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Differences in the Self-Talk of Students with Language Impairments when Completing Math Computation and Story Problems

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DIFFERENCES IN THE SELF-TALK OF STUDENTS WITH LANGUAGE IMPAIRMENTS WHEN COMPLETING MATH COMPUTATION AND STORY PROBLEMS

by

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This study was designed to analyze the differences in the self-talk of students with language impairments when compared with students with normal language. Nine fifth grade students with language impairments and nine fifth grade students with normal language, identified by their teachers as average-achieving, participated in this study. Participants were instructed to use a think-aloud technique while completing sets of computational and math story problems. Resulting samples of self-talk were transcribed and coded.

Results indicated several significant differences in the self-talk of students with language impairments when compared with their normal language peers. In regard to quantitative aspects of self-talk, students with language impairments used fewer total words, different words, personal pronouns, and completed fewer problems than their normal language peers. In regard to problem solving choices, students with language impairments were off track more often and on track less often than their normal language peers. In regard to self-regulatory talk, students with language impairments made fewer evaluating and confirming statements than their normal language peers.

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CHAPTER I

INTRODUCTION

Statement of the Problem

The study of self-regulation through self-talk can be traced back to the writings of Vygotsky (1934/1962). Vygotsky considered private speech to be responsible for the cognitive functions of orienting, organizing, and structuring behavior (Harris, 1990). Most theorists believe that self-talk develops in a curvilinear fashion, first appearing in the preschool years, with overt self-talk increasing in frequency gradually before becoming predominately internalized (covert / "inner speech") around the ages of seven and eight (Zivin, 1979). Berk (1992), however, cautioned that "Perhaps Vygotsky's inverted-U shaped function repeats itself each time children tackle a major new area of cognitive skill – for example, classifying and ordering stimuli during the preschool years and reading, writing, and mathematical reasoning during middle childhood" (p.33).

Some research has addressed the use of self-talk by populations of children known to have difficulty acquiring new areas of cognitive skills, including students with learning disabilities (e.g., Berk & Landau, 1993; Montague & Applegate, 1993; Harris, 1986) and students with attention-deficit hyperactivity disorder (ADHD) (e.g., Berk & Potts, 1991) or both (e.g., Berk & Landau, 1993). Although it has been difficult to find

self-talk studies that identified children with language impairments as the primary subject group, as it was in the current investigation, the populations of students with learning disabilities and language impairments overlap considerably by definition (Moats, 1994). Another distinction between the present study and prior research is that early researchers primarily investigated whether or not students with special needs use a similar quantity of self-talk as compared with their normally achieving peers. This study addressed the possible effects of language impairment on the qualitative aspects of self-talk in the context of a math problem solving task as well.

A review of prior literature on self-talk among special populations reveals two viewpoints, one based in sociocultural theory, and the other in cognitive behaviorism. The group of researchers (e.g., Diaz & Berk, 1992; Wertsch, 1979) who have a sociocultural perspective based it Vygotsky's earlier writings (1934/1962). It was Vygotsky's contention that private speech, which originates in early social experience, functions for young children as a plan that assists them to guide and control the self's actions. Early private speech is overt and serves the purpose of an externalized instrument of thought. Although overt self-talk eventually goes underground and becomes "inner speech," it may reappear during tasks that are difficult and demanding (Berk, 1986). According to the sociocultural theorists, students with special needs are not deficient in their ability to use private speech, but rather, are delayed in the point at which it becomes internalized. In support of this view, researchers have found that students with learning disabilities use as much, if not more, self-talk than their normally achieving peers (Montague & Applegate, 1993; Berk & Landau, 1993). Berk and

Landau (1993) found that students with learning disabilities, in fact, used more overt self-talk than their normally developing peers while doing math seatwork. This would support the researchers' contention that the self-talk abilities of such students are delayed, not deficient. However, the researchers did not find the evidence they expected that control group students used a less overt form of self-talk, represented by inaudible mutterings and lip and tongue movements, which they considered more mature. Rather, both groups of participants used a similar amount of this more mature form of self-talk. According to some sociocultural researchers (e.g., Berk & Diaz, 1992), instruction in the use of self-talk is not appropriate for students with learning problems. Rather than being taught to use self-talk, such students might be placed with teachers who establish an environment conducive to using more overt forms of self-talk as necessary.

Cautions about direct instruction in self-talk may have primarily been a reaction to early cognitive-behaviorist approaches to intervention (e.g., Harris, 1986; Kendall & Braswell, 1985; Meichenbaum & Goodman, 1971). Cognitive-behaviorist techniques assumed that children with special needs lacked skills for self-regulating strategic behaviors and would benefit from intervention focused directly on instruction in self-talk (Harris, 1986; Kendall & Braswell, 1985; Meichenbaum & Goodman, 1971). For example, the researchers might provide a specific script to be learned through repetition for solving all problems of a specific type.

This cognitive-behaviorist approach has been criticized by the sociocultural theorists on two bases. The first criticism relates to making therapeutic assumptions and carrying them out without first appropriately assessing spontaneously occurring private

speech of children with special needs. A second criticism relates to the design of the self-instruction intervention techniques. Berk (1992) expressed concern that cognitive-behavioral intervention researchers often use a uniform set of procedures across task domains and students without sufficient consideration of individual student characteristics. She argued that such research ignored the type and severity of the student's problem, the student's developmental level, and the student's pre-existing ability to use self-regulatory verbalizations. Berk suggested that the reason many of the studies using cognitive-behavioral techniques have not shown carryover to classroom tasks is that these techniques are based on the assumption that the development of self-regulatory private speech is a "mechanical process involving the direct transfer of adult verbal prescriptions and reinforcements to the child's internal plane of operation" (p. 25). Although cognitive-behaviorists often cite Vygotsky when defending the relevance of self-instructional intervention approaches, Berk asserted that cognitive-behavioral procedures, which focus on the modeling, rehearsal, and subvocalization of an adult's self-talk to provoke the use of self-talk in students with learning problems, are not consistent with Vygotsky's theory. More recent research by the interventionists (e.g., Case, Harris, and Graham, 1992), however, has shown a stronger sociocultural influence. Thus, the two perspectives appear to be converging.

Regardless, maybe it is premature to study interventions of self-talk with special populations when the qualitative nature of the language used in self-talk has not been thoroughly investigated. In particular, I hypothesized that children with a diagnosis of language impairment based on their oral communication ability would also show

differences in the nature of their self-talk used for thinking aloud while completing math computation and story problems. I chose to use a think-aloud protocol with the fifth grade participants in the present study because my interest was not in the developmental course of their self-talk. Rather, I was interested in the qualitative aspects of the language these students used. Considering that these children were beyond the age expected for internalization of self-talk, relying on spontaneous instances of self-talk would be less informative. Even if the experimental tasks were appropriately difficult and demanding so that overt private speech might be used, it would most likely be abbreviated and would not give a complete picture of the inner speech guiding the students' problem solving. A think-aloud protocol, therefore, was used as a window to the students' inner speech.

Another question was whether the quality of the self-talk used by students with language impairments be related to their math skills. I chose math problems as the context for examining self-talk because: (a) math work has been shown to be an appropriate task for eliciting self-talk; (b) math work has been used in prior self-talk studies (e.g., Montague & Applegate, 1993; Berk & Garvin, 1984; Berk, 1986); and (c) relatively little research has been done to assess the association of language impairments with mathematical problem solving abilities.

Statement of Research Questions

The purpose of the present study was to examine the self-talk of students with language impairments in order to compare it with the self-talk of peers with no language

impairment. This design was chosen to extend the results of prior research that suggested that there are few differences in the amount of self-talk used by students with and without specific learning problems when a think-aloud protocol was used instead of a spontaneous private speech paradigm (Berk & Potts, 1991; Berk & Landau, 1993). Therefore, one purpose of the current study was to find out whether the quantity of self-talk would differ for students with language impairments. This study was also designed to investigate whether children with language impairments would differ in the qualitative aspects of self-talk they used, specifically problem solving choices, regulatory self-talk, and referential self-talk, when compared to their average-achieving peers.

The choice of math problem-solving as the context for observing self talk raised some additional questions regarding possible interactions between language disorders and types of problems. Specifically, many clinicians and teachers have traditionally assumed that children with language disabilities have exaggerated difficulties with math story problems as compared with math computation problems. However, only a limited amount of empirical evidence supports this contention. In a recent study, Jordan, Levine, and Huttenlocher (1995) examined math calculation abilities of several groups of students by asking them to complete addition and subtraction problems presented in nonverbal problems, story problems, and number-fact problems. Jordan et al. found that students with language impairments performed significantly worse than students without language impairments on story problems. The present study was also designed to compare self-talk and problem solving skills when the students were attempting to solve

computation problems and math story problems.

In summary, the following questions were addressed in the present study:

1. Are there differences in the amount of self-talk used by students with language impairments when compared with their peers with normal language? Prior research would suggest that there are not.

2. Do students with language impairments differ in the qualitative aspects of their self-talk as evidenced in differences in their: (a) Problem solving choices (including the proportion of problems correct, instances of on-track and off-track self-talk, and reasons for being off track, including wrong approach or correct approach but transcription error, incorrect calculation, or non-completion of a problem); (b) self-regulatory talk (including instances of self-instructing and correcting, evaluating and confirming, or explaining); and (c) referential self-talk (including instances of reading matching printed text, and talking matching written work?

3. Do students with language impairments have more difficulty solving math story problems when compared with computation problems?

CHAPTER II

REVIEW OF THE LITERATURE

The first part of this chapter includes a historical look at self-talk and examines the literature focusing on this matter. The second section discusses the use of self-talk by children with specific learning problems and issues related to mathematical achievement within these populations. Although there seems to be agreement on several fundamental issues regarding self-talk, there are differences of opinion about related issues, such as intervention methods that incorporate self-talk. The chapter concludes with an examination of the use of self-talk in intervention, and includes a review of this controversy.

Self-Talk

Terminology

In this paper, I am using the term "self-talk" to refer to verbalized speech used to communicate with oneself rather than to another individual or group. Others have expressed preference for the term "private speech" to refer to all overt speech not specifically directed to others (Wertsch, 1979), and this group includes several recent researchers (e.g., Diaz & Berk, 1992; Diaz, Neal, & Amaya-Williams, 1990; Harris, 1990). Although the term private speech was coined by Flavell (1966), it was the

recommendation of Wertsch (1979) that resulted in the widespread use of the term. Wertsch suggested that private speech would be less confusing than the term "egocentric speech" considering that two prominent theorists, Piaget and Vygotsky, attached significantly different meanings to the term egocentric speech. The term "self-talk" can also be found in the more recent literature (e.g., Kamann & Wong, 1993; Vocate, 1994). and has been chosen as the most appropriate for the present study.

A number of distinctions are important to note when considering the terms (a) private speech, (b) self-talk, and (c) inner speech, as they will be referenced throughout this literature review. Both private speech and self-talk refer to overt verbalizations not intended for communication with or directed to others. The important distinction is that private speech most commonly refers to spontaneous verbalizations gathered in natural observations, whereas self-talk refers to verbalizations that are contrived (i.e., prompted by a researcher). Inner speech is used exclusively to refer to covert verbalizations, or, more precisely, the private speech that has become internalized.

