	18	V	Invisible Gesture	4c	Imitates invisible gesture without object by gradual approximation (GA)						
E_{2e}	19	V	Invisible Gesture (object)	4d	Imitates one invisible gesture with object						
8	20	V	Invisible Gesture	4d	Imitates one invisible gesture without object						

IIIB: DEVELOPMENT OF GESTURAL IMITATION — continued Child's Name_____ Date of Birth_____ Date of Test_____

SCALE STEP	AGE PLACEMENT (Months)	DEVELOP MENTAL STAGE	ELICITING CONTEXT	CRITICAL ACTION CODE	CRITICAL BEHAVIORS	SCORING 1	2	3	4	5	OBSERVATIONS
E_{31}	20	V	Invisible Gestures (object)		Imitates two invisible gestures with object						
E_{30}	20	V	Invisible Gestures		Imitates two invisible gestures without object						
E_{29}	22	V	Invisible Gestures (object)	4-	Imitates three invisible gestures with object						
9	23	VI	Invisible Gestures	4-	Imitates three invisible gestures without object						

V: CONSTRUCTION OF OBJECTS IN SPACE Child's Name _____ Date of Birth _____ Date of Test _____

SCALE STEP	AGE PLACEMENT (Months)	DEVELOP MENTAL STAGE	ELICITING CONTEXT	CRITICAL ACTION CODE	CRITICAL BEHAVIORS	SCORING 1	2	3	4	5	OBSERVATIONS
E_m	2	I	Visual Orientation	—	Searches for sound with eyes						
1	2	II	Visual Scanning	1b	Alternates glance slowly between two visually presented objects						
2	3	II	Visual Scanning	1c	Alternates glance rapidly between two visually presented objects						
3	4	II	Sound Localization	2d	Localizes the source of sound						
4	5	III	Visually Directed Reaching	3d	Secures visually presented objects						
5	6	III	Follows Trajectory	4c	Follows trajectory of objects falling within view						
6	7	IV	Follows Trajectory	4e	Follows trajectory of objects falling out of view						
E_m	9	IV	Reverses Objects	5c	Turns mirror over to view functional side						
E_m	9	IV	Reverses Objects	5c	Turns photograph or other picture around to view functional side						
7	9	IV	Reverses Objects	5c	Rotates three dimensional objects to view functional side						
E_{11}	10	IV	Combining Objects	6c	Places (drops) objects into a container						
E_{11}	10	IV	Combining Objects	—	Stirs with a spoon in a cup						
E_{11}	10	IV	Combining Objects	—	Uses hammer stick to play xylophone						
E_{11}	10	IV	Combining Objects	—	Bangs spoon on inverted cup						
E_{12}	13	IV	Combining Objects	—	Dumps contents out of a narrow necked container						
8	14	V	Combining Objects	6d	Places objects into a cup—dumps out contents						
9	14	V	Combining Objects	7c	Builds tower of two cubes						
E_m	15	V	Combining Objects	—	Places rings on a stacking stick						
10	15	V	Combining Objects	8c	Allows an object to move down an incline						
11a	16	V	Detour (simple)	10c	Makes simple detour to obtain a desired object						
E_{17}	18	VI	Detour (complex)	—	Makes complex detour from cul de sac to obtain a desired object						
11b	18	VI	Indicates Person's Absence	11c	Indicates the absence of familiar persons						

APPENDIX E

LEITER INTERNATIONAL PERFORMANCE SCALE

Ceiling: failure of all tests at two consecutive year levels.
Basal: II - first level or two years below chronological age (if all levels at that year are passed, it becomes the basal year).

Test Summary:

	Years	Months
II	_____	_____
III	_____	_____
IV	_____	_____
V	_____	_____
VI	_____	_____
VII	_____	_____
VIII	_____	_____
IX	_____	_____
X	_____	_____
Total:	_____	_____

Mental Age: _____ years _____ months

Year II
1. Matching Colors
2. Block Design
3. Matching Pictures
4. Matching Circles and Squares

Year III
1. Four Forms
2. Block Design
3. Picture Completion
4. Number Discrimination

Year IV
1. Form and Color
2. Eight Forms
3. Counts Four
4. Form, Color, and Number

Year V
1. Genus
2. Two Color Circles
3. Clothing
4. Block Design

Year VI
1. Analogous Progression
2. Pattern Completion Test
3. Matching on a Basis of Use
4. Block Design

Year VII
1. Reconstruction
2. Circle Series
3. Circumference series
4. Recognition of age differences

Year VIII
1. Matching shades of gray
2. Form discrimination
3. Judging Mass
4. Series of radii

Year IX
1. Dot estimation
2. Analogous designs
3. Block design
4. Line completion

Year X
1. Foot print recognition
2. Block design
3. Concealed cubes
4. Block design