Observation of Self-Talk

The rationale for differentiating private speech from self-talk relates to the different methods employed by researchers to study the phenomenon. Primary approaches include: (a) observation of spontaneous private speech, in which students' naturally occurring private speech is classified into levels based on the developmental progression of private speech; (b) think-aloud protocols, in which students are directed to speak their thoughts aloud; and (c) peer instruction protocols, in which students are

asked to instruct each other in talk to discover how they have structured concepts or procedures in their own minds.

Observation of Spontaneous Private Speech

Some researchers have observed private speech as it occurs in naturalistic classroom settings (Berk, 1986; Berk & Landau, 1993; Berk & Potts, 1991; Bivens & Berk, 1990) or in laboratory settings that permit slightly more control (Berk & Landau, 1993; Harris, 1986). When using this paradigm, researchers sit where they can watch students unobtrusively, and code students' self-talk on-line while it is occurring (Berk, 1986; Berk & Potts, 1991; Berk & Landau, 1993). Usually, they employ time-based observation techniques. That is, typically, when a student begins an experimental task, an observer focuses on the student, watches and listens for 10 seconds, and then records events on a code sheet for the next 20 seconds. Observations continue in the same fashion until the task is complete. This method has been employed as a way to determine the overall amount of self-talk used by students and whether it is task-relevant or task-irrelevant. Observation of spontaneous self-talk has been the method chosen by Berk (1986), Berk and Landau (1993), Berk and Potts (1991), and Bivens and Berk (1990) to lend empirical support to Vygotsky's premise regarding the curvilinear development of self-talk. These researchers used classroom settings and math seatwork as contexts for observing students' private speech.

Research devoted to investigating Vygotsky's theories regarding private speech led to the discrimination of levels of self-talk. Berk (1986) adapted speech categories

from the work of several prior researchers (Berk & Garvin, 1984; Frauenglass & Diaz, 1985; Kohlberg, Yaeger, & Hjertholm, 1968; Pechman, 1978) to establish three broad levels: Level 1 – self-stimulating, task-irrelevant private speech; Level 2 -- task-relevant externalized private speech; and Level 3 – task-relevant external manifestations of inner speech. These levels are indicative of the natural developmental progression of private speech in children.

Level 1 speech includes: (a) word play and repetition; (b) task-irrelevant affect expressions; and (c) comments to absent, imaginary or nonhuman others. Level 1 private speech is considered the least mature and earliest developing form of private speech.

Level 2 speech includes: (a) describing one's own activity and self-guiding comments; (b) task-relevant, self-answered questions; (c) reading aloud and sounding out words; and (d) task-relevant affect expressions. Level 2 private speech is triggered by tasks that are challenging and pose difficulties for students.

Level 3 speech includes: (a) inaudible mutterings (remarks that cannot be heard but involve clear mouthing of words); and (b) lip and tongue movement (no clear mouthing of words, just lip and tongue movements). Level 3 private speech is considered the most mature form of private speech. When students are using this level of private speech most exclusively, they are thought to have internalized their private speech

Other researchers use different category systems for identifying private speech. Harris (1986) divided instances of private speech into two categories: (1) task-relevant

private speech, and (2) task-irrelevant private speech. These categories were based on several category systems of prior researchers (Beaudichon, 1973; Klein, 1964; Meichenbaum & Goodman, 1979; Rubin, 1979). Task-relevant private speech includes: analytic statements, comments about materials, comments about activity, and questions. Task-irrelevant private speech includes: word play, storytelling/fantasy, talk about other activities, descriptions of irrelevant stimuli, general statements about the experimental task, positive affective statements, negative affective statements, and expletives and nonwords.

A close look at the classification systems of Berk (1986) and Harris (1986) reveals differences in experimenter point of view regarding relevant aspects of private speech. The differences in these two classification systems seem related to whether or not the experimenter was concerned about the developmental aspects of private speech. Harris focused on overt private speech only and was interested in whether overt private speech was task-relevant or task-irrelevant. Although Berk focused on whether or not speech was task-relevant or task-irrelevant, she was also interested in the distinctions between less mature and more mature forms of private speech and in the developmental hierarchy of such speech.

Vygotsky posited that private speech served to control behavior and that this function improved with age. Structural changes in private speech occur as command over behavior improves (Berk, 1992). Private speech is abbreviated and symbolic systems are remodeled in several ways (Berk, 1992).

Think Aloud Protocols

When interested in the self-talk of older elementary school students, observing spontaneous occurrences of private speech does not make it possible to analyze the full content of a student's thought processes. Private speech is in the process of decline between the ages of 7 and 8 years, and it may be almost completely internalized for some children beyond this point. Therefore, spontaneous observation is considered an unproductive method for studying private speech in the middle elementary school years. For those interested in the quality, especially, of the language of internalized speech, simply observing students' spontaneous uses of self-talk at this developmental stage would only be minimally helpful. That is, any overt verbalizations (Level 2 speech) at this age are likely to be abbreviated and incomplete, and a predominant amount of private speech is likely to consist of lip and tongue movements (Level 3 speech).

A think-aloud protocol involves asking subjects to verbalize what they are thinking and doing as they work through a chosen task. This method offers researchers a way to elicit more comprehensive information for analysis purposes and provides some access to inner speech and verbal thought processes. Ericcson and Simon (1980) examined the validity of verbal reports as data by reviewing a broad range of verbalization studies. One of the verbalization processes these reviewers discussed was the think-aloud procedure, in which subjects were instructed to verbalize information while performing a task, as was required in the present study. Ericcson and Simon did not view the additional cognitive load of instruction to verbalize as having any negative

impact on subjects' performances. They reported that instructing subjects to verbalize simultaneously with task performance provides a direct trace of the information being attended to, and therefore, an indirect trace of the internal stages of the cognitive process. Fry (1992), who has used think-aloud protocols with adults, noted that the think-aloud procedure is an "effective strategy for studying both surface and deep structure contents of private speech" (p. 274). A think-aloud protocol was used in the present study.

Peer Instruction Protocol

When the primary focus is on finding an avenue to learn about students' thought processes, peer instruction protocols offer an alternative. By asking an older or more competent student to instruct a younger or less competent student, the student's thought processes should be revealed in the way the student instructs his or her fellow peer. However, studies focused on peer instruction (e.g., Maheady, Sacca, & Harper, 1987; Roach, Paolucci-Whitcomb, Meyers, & Duncan, 1983; Rosen, Powell, Schubot, & Rollins, 1978) tended to concentrate on the peer-instruction task as a means to foster academic gains rather than to learn more about students' internal thought processes.

Historical Perspectives Regarding Private Speech

Much of the interest in the development of private speech came about as a result of a controversy between the classic theories of Piaget and Vygotsky regarding this

phenomenon. This controversy sparked research focused on verifying and extending different views regarding egocentric speech, which continues to influence researchers in several different disciplines.

Piaget

The term "egocentric speech" was coined by Piaget (1923/1955) and used to describe three types of speech he had observed in children: (1) repetition (echolalia), (2) monologue, and (3) collective monologue (Zivin, 1979). Piaget felt that egocentric speech provided evidence of children's lack of cognitive maturity. He did not view it as serving any communicative function. Piaget explained the disappearance of egocentric speech in older children as the effect of socialization as they become aware that such speech is inappropriate. One of the characteristics of Piaget's egocentric speech is overtness. Piaget did not view this socially unacceptable speech as having a covert form (Zivin, 1979). That is, Piaget theorized that egocentric speech merely disappeared as it was discarded by the maturing child.

Vygotsky

Vygotsky (1934/1962), who had read Piaget, also used a Russian term, which was translated as "egocentric speech." However, he specifically distinguished his views from Piaget's and focused on language and the social origin of each child's experience as critical components in the development of thought and intellect (Harris, 1990). To

avoid confusion, recent reviewers of Vygotsky have used the term "private speech" almost exclusively when referring to Vygotsky. Vygotsky stressed the self-regulatory, planning function of private speech, which he theorized develops from early socialized language. Vygotsky viewed private/egocentric speech as "thought spoken out loud," which had the purpose of communicating with the self to provide self-guidance and self-direction (Berk, 1986). Vygotsky considered egocentric speech as serving the purpose of the transition from overt verbalized thought, which might be socially mediated, to inner speech (Zivin, 1979). This process has been described as the transition from other-regulation to self-regulation.

Although Piaget's and Vygotsky's differing theories regarding private speech initially prompted researchers to carry out studies comparing their theories to try and determine which was more valid (e.g., Kohlberg, et al., 1968), current researchers have focused on investigating the dimensions of private speech. This seems to be related to the now accepted notion that comparison of the egocentric speech of Piaget and Vygotsky is irrelevant because they were not really referring to the same phenomenon. Piaget was interested in the structural level of egocentric speech, and Vygotsky was focused on the functional level (Zivin, 1979).

Luria

Luria (1961) was a student of Vygotsky. Although many researchers consider the theories of these two Soviet researchers to be exactly the same, Luria's theory and research took a different focus and direction than Vygotsky's (Harris, 1990). Luria used

the term "self-regulatory speech," as opposed to egocentric speech, when referring to the speech he observed in his laboratory setting (Zivin, 1979). Whereas Vygotsky was solely interested in the semantic aspect of private speech, Luria focused on the activational, impulse, and semantic aspects of such speech (Harris, 1990). Luria "emphasizes the sheer activational role of speech during the early years, but sees both impulse and semantic aspects contributing to full self-regulation" (Zivin, 1979). Although Vygotsky thought of self-regulation as an "interindividual" process due to socialization, Luria conceived self-regulation primarily as an "intraindividual" process contingent on neurophysiological processing (Harris, 1990). Another important difference between these theorists is the type of speech they chose to study. Vygotsky studied naturally occurring, spontaneous speech and made deductions about inner speech, whereas Luria studied experimenter-directed, induced speech in the context of a laboratory (Zivin, 1979).

Luria described the following three stages in the development of verbal self-regulation based on a series of studies he conducted: (1) the speech of others controls and directs the child's behavior; (2) the child's own overt speech begins to regulate his or her behavior (such speech can initiate but not inhibit behavior); and (3) the content/meaning of the child's overt or covert speech effectively regulates behavior (Harris, 1990). Theses three stages "have become the backbone of self-instructional approaches" (Harris, 1990).

Mead

Mead's (1934) theory regarding private speech is similar to Vygotsky's (1934/ 1962) in that both theorists believed social interaction was inherently related to developing private speech and internal thought (Berk & Garvin, 1984). Interestingly, Mead and Vygotsky were not familiar with one another's work (Vocate, 1994). Mead had been an active scholar in Chicago for nearly three decades before Vygotsky became known in Moscow for his work in psychology in the early 1920s (Valsiner & Van der Veer, 1988). Mead did not discuss inner speech, but he did offer "an explanation of how the self is created via speech and social interaction" (Vocate, 1994, p. 4). Berk and Garvin (1984) explained that, according to Mead, young children can only see themselves from the perspectives of others, and they begin to do this by describing their own activities to others. Children begin to differentiate the speaking self from the self talked to in this process. Having constructed the self as an auditor, the self can talk back, so that children use private speech that involves asking and answering their own questions. The transition from overt private speech to inner speech is marked by the suppression of the question, which involves an even clearer differentiation of speaker and auditor roles and functions.

Current Controversies

As introduced in Chapter I, two viewpoints exist in the literature regarding the self-talk of special populations. The first viewpoint (e.g., Diaz & Berk, 1992), which

was based on Vygotsky's (1934/1962) earlier writings, was that students with special problems do not need direct intervention in the use of self-talk. Supporters of this position have argued that such students may have self-talk that is delayed or may have attentional systems which interfere with their self-talk. Therefore they would benefit best by being placed with teachers who understand the value of overt self-talk and who provide an environment conducive to allowing these students to use overt self-talk freely. The second viewpoint was held by those who designed cognitive-behaviorist approaches to intervention (e.g., Harris, 1986; Kendall & Braswell, 1985; Meichenbaum & Goodman, 1971). Those approaches were based on the assumption that students with special problems are deficient in their ability to use self-talk and, therefore, need to be taught how to use self-talk to guide their behaviors. As noted in Chapter One, these two viewpoints have converged in recent years, as special educators have adopted a more sociocultural approach to intervention (Case, Harris, & Graham, 1992).

Appropriate Tasks and Contexts for Eliciting Private Speech

At one point, researchers questioned the validity of Vygotsky's theory, based on evidence that private speech was a seldom occurring phenomenon and that some children never produced it (Fuson, 1979). However, Frauenglass and Diaz (1985) conducted an important study that pointed out the importance of the type of task used when eliciting private speech. Specifically, they transcribed and coded the verbalizations of 32 preschoolers while performing semantic and perceptual tasks into private speech and social speech categories. They commented that the majority of prior studies that had

not agreed with Vygotsky's position had relied on tasks not effective in eliciting spontaneous private speech. For example, most studies used nonverbal tasks such as puzzles, finger mazes, or block designs that children could easily solve by using visual-spatial strategies, as opposed to using language. Also, most researchers conducting the studies did not instruct children to talk out loud if they wished to do so. The preschoolers studied by Frauenglass and Diaz performed tasks designed to require verbal mediation and produced a quantity of self-talk sufficient for investigation.

As a result of this shift in thinking about the importance of using tasks that necessitate verbal mediation as a trigger for invoking private speech, recent studies have focused on finding tasks that increase the quantity of private speech. Frauenglass and Diaz (1985) found that "visual-spatial tasks, such as block design and puzzles, could be easily solved with the use of perceptual-matching strategies without recourse to verbal mediation" (Diaz, 1992). Instead, tasks were sought to comply with Vygotsky's notion that the quantity of private speech would increase when children are faced with obstacles and difficulties.

Diaz (1992) noted that selecting a task neither too easy nor too difficult for a child results reliably in the use of private speech. Several studies have demonstrated that math seatwork maximizes children's use of private speech (Berk, 1986; Berk & Garvin, 1984; Berk & Landau, 1993; Berk & Potts; Bivens & Berk, 1990). The first of these studies (Berk & Garvin, 1984) looked at academic tasks versus nonacademic tasks, assuming that academic tasks would be more cognitively challenging, and therefore would elicit more private speech. Academic tasks included reading, spelling, arithmetic,

writing, science, and structured listening. The results of this study indicated that the overall frequency of private speech was greater during academic tasks. Discussion of these results noted that the specific academic tasks varied widely and that the amounts and varieties of private speech most likely varied also. A series of four studies that specifically used the task of math seatwork to observe for spontaneous use of private speech was conducted by Berk (1986), Bivens and Berk (1990), Berk and Potts (1991), and Berk and Landau (1993). Based on her review of prior research, Berk (1986) listed four reasons in support of using math work to study private speech:

1. Math seatwork involves problem-solving tasks in which children are likely to encounter obstacles and difficulties.

2. Conditions are such that children largely work alone and independently, without teacher guidance and assistance.

3. Early elementary school arithmetic tasks depend heavily on verbal processing.

4. Compared to instruction in other subject areas, math lessons are the most uniform of instructional contexts in elementary school classrooms.

In their 1993 publication, Berk and Landau concluded that either the natural classroom environment or the laboratory environment could be used for investigating self-talk. They found that use of a laboratory setting only slightly reduced the incidence of private speech and that the private speech elicited in the classroom and the laboratory were substantially intercorrelated.

Consideration of Special Populations

The current study was expressly aimed at investigating the self-talk of students with language impairments. Distinctions in the definition and the terminology used to describe language disorders have changed many times over the years, reflecting different theories regarding the causes of the disorders, the changing nature of symptoms over time, varied perspectives of different professional disciplines, relatedness to other disorders, and the preferences of different regions and professional associations over time (Nelson, 1993). Efforts to distinguish a language disorder by specific diagnostic procedures tends to neglect the fact that children may or may not have other problems to consider. Bashir (1989) offers the following comprehensive definition of language disorders:

> Language disorders is a term that represents a heterogeneous group of either developmental or acquired disabilities principally characterized by deficits in comprehension, production, and/or use of language. Language disorders are chronic and may persist across the lifetime of the individual. The symptoms, manifestations, effects, and severity of the problems change over time. The changes occur as a consequence of context, content, and learning tasks. (p.181)

Much of the research on uses of self-talk by students with special needs applies to students with learning disabilities. In some studies, "language disorders" are only mentioned when describing the experimental sample (e.g., Montague & Applegate, 1993), not establishing criteria for it. However, it is reasonable to assume that research with students with learning disabilities applies to students with language impairments as well, because of their overlapping definitions. That is, the definition of learning disabilities recommended by the National Joint Committee on Learning Disabilities

(NJCLD) is as follows:

> Learning disabilities is a general term that refers to a heterogenous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual, presumed to be due to central nervous system dysfunction, and may occur across the life span. Problems in self-regulatory behaviors, social perception, and social interaction may exist with learning disabilities but do not by themselves constitute a learning disability. Although learning disabilities may occur concomitantly with other handicapping conditions (for example, sensory impairment, mental retardation, serious emotional disturbance), or with extrinsic influences (such as cultural differences, insufficient of inappropriate instruction), they are not the result of those conditions or influences. (p. 63)

Moats (1994) emphasized the strong overlap between language disorders and several categories of learning disabilities and suggested that distinctions made between language disorders and learning disabilities "are more imagined than real" (p. 231).

Research Examining the Private Speech of Students With Special Needs

Students With Learning Disabilities

Berk and Potts (1991) and Berk and Landau (1993) examined special populations to test the universality of Vygotsky's theory in child development. Of particular relevance regarding students with learning disabilities is the study that compared students with learning disabilities (LD) and children with LD and attention-deficit hyperactivity disorder (ADHD) to normally achieving peers (Berk & Landau, 1993). Results indicated that although students with learning disabilities appeared to follow the same developmental sequence regarding private speech as their normally achieving peers, they were delayed in their Level 3 private speech internalization. In the context

of academic seatwork, students with learning disabilities used more Level 2, task-relevant externalized speech, and an equivalent percentage of Level 3, task-relevant internalized speech. Berk and Landau (1993) noted that the results of their study indicated that:

> LD children's achievement difficulties are not a function of deficits in the production of task-relevant private speech, as some cognitive-behavioral investigators have assumed (e.g., Harris, 1986). Instead, it is more likely that LD children's poor academic performance results from true ability deficits, which act as tenacious obstacles to task success and lead them to produce more externalized speech in an effort to overcome these obstacles." (p. 567)

Students With Attention-Deficit Hyperactivity Disorder

As noted previously, the Berk and Landau (1993) study investigated students with LD and ADHD. Results indicated that students with both LD and ADHD used Level 2 speech more often than either their LD or normally achieving peers. Berk and Potts (1991) conducted a study that specifically focused on the private speech of boys with ADHD and normally developing boys. The purpose of the study was to investigate the development of private speech and its relationship to task-related behavior for both groups. Students were observed during periods of math seatwork and their private speech, motor accompaniment to task, and level of attention were recorded. Results of the study indicated that students with ADHD are not deficient in their use of private speech. Rather, during periods of math seatwork, these students used as much private speech as their normally developing peers. However, they used more overt forms of Level 2 speech and less of the more mature Level 3 speech than their normal peers. Berk

and Potts concluded that ADHD students are substantially delayed in their development of private speech in terms of the progression towards private speech internalization.

Research Examining the Use of Self-Talk in Intervention

Cognitive behavior modification (CBM) procedures (e.g., Harris, 1986; Kendall & Braswell, 1985; Meichenbaum & Goodman, 1971) have been criticized by sociocultural theorists. Berk (1992) asserted that these methods "attempt to induce speech in children with learning problems through modeling, rehearsal, and subvocalization of an adult's self-instructional statements" (p.45). For example, Meichenbaum and Goodman (1971) conducted two studies to assess the efficacy of the CBM technique of self-instructional training with impulsive students. This technique was designed using the developmental sequence of private speech as a guide, whereby the overt verbalizations of the examiner were followed by the student's overt self-verbalization, then covert self-verbalization. Using this technique, the researchers hoped to train the impulsive students to use internally originated self-instructions to control their behavior. Although students showed improvements for the experimental tasks on which they were trained, no significant differences were observed in the students' classroom behavior.

Diaz, Neal, and Amaya-Williams (1990) suggested that the limited effectiveness of the CBM techniques has to do with the fact that such techniques teach self-control rather than self-regulation. Self-control is a developmentally earlier and simpler form of behavioral organization in which the student simply complies with an adult's

commands and directives in the absence of the adult. Self-regulation is different from self-control in its "flexible adjustment of behavior to changing situations and also in the active use of reflection and metacognitive strategies" (Diaz, Neal, & Amaya-Williams, 1990, p. 132). Berk (1992) explained that, according to Vygotsky, self-regulation is:

> encouraged by dialogues that actively engage the child as a collaborative partner in problem-solving activities that lie just beyond the child's independent capacity. From these dialogues the child appropriates cognitive strategies and then constructs private speech utterances uniquely suited to overcoming obstacles encountered in independent problem solving. (p. 26)

Adult speech is not mimicked in children's self-talk. If it were, it would not serve the flexible and self-regulatory purposes necessary for overcoming obstacles and solving problems (Berk, 1992).

More recently, special educators have conducted research using techniques that are not nearly as directive as the earlier cited CBM techniques, that take into consideration the unique differences among children, and that show a stronger sociocultural influence. Case, Harris, and Graham (1992) investigated the use of a technique they called "self-regulated strategy development" with students with learning disabilities working on math problems. This technique involved teaching students problem-solving strategies. Students were active collaborators in this process and interactional scaffolding was used. Strategies and procedures were explicitly and overtly modeled, and the students became gradually more responsible for deciding upon and applying strategies. This study differed greatly from earlier CBM techniques. Students were active participants in learning strategies relevant to academic needs. All students showed treatment gains and three of the four students maintained treatment gains.

Although a limited number of participants were involved in this study, research such as this seems to offer a more positive perspective regarding the use of self-talk in intervention.

Math Issues for Students with Learning and Language Disabilities

Math was chosen for the task in the current study both because of its documented use for eliciting and observing self-talk, and because of the possibility of adding to the knowledge base about how students with language disorders think about and talk about math. The relationship between math ability and language impairment, specifically, has not received much attention in prior research. The effect of learning disabilities on math achievement has been researched more extensively.