Year XII
1. Block design
2. Similarities
3. Recog - facial expressions
4. Classification - animals

APPENDIX F

MILLER AND PAUL COMPREHENSION ASSESSMENT

FOR USE WITH PROCEDURE: 3.7

STIMULUS ITEMS
Word Order Comprehension

Pretest

A.	B.	C.
Daddy	Crawling	Pouring
Girl	Hugging	Pushing
Boy	Kissing	Touching
Mommy	Climbing	Dropping

D.	E.
[illegible]n	Pitcher
Blanket	Water
[illegible]up	Doll
[illegible]n	Truck

Test

Subject-Verb (S-V)

1. Mommy's kissing.
2. Daddy's kissing.
3. Daddy's hugging.
4. Mommy's hugging.

Verb-Object (V-O)

5. Pushing the girl.
6. Pushing the boy.
7. Touching the boy.
8. Touching the girl.

Subject-Prepositional Phrase (S-PP)

9. Doll on blanket.
10. Blanket on doll.
11. Cup in water.
12. Water in cup.

Subject-Verb-Object (S-V-O)

13. Daddy's kissing Mommy.
14. Mommy's kissing Daddy.
15. Mommy's hugging Daddy.
16. Daddy's hugging Mommy.

Subject-Verb-Prepositional Phrase (S-V-PP)

17. The boy climbs on Daddy.
18. Daddy climbs on the boy.
19. The girl crawls on Mommy.
20. Mommy crawls on the girl.

Verb-Object-Prepositional Phrase (V-O-PP)

21. Touching the water in the cup.
22. Touching the cup in the water.
23. Hugging the doll on the blanket.
24. Hugging the blanket on the doll.

FOR USE WITH PROCEDURE: 3.7

SCORE SHEET
Word Order Comprehension

Instructions: For each stimulus item, record the number of the picture (1–4) to which the child points. Complete the pretest before proceeding with the test items.

Child's name: _____ _____

Child's chronological age (years.months): ____ _____

Date: _____

Pretest

A.	Daddy _____	B.	Crawling _____	C.	Pouring _____
	Girl _____		Hugging _____		Pushing _____
	Boy _____		Kissing _____		Touching _____
	Mommy _____		Climbing _____		Dropping _____

D.	In _____	E.	Pitcher _____
	Blanket _____		Water _____
	Cup _____		Doll _____
	On _____		Truck _____

Test

1. _____	9. _____	17. _____
2. _____	10. _____	18. _____
3. _____	11. _____	19. _____
4. _____	12. _____	20. _____
5. _____	13. _____	21. _____
6. _____	14. _____	22. _____
7. _____	15. _____	23. _____
8. _____	16. _____	24. _____

FOR USE WITH PROCEDURE: 3.7

INTERPRETATION FORM Word Order Comprehension

Instructions: This form is intended to be used with the score sheet for Procedure 3.7 (see p. 52). For each plate entry below, circle the child's response number. Total the columns as indicated. Upon completion, proceed with data analysis as described in Procedure 3.7.

Child's name:

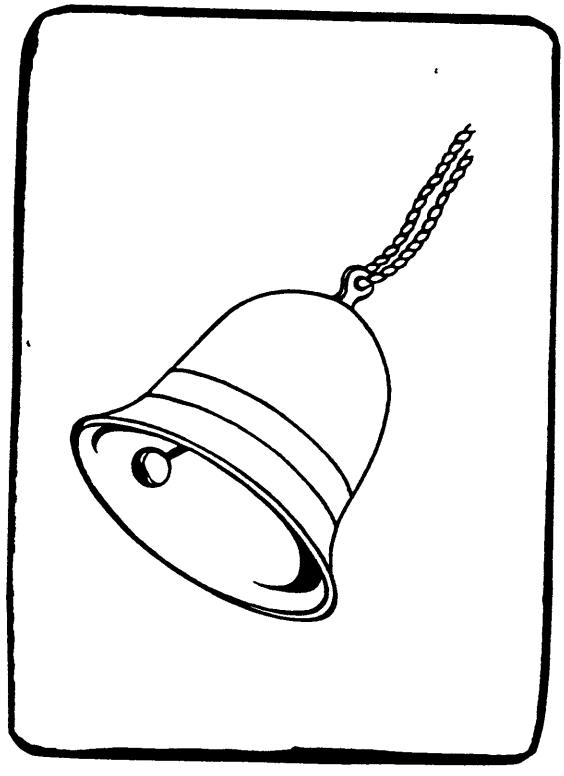
Child's chronological age (years.months):

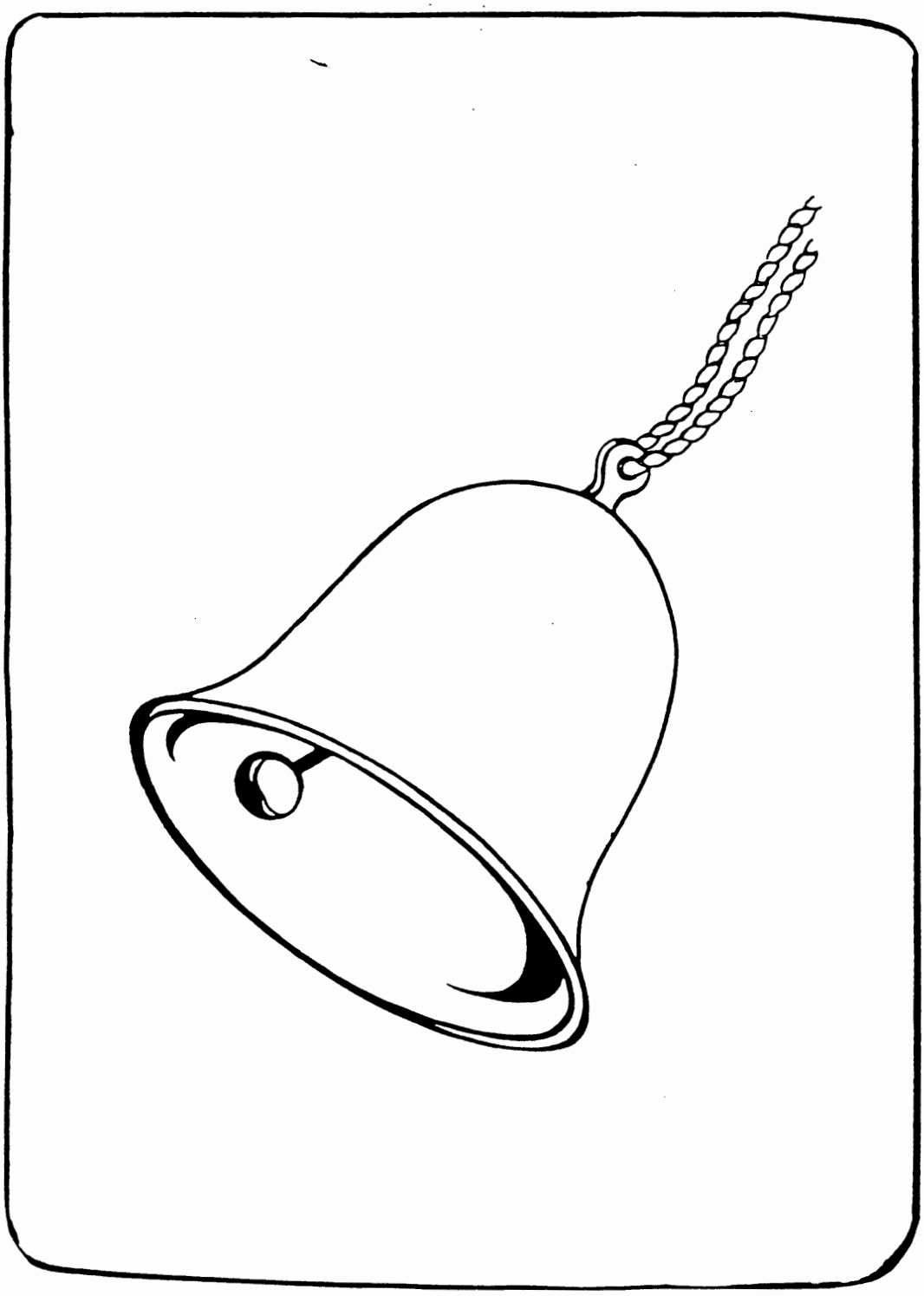
Date:

	Plate	Correct	Reversed	Unrelated	Substituted
S-V sentences	1	1		3	4
	2		1	2	3
	3		4	1	2
	4	2	3	4	1
Total S-V (1–4)					
V-O sentences	5		1	3	4
	6		3	1	2
	7		4	2	1
	8			4	3
Total V-O (5–8)					
S-PP sentences	9	2		1	3
	10	3	2	4	1
	11	1	3	2	4
	12	4	1	3	2
Total S-PP (9–12)					
Total two-element sentences (1–12)					
S-V-O sentences	13	4	2	3	1
	14	1	4	2	3
	15	3	1	4	2
	16	2	3	1	4
Total S-V-O (13–16)					
S-V-PP sentences	17	2	4	3	1
	18	4	2	1	3
	19	3	1	2	4
	20	1	3	4	2
Total S-V-PP (17–20)					
V-O-PP sentences	21	3	2	1	4
	22	2	1	4	3
	23	1	4	3	2
	24	4	3	2	1
Total V-O-PP (21–24)					
Total three-element sentences (13–24)					
Grand total (1–24)					