In one study, Jordan, Levine, and Huttenlocher (1995) investigated the calculation abilities of students with different patterns of cognitive functioning. They compared the performances of students with: (a) specific language difficulties, (b) specific spatial difficulties, (c) both types of difficulties, and (d) neither difficulty. Their tasks included one nonverbal calculation task and two verbal calculation tasks, with both story problems and number-fact problems. Students with specific language difficulties performed as well as the group without impairments on nonverbal problems but performed significantly worse on verbal story problems when compared to the nonimpaired group. This empirical evidence confirms what many teachers and clinicians have suspected intuitively to be the case. That is, Jordan et al. concluded that the "findings suggest that children with specific language difficulties develop basic

nonverbal calculation skills at a rate similar to that of their nonimpaired peers. However, their quantitative competence may not be reflected when calculations are embedded in verbal contexts, such as story problems" (p.61).

In another study, Conti-Ramsden, North, and Ward (1995) investigated the number skills of students. They compared the performances of students with: (a) specific language difficulties, (b) specific math difficulties, and (c) neither difficulty. They used the task of processing two and three digit numbers with: (a) an oral presentation, (b) a written presentation, and (c) an analogue presentation. Students with specific language difficulties and students with specific math difficulties performed similarly on the experimental tasks. These students were indistinguishable in performance on the three digit task and both performed worse than the students with neither difficulty. Conti-Ramsden et al. suggested that this lack of difference in performance between students with specific language difficulties and students with specific math difficulties may be due to problems associated with defining groups of students on the basis of special educational needs and the possibility of considerable overlap between both groups of students.

Summary

This chapter offered a review of the literature regarding the development of private speech, the private speech of students with special needs, and the use of self-talk in intervention. There are still many unanswered questions related to these issues and a need for continued research to offer new information and perspectives. The current

study attempts to move forward by researching the differences in the self-talk of students with language impairments when compared with students with normal language while completing math computation and story problems.

CHAPTER III

METHOD

This chapter discusses the methodology of the present study. Description of the subjects involved in the study and the procedures employed are included. Methods of data analysis are also included along with evidence of interrater and intrarater reliability.

Subjects

Eighteen fifth grade students, ten males and eight females, participated in this study. All students attended an elementary school in an upper middle class suburban district in the east northcentral United States. Nine of the students, five males and four females, were identified as having language impairments (LI). Two of these students were also identified as having a learning disability. The group of students with language impairments was matched for gender and grade level with a group of students (also five males and four females) identified as having normal language (NL).

Students With Language Impairments

Students in the LI group had a mean age of 10 years, 9 months. They were documented as having language impairments by the school's speech-language pathologist, according to Michigan policy and local policy. The Michigan State Board

of Education (1987) defines language impairment as:

> One or more of the following language impairments: phonological, morphological, syntactic, semantic, or pragmatic use of aural/oral language as evidenced by both of the following: (a) A spontaneous language sample demonstrating inadequate language functioning. (b) Test results, on not less than 2 standardized instruments, or 2 subtests designed to determine language functioning, which indicate inappropriate language functioning for the student's age. (p. 31)

The state guidelines, which augment the policies, suggest that students must score at least than one and one-third standard deviations below expected language performance to be considered mildly language impaired. The interpretation of this suggestion by the district involved is that students must show at least a 20 point discrepancy between some measure of cognitive ability and some measure of language functioning. Upon reevaluation for services, students need to show at least a 15 point discrepancy between cognitive ability and language functioning. Cognitive tests used by this district to make this determination include the Test of Nonverbal Intelligence -2 (TONI-2) (Brown, Sherbenou, & Johnsen, 1990), the Wechsler Intelligence Scale for Children - Third Edition (WISC-III) (Wechsler, 1991), and the Kaufman Brief Intelligence Test (K-BIT) (Kaufman & Kaufman, 1990). Tests used to measure language functioning include the Clinical Evaluation of Language Fundamentals - Revised (CELF-R) (Semel, E., Wiig & Secord, 1987), The Listening Test (Barrett, Huisingh, Zachman, LoGiudice, & Orman, 1992), the Test of Language Competence - Expanded Edition (TLC-Expanded) (Wiig & Secord, 1989), and the Peabody Picture Vocabulary Test - Revised (PPVT-R) (Dunn & Dunn, 1981). Identifying information regarding these students is shown in Table 1.

Students With Normal Language

Students in the NL group had a mean age of 10 years, 10 months. They were selected on the basis of their teachers' comments or estimates that they were functioning in the middle third of their classes academically. The teachers further identified the NL students as having no history of speech and language therapy, special education, Section 504 accommodations or needs, behavioral or emotional problems, or known hearing loss. The average CA for students in the NL group was 10 years, 10 months. Identifying information regarding these students is shown in Table 1.

Table 1

Identifying Information for LI and NL Students

Group	No.	$\bar{x}$ CA	Description
LI	9	10 ; 9	· documented as having a language impairment by school speech-language pathologist
NL	9	10; 10	· functioning in the middle third of their class academically · no history of speech and language therapy, special education, Section 504 accommodations or needs, behavioral or emotional problems, or known hearing loss

Note. LI = students with language impairments; NL = students with normal language

Recruitment Procedures

Students With Language Impairments

The school's speech-language pathologist was asked to identify all fifth grade students who qualified as speech-language impaired and were receiving language therapy to serve as potential LI group participants. Letters containing response post cards were sent to the parents of all students who met these criteria (see Appendix A). Parents were requested to return the enclosed post cards indicating their interest in being contacted with further information regarding the project. When no post cards were received from these parents, the school's speech-language pathologist contacted them. The letter indicated a due date which conveyed the unintended impression to parents that if they did not return the post cards before that date, it was too late for their children to participate in the study. The school's speech-language pathologist was able to clear up this matter by speaking with parents about the project, and sent out consent letters to those who agreed to allow their children to participate.

Students With Normal Language

The school's fifth grade teachers were asked to use criteria, established by the examiner, to identify all fifth grade students who could be considered "average-achieving" and who demonstrated none of the rule-out criteria for the control group of subjects with normal language (NL). Letters with enclosed response post cards were sent to the parents of all students who met these criteria. Parents were not contacted

until post cards were returned indicating that further contact was permissible. As a result of one subject from the NL group withdrawing from the project and the need for two other male students to complete the gender matching for the NL group, a second letter was sent out to any parents of male students who did not respond to the first letter. Again, parents were not contacted until enclosed post cards indicating this as acceptable were received.

Procedure

Parents signed and returned consent forms before any of the experimental procedures began (see Appendix B). The consent form notified parents that their children's participation in the study would involve two forty-minute sessions away from class. Parents were also informed of their right to change their minds about their children's participation at any time.

The procedure involved two sessions. The purposes of the first session were to introduce students to the study, ask students to participate in the study, screen students' hearing, show students a demonstration video tape explaining the think-aloud procedure, give students practice problems, and administer the experimental protocol to students. The purpose of the second session was to administer four subtests of the Woodcock-Johnson Psycho-Educational Battery - Revised (WJ-R) (Woodcock & Johnson, 1989, 1990) to students.

Session One

Introduction to Study and Student Assent for Participation

The experimenter explained the tasks involved in the study to students and specified that the study was being conducted to learn more about how fifth grade students solve math problems. Students willing to participate read and signed an assent form and continued with the tasks of session one (see Appendix C). The examiner read through the assent form with each subject and allowed time for the students to ask questions.

Hearing Screening

A hearing screening was conducted first. All students responded to pure tones with 20 dB loudness level at 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz. One subject did not respond to pure tones with a loudness level of 20 dB at 125 Hz and 250 Hz for both ears and another subject did not respond to the same conditions for his right ear only. This nonresponse was likely caused by masking by ambient noise and was not considered failure.

Demonstration Video Tape

Students were introduced to the concept of "thinking aloud" by a demonstration video tape of the examiner thinking through two computation problems and two story problems. The video tape began with the following instructions:

> I want to know all about what fifth graders are thinking about and saying to themselves while they work through math problems. It is important that you say out loud everything you are thinking and doing while you solve the math problems. I want you to do your best on all the problems, but it's okay if you don't get them all right. I won't be grading your papers. The important thing is that you remember to say everything you are thinking and doing the whole time you are working on the math problems. I'm going to talk through a few problems now to help you understand what I want you to do.

The examiner attempted to model a variety of self-talk in the demonstration video tape, including the self-talk the examiner was interested in for the study. For example, the examiner demonstrated affective self-talk by making positive and negative statements about her performance and about her feelings regarding the problems themselves. The examiner also demonstrated referential self-talk by evaluating and confirming her work, making self-correcting and self-instructing statements, and by explaining why she chose particular processes. After viewing the video tape, students were encouraged to ask any questions if they were unsure about the think-aloud technique or what they were supposed to do.

Practice Problems

Students were given a set of practice problems to ensure that they understood the think-aloud procedure. A video camera was positioned in an over-the-shoulder manner to capture the students' written work and a micro-cassette recorder and a clip-on microphone were used to record what the students were saying as they completed problems. The practice protocol consisted of two computation problems followed by two story problems (see Appendix D). If during completion of these problems, thirty

consecutive seconds of no talking passed, the examiner stopped the student and used the prompt, "Make sure you are saying everything you are thinking and doing." This prompt was used with one of the LI students. If a second instance of silence for thirty consecutive seconds passed, the examiner stopped the student and demonstrated thinking aloud with the problem the student was working on and then repeated the above-noted prompt. This demonstration and prompt were used with the same LI student mentioned above. Although this demonstration and second prompt did not result in a substantial increase in the amount of self-talk this student used, this seemed to be related to extreme difficulty with the math problems rather than a lack of understanding of the think-aloud procedure. The following oral instructions were given before students began work on the problems: "I'm going to have you do a few practice problems first. Please use this notebook paper to show your work. Remember to say everything out loud." Students were finished when all four problems had been completed.

Experimental Protocol

The experimental protocol was set up like the practice protocol, but with 20 computation problems and 16 story problems (see Appendix E). Students were reassured that they were not expected to complete all the problems and that it did not matter how many problems they completed. The experimenter encouraged students just to do their best and reiterated the importance of saying everything out loud. Students were instructed that they would be working on the computation problems for 5 minutes and on the story problems for 10 minutes. Time was monitored on a watch with a second

hand. When the allotted time had elapsed, the examiner instructed the students to stop working. Students were not stopped in the middle of a problem.

Session Two

The second meeting with students incorporated the administration of subtests from the Woodcock-Johnson Psycho-Educational Battery-Revised (WJ-R) (Woodcock & Johnson, 1989, 1990) to permit descriptive comparisons of the two subject groups on several standardized measures of language and mathematics. It was not used as one of the tests to diagnose language impairment, but was given as a part of the study.

The specific subtests chosen were selected for their similarity to tasks in the experimental protocol. The four subtests administered were: Passage Comprehension, Calculation, Applied Problems, and Quantitative Concepts. Standard scores for these subtest are shown in Table 2. The Passage Comprehension subtest was chosen as a language measure to assess students' comprehension and vocabulary skills. The Calculation and Applied Problems subtests were chosen for their resemblance to the calculation and story problems that were part of the experimental protocol. The Quantitative Concepts subtest was chosen to assess students' knowledge of mathematical concepts and vocabulary. It is important to note that the WJ-R is not a test designed to assess language impairment and was not used as such in the present study. The WJ-R subtests were chosen for their similarity to tasks in the experimental protocol.

Table 2

Woodcock-Johnson Psycho-Educational Battery - Revised
(Woodcock & Johnson, 1989, 1990) Standard Scores

Subject	Passage Compre-hension	Calculation	Applied Problems	Quantitative Concepts
Language Impaired				
1	95	99	103	96
2	87	66	90	62
3	92	87	117	101
4	95	104	96	81
5	109	99	103	92
6	98	90	94	89
7	101	113	99	112
8	98	87	103	92
9	84	123	115	112
Mean	95.44	96.44	102.22	93.00
SD	7.44	16.57	9.01	15.48
Normal Language				
1	109	113	121	112
2	112	99	111	112
3	123	113	125	124
4	112	118	125	124
5	112	99	98	101
6	120	107	115	96
7	105	113	111	131
8	105	139	117	138
9	112	104	117	92
Mean	112.22	111.67	115.56	114.44
SD	6.04	12.22	8.38	16.00

Data Analysis

Each students' self-talk corpus, which was produced during the experimental protocol, was transcribed and coded using Systematic Analysis of Language Transcripts (SALT) (Miller & Chapman, 1984). Samples were segmented, using a list of guidelines, dividing utterances into sentence-like units, corresponding to units of thought. Because students were thinking aloud, they were not talking as though there was a conversational partner involved. This resulted in several characteristics which made it difficult to simply transcribe students' self-talk into sentence units or T-units. For example, students' rate of speech was often influenced by the rate at which they were solving a particular problem, making it difficult to distinguish sentence boundaries. However, regardless of whether or not utterances were cluttered together by fast speech or separated by long pauses, it was possible to separate utterances into units of thought. Although students often spoke with a monotone as they thought aloud, inflection was used as a guide to distinguish units when possible. For example, downward inflection was used to help determine the end of thought units. Satisfactory reliability was determined and will be reported later.

Codes were designed to capture the following qualitative aspects of self-talk: (a) problem solving choices, (b) self-regulatory talk, and (c) referential self-talk. These codes are shown in Table 3. Codes that reflected problem solving choices were important in that they enabled the examiner to determine whether or not students' self-talk was leading them in the right direction for correct problem solution and the reasons

for incorrect problem solutions, when they occurred. This was important to capture because it would show that even when students were using "task relevant" self-talk, they might not be using skills necessary to make accurate problem solving choices. It was important to code instances of self-regulatory talk because this showed evidence of students' awareness of the decisions they were making (i.e., metacognitive skills). Codes that captured referential self-talk were important in that they enabled the examiner to determine how accurately the self-talk referred to what was printed (i.e., whether or not students were reading problems correctly) or to what the student was writing (i.e., whether or not students' self-talk matched their written work). Each unit was assigned one or more codes from the coding system.

Table 3

Utterance Codes

Problem Solving Codes	Self-Regulatory Codes	Referential Codes
[+]/[-] = correct/ incorrect answer	[SC] = self-correction	[R+]/[R-] = correct/ incorrect reading of a problem
[P+]/[P-] = whether student was on the right track or wrong track during problem solution	[SI] = self-instruction	[T+]/[T-] = whether student's self-talk matched/ did not match what student was doing
	[SE] = self-evaluation	
	[EC] = evaluating/ confirming (when student made a judgement or evaluated a process)	
	[EX] = explaining	[CP] = computation

Codes reflecting qualitative information and specific quantitative information were totaled using the SALT (Miller & Chapman, 1984) interface program. This was accomplished by the examiner programming a list of the variables to be counted by the interface program. This information was then entered into the SPSS (1994) statistical program for analysis. Before any analyses were run, totals were divided by minutes of observation (10 for computation problems and 5 for story problems) so that numbers represented per minute frequencies. For the MANOVA analyses, codes were organized into their variable groups according to the variables that the study set out to investigate (one set of quantitative variables and three sets of qualitative variables).

Interrater Reliability

Interrater Transcription

Interrater reliability for transcription of students' self-talk was achieved by having a second graduate student independently transcribe the self-talk samples of several students produced during the experimental protocol. The experimenter provided the second transcriber with guidelines for segmenting utterances into sentence-like units. The number of agreements for utterance boundaries was divided by the number of agreements plus disagreements and multiplied by 100. This procedure resulted in 86% reliability.

Interrater Coding

Interrater reliability for coding of transcribed utterances was achieved by having another graduate student familiar with the coding software program used to independently code several transcripts. The experimenter provided the second coder with an explanation of all codes and guidelines for coding utterances. The second coder was allowed to ask questions during her first attempt at coding (this attempt was not scored). Some of the second coder's questions and comments led to changes in the coding system which made it more reliable. Specifically, codes so close in meaning that they were difficult to distinguish were collapsed for ease and accuracy of coding. The second coder then coded a transcript entirely on her own. The number of agreements was divided by the number of agreements plus disagreements and multiplied by 100. This procedure resulted in 86% accuracy. Adjustments were made again after this coding process to ensure greater consistency. For instance, the off track ([P-]) and on track ([P+]) codes were added because often times students were receiving a talking matching code ([T+]) for their talking matching their written work, but what they were saying was off track for correct problem solution. The addition of the on track/off track codes made it possible to determine whether or not what they were saying matched what they were doing and whether or not what they were saying was on track or off track. The same graduate student coded two additional transcripts, one transcript randomly chosen from the group of experimental group subjects and one transcript randomly chosen from the control group subjects. The same calculations of agreements and disagreements

were made again, this time resulting in 92% accuracy.

Intrarater Reliability

Intrarater Transcription

The experimenter randomly chose audio-taped self-talk samples of students produced during the experimental protocol and transcribed them again to achieve intrarater reliability for transcription. Samples were retranscribed only after at least one month had passed from the time of the original transcriptions. The number of agreements was divided by the number of agreements plus disagreements and multiplied by 100. This procedure resulted in 93% accuracy.

Intrarater Coding

The experimenter chose transcripts and coded 4 of the 18 transcripts a second time to achieve intrarater reliability for coding. Transcripts that had been randomly chosen to be coded the earliest were chosen for recoding to assure that reliance on the memory of the first coding would not be a factor. The number of agreements was divided by the number of agreements plus disagreements and multiplied by 100. This procedure resulted in 92% accuracy.

CHAPTER IV

RESULTS

This study was designed to test three major questions regarding differences in the self-talk of students with language impairments (LI) and normal language (NL) when completing math computation and story problems. The first question addressed quantitative variables of the students' self-talk. The second question dealt with qualitative aspects of the students' self-talk. The third question addressed the issue of whether or not students with language impairments would have more difficulty completing math story problems as opposed to math computation problems. The results of this study are addressed below.

Quantitative Variables

Quantitative variables were assessed using 2 factor multivariate analysis of variance (MANOVA) using the SPSS (1994) statistical package, with group (LI, NL) and type problem (computation, story problems) as the two factors. Total words, total different words, total personal pronouns, total problems completed, and total number of utterances were used as the dependent variables in the MANOVA for quantitative aspects of self-talk. The Hotelling's test was selected for assessing significance. A confidence level of $p < .05$ was established a priori for rejecting the null hypothesis.

Using this procedure, significant differences in quantity of self-talk used by the students were found. The MANOVA for quantity variables showed significant group differences ($F = 4.107$; 5, 26 df; $p < .007$) and significant type of problem effects ($F = 122.012$; 5, 26 df; $p < .000$). The related univariate F-tests (1,30 df) showed significant differences between groups for total words, total different words, total personal pronouns, and total problems completed. NL students used significantly more words, more different words, and more personal pronouns. They also completed more problems than their LI peers. The test for differences for total number of utterances was not significant. The results for these tests, including means and standard deviations, are shown in Table 4.

Qualitative Variables

Qualitative variables were also assessed using 2 factor MANOVA, with group (LI, NL) and type problem (computation, story problems) as the two factors. A different MANOVA was completed for each set of qualitative variables addressed.

Self-Talk Associated With Problem Solving Choices

In answer to the question about whether or not there are differences in the self-talk associated with problem solving choices used by students with language impairments when compared with their normal language peers, qualitative differences did appear. The MANOVA related to self-talk associated with problem solving choices resulted in the confirmation both of group differences ($F = 3.890$; 7, 26 df; $p < .005$) and type of problem effects ($F = 10.033$; 7, 26 df; $p < .001$). Several univariate F-tests (1,

32 df) also showed significant differences between groups. NL students were on the right track (i.e., working towards a correct answer) significantly more often and were

Table 4

Overall Univariate Tests, Means (Expressed as Frequency Per Minute) and Standard Deviations Following MANOVA for Quantitative Variables

Variable	Group				F	p
	LI		NL			
	M	SD	M	SD		
Total words	68.65	20.29	82.04	12.51	5.782	.023*
Total different words (in first 50 utterances)	70.78	22.76	80.78	24.87	14.976	.001**
Total personal pronouns	1.83	.96	2.59	1.21	5.390	.027*
Total problems	1.07	.47	1.27	.51	6.029	.020*
Total utterances	14.81	4.59	16.05	2.32	2.186	.150

Note. LI = students with language impairments; NL = students with normal language. *Significant at the .05 level. **Significant at the .005 level.

off track (i.e., heading in the wrong direction) significantly less often than their LI peers. When an incorrect answer was reached, LI students took the wrong approach to a problem significantly more often, whereas NL students chose the correct approach, but

made an incorrect calculation or did not finish all the necessary steps to a problem significantly more often. The tests for differences for taking the correct approach but making a transcription error and for the proportion of problems correct were not significant. The results for these tests, including means and standard deviations, are shown in Table 5.

Self-Regulatory Talk

In answer to the question regarding whether or not there are differences in the self-regulatory talk of students with language impairments when compared with their normal language peers, qualitative differences did occur. The MANOVA related to self-regulatory talk resulted in evidence of group differences ($F = 3.107$; 3, 30 df; $p < .041$) and type of problem effects ($F = 11.668$; 3, 30 df; $p < .0001$). One univariate F-test (3, 30 df) showed significant differences between groups. NL students made evaluating and confirming statements significantly more often than their LI peers. The tests for differences for explanatory statements and self-instructional and self-correctional statements were not significant. The results for these tests, including means and standard deviations, are shown in Table 6.

Referential Self-Talk

In answer to the question about whether or not there are differences in the referential self-talk of students with language impairments when compared with their normal language peers, qualitative differences did appear. The MANOVA related to

Table 5

Overall Univariate Tests, Means (Expressed as Frequency Per Minute) and Standard Deviations for Self-Talk Following MANOVA for Problem Solving Choices

Variable	Group				F	p
	LI		NL			
	M	SD	M	SD		
On track	6.24	3.86	9.04	3.66	10.227	.003**
Off track	2.70	2.17	1.09	.76	8.720	.006*
Wrong approach	.09	.16	.02	.04	5.541	.025*
Correct approach, incorrect calculation	.01	.05	.09	.14	6.294	.017*
Correct approach, non-completion of problem	.02	.07	.07	.09	4.655	.039*
Correct approach, transcription error	.02	.07	.04	.08	.462	.502
Proportion of problems correct	.64	.23	.73	.18	2.195	.148

Note. LI = students with language impairments; NL = students with normal language.
*Significant at the .05 level. **Significant at the .005 level.

referential self-talk resulted in the confirmation of group differences ($F = 2.926$; 5, 28 df; $p < .030$) and type of problem effects ($F = 12.762$; 5, 28 df; $p < .0001$), but none of the subsequent univariate F-tests (5, 28 df) showed significant differences between groups. The fact that the MANOVA differences seemed to appear, yet were not statistically significant may be explained by Winer (1971) who wrote that:

> In spite of a significant multivariate test it may be that no univariate test of the form indicated will be significant. Considered singly, the univariate tests disregard the covariances among the variables and hence use less of the information available about a set of observations. (p. 56)

The only univariate analysis to approach significance ($p< .053$) was the one that identified matches in talking (see Table 7). In this case, the NL group showed more matches in talking while solving the math problems. Talking matching means that when students were talking through problems, their self-talk matched their written work (i.e., what they were saying matched what they were doing).