APPENDIX G

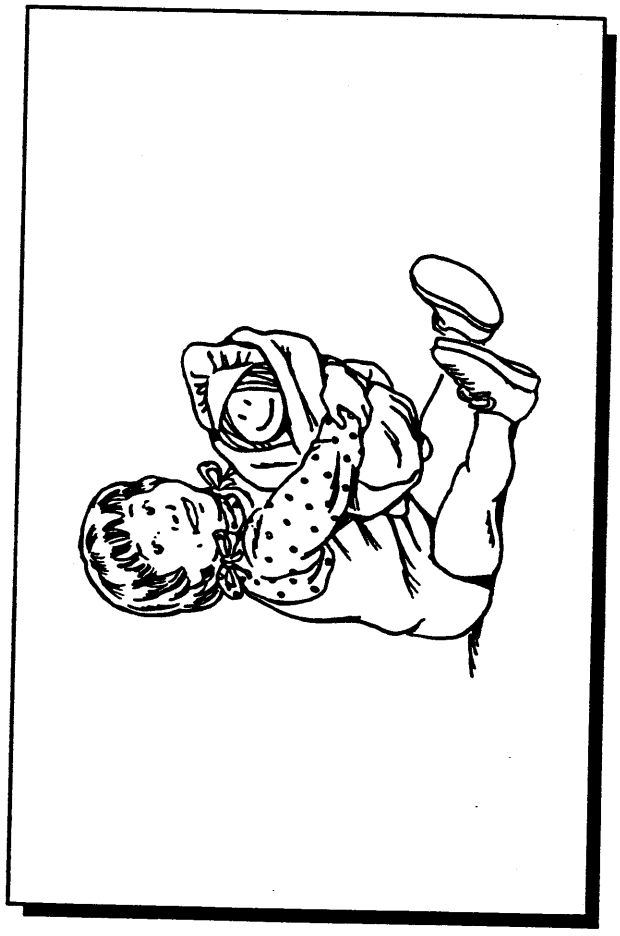
PEABODY PICTURE VOCABULARY TEST-REVISED, FORM L, SIZE MODIFICATIONS





APPENDIX H

MILLER AND PAUL COMPREHENSION ASSESSMENT, SIZE MODIFICATIONS



APPENDIX I

RAW DATA TABLE

SUBJ	AGE	GENDER	GROUP	PPVT SS	CAUS	VOC	GES	M/E	OBJ	SCH	SP	S/V	V/O	S/P	SVO	SVP	VOP	M/P TT	LEITER
1	44	male	severe	79	5	4	4	6	6	6	6	75						12.5	
2	56	female	moderate	79	6	6	6	5	6	6	6	25	100	50	50	50	25	50	36
3	68	male	mild	84	6	6	6	6	6	6	6	50	75	75	75	75	50	67	48
4	62	male	moderate	39	6	4	5	5	6	6	6								
5	37	female	severe	75	6	5	4	3	4	5	5								
6	37	male	moderate	108	6	6	6	6	6	6	6	100	75		50	75		54	24
7	52	male	moderate	98	6	6	6	6	6	6	6	50	75	75	100	50	75	71	33
8	72	male	severe	73	5	6	5	5	6	6	6	50	75	75	50	100	25	63	18
9	68	female	mild	82	6	6	6	6	6	6	6	100	100	100	100	100	100	100	39
10	50	male	severe	39	6	4	5	6	6	6	6								18
11	47	female	moderate	57	6	4	5	6	6	6	6								
12	62	male	moderate	59	6	6	5	6	6	6	6	50	75	25				25	36
13	41	female	moderate	81	6	6	6	6	6	6	6	75	100		25		25	37.5	42
14	71	male	severe	40	6	2	3	5	6	4	4								
15	43	male	severe	56	6	6	5	6	6	6	5	75	100	50	25	50	50	58	

PPVT SS - Peabody Picture Vocabulary Test - Revised, Form L (Dunn, 1981) - Standard Score
CAUS - Uzgiris and Hunt Scales of Infant Psychological Development (Dunst, 1980) - Causality - Stage Score
VOC - Vocal Imitation - Stage Score
GES - Gestural Imitation - Stage Score
M/E - Means/Ends - Stage Score
OBJ - Object Permanence - Stage Score
SCH - Schemes for Relating to Objects - Stage Score
SP - Objects in Space - Stage Score

S/V - Miller and Paul Comprehension Assessment (Miller & Paul, 1995) - Subject-Verb Subsection % Score
V/O - Verb-Object Subsection Percentage Score
S/P - Subject-Prepositional Phrase Subsection Percentage Score
SVO - Subject-Verb-Object Subsection Percentage Score
SVP - Subject-Verb-Prepositional Phrase
VOP - Verb-Object-Prepositional Phrase
M/P TT - Miller and Paul Comprehension Assessment - Total Percentage Score