Relative Difficulty With Story Problems

A 2 factor univariate ANOVA was used to test the relative difficulty with story problems using group (LI, NL) and type problem (computation, story problems) as the 2 factors, and proportion of problems completed correctly as the dependent variable. Using this procedure, students with language impairments were not found to have significantly more difficulty completing story problems compared with computation problems than their NL peers. For a significant difference to be confirmed, a significant interaction between group and type problem would have to be found. Contrary to the

anticipated result, no significant effect appeared (F=2.136; 1, 32 df; p< .154) in this ANOVA. There was a significant main effect for type problem (F= 9.858; 1, 32 df; p< .004) showing that the proportion of story problems answered correctly was significantly lower and the proportion of computation problems answered correctly was significantly higher. The main effect for group was not significant.

Table 6

Overall Univariate Tests, Means (Expressed as Frequency Per Minute) and Standard Deviations Following MANOVA for Self-Regulatory Talk

	Group					
	LI		NL			
Variable	M	SD	M	SD	F	p
Evaluating/ Confirming	1.59	.85	2.11	.58	4.885	.034*
Explaining	.01	.05	.07	.12	3.333	.077
Self-instructing & self-correcting	.58	.40	.66	.34	3.299	.079

Note. LI = students with language impairments; NL = students with normal language
*Significant at the .05 level. **Significant at the .005 level.

As noted earlier in this chapter, significant type of problem effects were found in the MANOVA for quantitative variables and the three MANOVAs for each of the qualitative variables (problem solving choices, referential self-talk, and self-regulatory

talk). There were significant univariate F-tests for each of these variables also, which are shown in Tables 8, 9, 10, and 11. In each case, story problems tended to be more challenging for both groups (LI and NL). The means for total number of problems, total different words, total utterances, on track self-talk, proportion of problems correct, self-instructional and self-correctional statements, instances of misreading, and instances of talking matching written work were all higher for computation problems regardless of group.

Table 7

Overall Univariate Tests, Means (Expressed as Frequency Per Minute) and Standard Deviations Following MANOVA for Referential Self-Talk

	Group					
	LI		NL			
Variable	M	SD	M	SD	F	p
Talking - match	7.99	3.81	9.49	3.29	4.031	.053
Talking - mismatch	.61	.48	.44	.30	2.116	.156
Reading - match	2.02	.65	2.24	.75	.894	.351
Reading - mismatch	.23	.16	.26	.23	.287	.596

Note. LI = students with language impairments; NL = students with normal language.
*Significant at the .05 level. **Significant at the .005 level.

Table 8

Overall Univariate Tests, Means (Expressed as Frequency Per Minute) and Standard Deviations Following MANOVA for Quantitative Variables

Variable	Type Problem: Computation M	Computation SD	Story Problems M	Story Problems SD	F	p
Total words	77.99	18.73	73.49	16.90	.828	.370
Total different words (in first 50 utterances)	53.94	8.09	97.61	10.71	257.404	.000**
Total personal pronouns	1.67	1.07	2.76	1.00	9.804	.004**
Total problems	1.60	.30	.74	.14	143.302	.000**
Total utterances	17.94	3.00	12.91	2.20	31.703	.000**

*Significant at the .05 level. **Significant at the .005 level

Additional information about the mathematical abilities and passage comprehension abilities of the two groups of students was obtained by statistical analysis of standard scores for the four subtests selected from the Woodcock-Johnson Psycho-Educational Battery - Revised (Woodcock & Johnson, 1989, 1990). In this case, a single factor MANOVA, with group (LI, NL) as the factor, showed significant group differences ($F = 2.711$; 4, 13 df; $p < .001$). Univariate F-tests for Passage Comprehension, Calculation,

Table 9

Overall Univariate Tests, Means (Expressed as Frequency Per Minute) and Standard Deviations Following MANOVA for Problem Solving Choices

Variable	Type Problem: Computation M	Computation SD	Story Problems M	Story Problems SD	F	p
On track	10.32	3.41	4.96	2.35	37.571	.000**
Off track	2.19	2.23	1.60	1.23	1.165	.288
Wrong approach	.00	.00	.12	.15	14.459	.001**
Correct approach, incorrect calculation	.08	.14	.03	.06	2.266	.142
Correct approach, non-completion of problem	.00	.00	.09	.10	18.618	.000**
Correct approach, transcription error	.03	.08	.03	.07	.0513	.822
Proportion of problems correct	.78	.12	.59	.24	9.858	.004**

*Significant at the .05 level. **Significant at the .005 level.

Applied Problems, and Quantitative Concepts showed significant differences between groups. For each subtest, NL students scored significantly higher than their LI peers. It should be noted, however, that both groups (LI and NL) scored within normal limits on all subtests. The widest differences appeared for Passage Comprehension and Applied Problems. The results for these tests, including means and standard deviations, are shown in Table 12.

Table 10

Overall Univariate Tests, Means (Expressed as Frequency Per Minute) and Standard Deviations Following MANOVA for Referential Self-Talk

	Type Problem					
	Computation		Story Problems			
Variable	M	SD	M	SD	F	p
Talking - match	6.00	1.80	11.48	2.72	53.762	.000**
Talking - mismatch	.74	.41	.31	.25	15.701	.000**
Reading - match	2.00	.79	2.26	.58	1.299	.263
Reading - mismatch	.36	.20	.13	.11	19.322	.000**

*Significant at the .05 level. **Significant at the .005 level.

Table 11

Overall Univariate Tests, Means (Expressed as Frequency Per Minute) and Standard Deviations Following MANOVA for Self-Regulatory Talk

	Type Problem					
	Computation		Story Problems			
Variable	M	SD	M	SD	F	p
Evaluating/ Confirming	2.08	.80	1.62	.67	3.881	.058
Explaining	.04	.11	.03	.08	.133	.717
Self-instructing & self-correcting	2.99	1.19	1.13	.61	36.292	.000**

*Significant at the .05 level. **Significant at the .005 level.

Table 12

Overall Univariate Tests, Means (Expressed as Frequency Per Minute) and Standard Deviations for WJ-R Standard Scores

Variable	Group				F	p
	LI		NL			
	M	SD	M	SD		
Passage Comprehension	95.44	7.44	112.22	6.04	27.621	.000**
Calculation	96.44	16.57	111.67	12.22	4.921	.041*
Applied Problems	102.22	9.01	115.56	8.38	10.563	.005*
Quantitative Concepts	93.00	15.48	114.44	16.00	8.348	.011*

Note. LI = students with language impairments; NL = students with normal language.
*Significant at the .05 level. **Significant at the .005 level.

CHAPTER V

DISCUSSION

This study revealed several significant differences in the self-talk of students with language impairments (LI) when compared with their normal language (NL) peers. These differences, and their clinical implications, are discussed in this chapter. Suggestions for future research are also be addressed.

Group Differences in Quantitative Aspects of Self-Talk

The fact that differences appeared in the amount of self-talk of students with LI when compared with their NL peers is not necessarily contradictory with previous studies, which reported no differences in the amount of self-talk for students with special needs when compared to normally achieving peers. The current study did not reveal significant group differences in the total number of utterances produced. This is consistent with the findings of previous research and indicates that a broad look at overall amount of self-talk may not be an adequate way to determine group differences for quantity of self-talk. A closer look at the quantitative aspects of students' self-talk revealed that NL students did use significantly more words, different words, and personal pronouns than their LI peers. They also completed significantly more problems. The differences in the number of words used (tokens) and the number of

different words used (type) suggests that NL students produce more words per self-talk utterance and use a greater variety of words when talking themselves through math problems. Perhaps NL students have a richer vocabulary base from which to draw. The difference in number of personal pronouns is difficult to interpret. The fact that NL students used significantly more personal pronouns may represent greater self-reflection and ability to visualize the participants in story problems. The fact that NL students completed more problems indicates that they were able to work through problems at a quicker pace and were not slowed by using more words.

Previous studies that examined the broad overall amount of self-talk produced by students found no significant differences in the amount used by students with special needs when compared to their normally achieving peers. The authors of such studies (e.g., Berk & Landau, 1993; Berk & Potts, 1991) suggested that students with special problems need only be encouraged to use self-talk to enhance their academic skills. The findings of the present study suggests that there are important quantitative differences which would not be appropriately addressed by simply encouraging students' to use self-talk. This is further supported by the qualitative differences found which will be discussed below.

Group Differences in Qualitative Aspects of Self-Talk

An examination of the content of students' self-talk also revealed several qualitative differences. Differences were found in the three qualitative categories examined: problem solving choices, self-regulatory talk, and referential self-talk.

Problem Solving Choices

A significant overall group difference was found for the qualitative category of problem solving choices. Specifically, LI students were off track significantly more often and on track significantly less often than their NL peers. That is, LI students made statements associated with going in the wrong direction for problem solution more often when solving both computation and story problems and made statements associated with going toward a correct answer less often than their NL peers. Statements were coded "off track," when they literally related to an off-track problem solving move. Sometimes, self-talk was considered off track because of an error in calculation. For example, LI Student 3 said "One times five is fifty." Other times, self-talk was considered off track because of an error in choice regarding the route to problem solution. For example, when solving the story problem which read "Sandy worked four hours a day at the town library. One week she worked six days. How many hours did she work that week?," LI Student 11 said "There's twenty four hours in a day. Twenty four times six. Six times four is twenty four. Six times two is twelve. Plus the two. Fourteen. A hundred and forty four hours." In this situation, each of the above utterances were considered off track, as they were undoubtably leading her to an incorrect solution. It should be noted that if students got back "on track," their utterances were coded accordingly.

When students reached an incorrect answer, the reasons varied significantly between groups. Students with LI reached an incorrect answer more often because they

took the wrong approach. For example, in response to the story problem that read "Jeff and Bob started reading their books on the same day. Jeff read six pages a day and Bob read four pages a day. How many more pages had Jeff read than Bob after six days?," LI Student 8 said "Six times four equals twenty four. So twenty four pages in six days." taking the wrong approach for problem solution. Students with NL reached an incorrect answer more often as a result of taking the correct approach, but making in incorrect calculation or not fully completing all the necessary steps of a problem. For example, in response to the same story problem mentioned above, NL Student 12 said "Four pages a day. So we have to see how many that is. So six pages a day. So that would be six times six. Six times six is thirty six. And six times four is twenty four. So we have to do thirty six minus twenty four." taking the correct approach for problem solution. However, this student then misread the six he wrote down in the number thirty six as a zero and therefore arrived at a wrong answer because of incorrect calculation.

Self-Regulatory Talk

A significant overall group difference was found in the qualitative category of self-regulatory talk. Specifically, LI students used significantly fewer evaluating and confirming statements than their NL peers. An example of an evaluating/confirming statement can be shown with an excerpt from a NL student's self-talk transcript. Student 12 said "We can't take eight away from four because eight is a bigger number than four." Another example from a NL student transcript (Student 7) is the statement "So we just have to increase by two." The fact that LI students used fewer evaluating/

confirming statements suggests that LI students were not making judgements or confirming their answers and the procedures they chose as actively. This suggests that LI students may benefit from intervention techniques that focus on evaluation and confirmation skills.

Referential Self-Talk

An overall group difference was determined for the qualitative category of referential self-talk. However, no specific univariate tests were significant. This significant MANOVA result, with nonsignificant univariate tests, suggests that there is not a strong difference between groups for this category, but justifies further research in this area. These findings may be important clinically and future research should focus on individual students to note whether certain students are especially high in mismatches in talking and/or reading.

Relative Difficulty With Story Problems

The lack of a significant interaction effect between group and type of problem indicates that LI students did not have relatively more difficulty with math story problems than with computation problems when compared with their NL peers in this study. However, analysis of the MANOVA for quantitative variables and the three MANOVAs for the qualitative variables of problem solving choices, self-regulatory talk, and referential self-talk resulted in several significant univariate F-tests indicating that story problems were more challenging for both groups. This may warrant further

investigation in this area. The fact that there were significant group differences for each of the math subtests administered from the Woodcock-Johnson Psycho-Educational Battery - Revised adds support to the notion of further investigation.

Conclusions

This study set out to answer questions regarding the quantitative differences and qualitative differences in the self-talk of students with LI when compared with their NL peers and the question of whether or not story problems were relatively more difficult than computation problems for students with LI when compared to their NL peers. The statistical analyses used to answer these questions resulted in the following conclusions:

1. Differences are apparent in the quantitative aspects of self-talk used by students with LI, in that students with LI use fewer total words, different words, personal pro- nouns and complete fewer problems than NL peers.

2. Differences are apparent in the problem solving choices made by students with LI, in that students with LI were off track more often and on track less often than their NL peers. When LI students reached an incorrect answer, it was more often the result of taking the wrong approach when compared with their NL peers who more often chose the correct approach, but made an incorrect calculation or did not finish all the necessary steps to a problem when they reached an incorrect answer.

3. Differences are apparent in the self-regulatory talk used by students with LI, in that students with LI make fewer evaluating and confirming statements than their NL peers.

4. Differences were not apparent in the relative difficulty of math story problems as opposed to computation problems for LI students when compared with their NL peers.

5. Students with LI have significantly poorer reading comprehension and math skills than their same grade NL peers, even though their skills may be within normal limits.

Summary of Clinical Recommendations

One previously unresolved issue was whether students with special needs would benefit from intervention focused on the teaching of self-talk. Perhaps the current study sheds some new light on this old argument. One of the main reasons why sociocultural theorists have disagreed with cognitive-behavioral techniques that "teach" self-talk has been based on their observation that students with special problems are not deficient in the amount of self-talk they produce. Therefore, teaching them to use self-talk has been considered unjustified. The fact that the present study did find important differences in the self-talk of students with language impairments when compared with their normal language peers indicates that, although students with special needs may not be deficient in their ability to use self-talk, they definitely are not as adept at using their self-talk in helpful ways. Perhaps intervention focused on teaching more strategic use of self-talk would benefit students with special problems. Any type of intervention would have to be based on an individual's particular needs in terms of his/her self-talk. For instance, it would be helpful to look for inadequate vocabulary, lack of personal pronoun use, instances of being off track and taking the wrong approach, and a lack of confirming

questions and evaluating comments when evaluating students' self-talk.

Future Research

The small number of participants in this study suggests that this study should be replicated with a larger number of participants to determine reliability of results. This study could also be replicated with a group matched for mathematical ability to see if they would differ in some ways. Focus on individual students in future research might offer important clinical benefits. Additional investigation is also needed to further assess the possibility of students with language impairments having more difficulty with story problems as opposed to computation problems when compared with their NL peers. A replication study might help to address this issue.

Research investigating therapy focused on the self-talk of students with LI might prove beneficial. Perhaps therapy focused on building the self-talk of students with LI to be more like their NL peers would result in improved problem solving speed and skills. Results of studies focused on using self-talk in intervention could offer insight to the discussion regarding the relevance of such techniques.

Appendix A

Subject Recruitment Letter and Response Post Card

Department of Speech Pathology and Audiology
Charles VanRiper Language, Speech and Hearing Clinic

Kalamazoo, Michigan 49008-3825
616 387-8045

WESTERN MICHIGAN UNIVERSITY

November 17, 1995

Dear parents:

I am writing to invite your child to participate in a research project I am conducting under the supervision of Dr. Nicki Nelson of Western Michigan University. We are interested in the differences between the self-talk used by students when they are solving academic problems, particularly math.

Being involved in this study would involve three short sessions during the month of November. Because we are interested in self-talk, the main activity of the project will be observing your child "thinking aloud" while doing math problems. All data and information gathered during this project will remain confidential. One-word fictitious names will be used on all data collection forms instead of students' real names.

By participating in this project, your child will receive a free hearing screening and I will give you the video tape made during the project when the analysis is complete.

We are not asking for consent at this point, but if you are willing to allow your child to participate in our project or would like to have questions answered before deciding, please indicate this on the enclosed post card and give it to your child's classroom teacher, or to Dortha Braat (Teacher of Speech-Language Impaired Students at Amberly), or mail it directly to me by November 28, 1995. If you note that you are interested, I will contact you with further information.

Jennifer S. Crouse
Graduate Student in Speech-Language Pathology

Nickola W. Nelson
Professor
Faculty Member

You may contact me with further information regarding your research project:

Yes ____ No ____

My name _____

My child's name _____

Home phone number _____

** My home phone number is 382-1277 if you would like to contact me at any time with questions or concerns you might have.

Appendix B

Parent Consent Form

Western Michigan University
Department of Speech Pathology and Audiology

Principal Investigator: Nickola Wolf Nelson, Ph.D., CCC-SLP
Research Associate: Jennifer Shephard Crouse, B.A.

I understand that my child has been asked to participate in a research project entitled "Qualitative differences in the self-talk of fifth grade children." The purpose of this study is to determine the different features of self-talk used by fifth grade children. I understand that this project is also being done in order to fulfill Jennifer Crouse's thesis requirements.

My consent for my child to participate in this project means that my child will leave class three separate times during the month of December or January for approximately one-half hour per session. During the first session, my child will have his/her hearing screened. The project and the equipment to be used (audio and video taping equipment) will be explained and my child will be able to try wearing the audio taping equipment and do a practice video tape. During the second session, my child will complete some math problems while talking aloud. What my child says and the work he/she does will be audio and video taped. During the last session, five subtests from the *Woodcock-Johnson Psycho-Educational Battery-Revised* will be administered to my child. My child will be tested individually by someone experienced in test administration. Any child involved with this project may choose not to participate at any time. If my child refuses or quits, there will be no negative effect on her/his school programming.

By participating in this project, my child will receive a free hearing screening and will get to keep the video tape made during the project when the analysis is complete. Although there may be no other immediate benefits to my child for participating, it is possible that the school district and subsequent students in special education programs may benefit in the future, depending on the project's results.

I further give you my permission to have Amberly Elementary School provide you with information from my child's school records regarding previous test scores. I understand that all test data and information will remain confidential. A fictitious name will be used instead of my child's name on all test forms and data collection forms used for this project. A separate list of all the children's names and corresponding fictitious names will be kept in a locked file. No names will be used if the results are published or reported at a professional meeting.

I understand that audio and video tapes are to be used for collecting accurate data for the project. By signing this form, I am giving you permission to audio tape what my child says while working on math problems and video tape my child's written work while working on math problems.

I understand that the only risks anticipated are minor discomforts typically experienced by children when they are being tested (e.g., boredom, mild stress owing to the testing situation, and missing time from class). I understand that all the usual methods applied during

standardization testing to minimize discomforts will be applied in this study. Sessions will be scheduled in consultation with classroom teachers to minimize any negative effects of being out of the classroom for brief periods. As in all research, there may be unforeseen risks to my child. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or additional treatment will be made available to my child except as otherwise specified in this consent form.

I understand that I may also withdraw my child from this study at any time without any negative effect on services to my child. If I have any questions or concerns about this study, I may contact either Dr. Nicki Nelson at 387-8058 or Jennifer Crouse at 382-1277. I may also contact the Chair of Human Subjects Institutional Review Board of Western Michigan University at 387-8293 or the Vice President for Research at 387-9298 with any concerns that I have.

My signature below indicates that I give permission for _____ (child's name) to participate in the project's three sessions, have his/her hearing screened, be audio and video taped while working on math problems, be tested with five subtests from the *Woodcock-Johnson Psycho-Educational Battery-Revised*, and for information in my child's school records to be released to you for this research.

_____ _____

Signature Date

PLEASE CHECK ANY OF THE ITEMS BELOW THAT APPLY TO YOUR CHILD

___ Has received speech and language therapy, special education, or Section 504 accommodations or needs. If yes, explain _____
_____
_____

___ Has a history of emotional problems. If yes, explain _____
_____
_____

___ Has experienced five of more ear infections before the age of four. If yes, explain _____
_____
_____

___ Is currently taking any medications. If yes, explain _____
_____
_____

Appendix C

Student Assent Form

STUDENT ASSENT FORM

Western Michigan University
Department of Speech Pathology and Audiology

Principal Investigator: Nickola Wolf Nelson, Ph.D., CCC-SLP
Research Associate: Jennifer Shephard Crouse, B.A.

I understand that I have been asked to be part of a research project. The project is being done to find out if there are differences in the way children talk to themselves.

I understand that if I agree to be part of the project, I will leave my class two different times in December and/or January. Each time I leave class, I will go to a session that lasts about one-half hour. If I do not want to be part of the project, it is okay. Even if I agree to participate by signing this form today, I can change my mind any time.

If I agree to be part of the project, I understand that I will be doing some different activities during each session I am away from class. During the first session, my hearing will be checked. I will learn about the equipment that will be used. I will get to wear the audio taping equipment and do a practice video tape. I will do some math problems while talking out loud. What I say will be audio taped and the work I am doing will be video taped. During the second session, I will be given some tests from the *Woodcock-Johnson Psycho-Educational Battery-Revised.*

If I sign below, I am agreeing to let the school show you my school records. These records have old test scores in them.

I understand that my name will not be on any of the papers used for the project. I will make up a code name that will be used instead. You will keep a list of real names and code names in a locked file.

If I have any questions about this project, I can call Dr. Nelson at 387-8058 or Mrs. Crouse at 382-1277.

If I sign my name below I agree:
1) to participate in the project's two sessions,
2) to have my hearing screened,
3) to be audio and video taped while working on math problems,
4) to be tested with five subtests from the *Woodcock-Johnson Psycho-Educational Battery-Revised*,
   and
5) for my school to share information that is in my school records.

Print name here _____

Sign name here _____ Today's date _____

Appendix D

Practice Protocol

PRACTICE

1. $\begin{array}{r} 33 \\ +9 \\ \hline \end{array}$

2. $\begin{array}{r} 72 \\ \times 8 \\ \hline \end{array}$

---

1. Tim rode 393 km one month, 464 km the next month, and 639 km the third month. How far did he ride during the 3 months?

2. An indigo snake is 234 cm long. A water snake is 127 cm shorter. How long is the water snake?

Appendix E

Experimental Protocol

1. 24 +8	2. 36 -11	3. 203 +154	4. 64 x7
5. 5324 +3679	6. $50\overline{)300}$	7. 174 -96	8. $5\overline{)3470}$
9. 523 x 4	10. 9617 -7508	11. 732.76 18.27 + 5.18	12. 607 x36
13. 789 x 5	14. 592 - 65	15. 429 + 398	16. 7853 + 544
17. 45 x 23	18. 100 - 50	19. 8721 - 98	20. 7658 + 623 + 24

---

1. Conrad bought 13 post cards, but he only had stamps for 7 of the cards. How many more stamps did he need?

2. Sandy worked 4 hours a day at the town library. One week she worked 6 days. How many hours did she work that week?

3. Jeff and Bob started reading their books on the same day. Jeff read 6 pages a day and Bob read 4 pages a day. How many more pages had Jeff read than Bob after 6 days?

4. A shipping clerk has 72 books to pack in boxes. Each box will hold 8 books. How many boxes does he need?

5. What would be the total cost of 7 pairs of socks for $4.00 a pair and a shirt for $9.89?

6. Ned is saving $20 a week to buy a tape deck. He already saved $60. The tape deck costs $220. How many more weeks will it be before he has enough money to buy the tape deck?

7. Jean paid $369.00 for a 35-mm camera. She also bought a special lens for $297.00, a tripod for $47.29, and 2 rolls of film for $3.29 a roll. What was the total cost?

8. Kim jogged around a rectangular field 337 meters long and 225 meters wide. How far did she jog in 1 lap around the field?

9. A car travels at an average speed of 88 km per hour. About how far will it travel in 8 hours?

10. The Soos have 392 lb of beef in one freezer and 178 lb in another. This is enough beef to last for one year. If each family member eats an average of 95 lb of beef a year, how many people are in the family?

11. A clerk in a grocery store receives $5 per hour. If she works 35 hours a week, how much does she receive for 6 weeks?

12. Carrie rode her bicycle 2.7 km on Monday, 3.5 km on Wednesday, and 12.9 km on Saturday. How far did she ride all together?

13. The 4 members of a band will earn $276 for playing at the school dance. They will divide the money equally. How much will each get?

14. Jo agreed to collect 150 cans for recycling. She collected 36 cans the first week and 75 cans the second week. How many more cans does she need?

15. Marco plans to take a 2-hour typing lesson 3 days a week. He will take the lessons for 12 weeks. How many hours of lessons will he take in all?

16. The Rose Bowl in Pasadena, California, has 101,025 seats. Memorial Coliseum in Los Angeles has 93,791 seats. How many more seats does the Rose Bowl have?

Appendix F

Coded Transcript of LI Student Number 3

Mon May 06 11:05:06 1996
A:\expsubj3.all

ALL ENTRIES

```
  1 $
  2 + 12-20-95
  3 + protocol
  4 = cp.1
  5 =[+]
  6 P Twenty four plus eight [R+].
  7 P Four and eight is twelve [T+][CP][P+].
  8 P Carry the one [T+][CP][P+][SI].
  9 P Two plus one is three [T+][CP][P+].
 10 = cp.2
 11 =[+]
 12 P Problem two [R+].
 13 P Thirty six minus eleven [R+].
 14 P Six minus (fi*) one is five [T+][CP][P+][SC].
 15 P Three minus one is two [T+][CP][P+].
 16 = cp.3
 17 =[+]
 18 P Problem number three [R+].
 19 P (Two o five, er) two o three plus one fifty four [R+][SC].
 20 P Three plus four is seven [T+][CP][P+].
 21 P Zero plus five is five [T+][CP][P+].
 22 P Two plus one is three [T+][CP][P+].
 23 = cp.4
 24 =[+]
 25 P Problem number four [R+].
 26 P Sixty four times seven [R+].
 27 P Sixty four times seven [T].
 28 P Seven times four is twenty eight [T+][CP][P+].
 29 P Six times seven is forty two [T+][CP][P+].
 30 P Plus two [T+][CP][P+].
 31 P Forty four [T+][CP][P+].
 32 = cp.5
 33 =[+]
 34 P Problem number five [R+].
 35 P (Three) five thousand three hundred twenty four plus three thousand six
      hundred seventy nine [R+][SC].
 37 P Four plus nine is thirteen [T+][CP][P+].
 38 P Seven plus two is nine [T+][CP][P+].
 39 P Plus one is ten [T+][CP][P+].
 40 P Carry the one [T+][CP][P+][SI].
 41 P Six plus three is nine [T+][CP][P+].
 42 P Plus one is ten [T+][CP][P+].
 43 P Carry the one [T+][CP][P+][SI].
 44 P Five and three is eight [T+][CP][P+].
 45 P Carry the one is nine [T-][CP][P+][SI].
 46 = cp.6
 47 =[-][CAOT]
 48 P Problem number six [R+].
 49 P Fifty divide/ed by three hundred [R-].
 50 P Five go/3s into three once [T+][CP][P-][EC].
 51 P (Five times fifty is) one times fifty is fifty [T+][CP][P-].
 52 P Wait a second [T][AC].
```

53 P One times five is (five, er) fifty [T-][CP][P-].
54 P One times fifty is fifty [T+][CP][P-][SC].
55 P Okay [T][AC].
56 P Then you minus [T+][P-][EC].
57 P Zero minus zero [T+][CP][P-].
58 P Zero [T+][CP][P-].
59 P (Zero) you cross out the a zero [T+][CP][P-][SI].
60 P (Put) make a ten [T+][CP][P-][SI].
61 P Make the three a two [T+][CP][P-][SI].
62 P And ten minus five is five [T+][CP][P-].
63 P And (minus two, er, zero) two minus zero (is) is two [T+][CP][P-][SC].
64 P Okay [T][AC].
65 = cp.7
66 =[+]
67 P Problem number seven [R+].
68 P One seventy four minus ninety six [R+].
69 P Four minus six you can/'t do [T+][P+][EC].
70 P Cross that out [T+][CP][P+][SI].
71 P Cross seven out [T+][CP][P+][SI].
72 P Change it to a six [T+][CP][P+][SI].
73 P Make four fourteen [T+][CP][P+][SI].
74 P Fourteen minus six (is) is eight [T+][CP][P+].
75 P Go to your six [T][P+][SI].
76 P (Cross) make that a sixteen and cross the one out [T+][CP][P+][SI].
77 P (Sixteen minus nine is) make that into a seven [T+][CP][P+][SI].
78 P And seventy eight [T+][P+].
79 = cp.8
80 =[-][CAOT]
81 P Problem number eight [R+].
82 P Five divide/ed by (thirty) three thousand four hundred seventy [R-]
[SC].
83 P Kay [T][AC].
84 P (Five go/3s into tw*) five does/n't go in three [T+][P+][EC].
85 P So five has to go into thirty four six time/s [T+][CP][P+][EC].
86 P So put your six above the three [T+][CP][P-].
87 P Six times five is thirty [T+][CP][P+].
88 P And then minus [T][P+][EC].
89 P Drop your zero [T+][CP][P-].
90 P Seven minus three is four [T+][CP][P-].
91 P And then four minus zero is four [T+][CP][P-].
92 P Three minus zero is three [T+][CP][P-].
93 P (Then, um) let/'s see [T][AC].
94 P (Then you, um) six times five is thirty [T+][CP][P-].
95 P And (zero ti*) zero minus zero is zero [T+][CP][P-].
96 P Four minus three is one [T+][CP][P-].
97 P Four minus zero is four [T+][CP][P-].
98 P Three minus zero is three [T+][CP][P-].
99 P So you have a total of three thousand four hundred ten [T+][P-].
100 P A remainder [T+][P-][EC].
101 P Six remainder three thousand four hundred and ten [T+][P-].
102 = sp.1
103 =[+]
104 P Number one [R+].

105 P Cornrad bought thirteen post card/s, but he only had stamp/s for seven of the card/s [R+].
107 P How many more stamp/s did he need [R+]?
108 P So you do thirteen minus seven [T+][P+][EC].
109 P (Zer*) three minus seven you can/'t do [T+][P+][EC].
110 P Cross the three out [T+][CP][P+][SI].
111 P Cross the one out [T+][CP][P+][SI].
112 P Put a zero on top of the one [T+][CP][P+][SI].
113 P Make a thirteen [T+][CP][P+][SI].
114 P Thirteen minus seven is thirteen, twelve, eleven, ten, nine, eight, seven, six, is six [T+][CP][P+].
116 P (So you) six stamp/s [T+][P+].
117 = sp.2
118 =[+]
119 P Number two [R+].
120 P Sandy work/ed four hour/s a day at the town library [R+].
121 P One week she work/ed six [R-].
122 P How many hour/s did she work that week [R+]?
123 P Sandy work/ed four hour/s a day [T].
124 P Four times six is twenty four hour/s [T+][CP][P+].
125 = sp.3
126 =[-][WA]
127 P Number three [R+].
128 P Jeff and Bob start/ed reading their book/s on the same day [R+].
129 P Jeff read six page/s a day and Bob read four page/s a day [R+].
130 P How many more page/s had Jeff read than Bob after six day/s [R+]?
131 P There are seven day/s in a week [T].
132 P (Um) let/'s see [T][AC].
133 P Jeff read six page/s a day [T].
134 P Bob read four page/s a day [T].
135 P How many more page/s did Jeff read than Bob after six day/s [T]?
136 P (Um, so six, um) six plus four is ten [T+][CP][P-].
137 P (Um, so he read) oh wait a second [T][AC].
138 P Jeff read six page/s a day [T].
139 P Bob read four page/s a day [T].
140 P How many more page/s did Jeff read than Bob after six day/s [T]?
141 P Ten page/s [T+][P-].
142 = sp.4
143 =[-][WA]
144 P Number four [R+].
145 P A shipping clerk has seventy two book/s to pack (in a, in a) in box/s [R+].
146 P Each box will hold eight book/s [R+].
147 P How many box/s does he need [R+]?
148 P Seventy two times eight [T+][P-][EC].
149 P Two times eight is sixteen [T+][CP][P-].
150 P Eight times seven is fifty six [T+][CP][P-].
151 P Plus one is fifty seven [T+][CP][P-].
152 P Five hundred (si*) seventy six [T+][P-][SC].
153 = sp.5
154 =[-][CAOT]
155 P Number five [R+].
156 P What would be the total cost of seven pair/s of sock/s for four

dollar/s a pair (and a pair) and a shirt for nine eighty nine [R+]?
158 P So [T][AC].
159 P Okay [T][AC].
160 P So you go four, eight, twelve, sixteen [T+][CP][P-].
161 P And sixteen dollar/s plus nine eighty nine [T+][P-][EC].
162 P Nine eighty nine [T+][P-].
163 P Nine eighty nine [T+][P-].
164 P Plus nine eighty nine [T+][P-][EC].
165 P So nine and nine is eighteen [T+][CP][P-].
166 P Plus another nine [T+][CP][P-].
167 P Twenty seven [T+][CP][P-].
168 P Plus another equal/3s thirty six [T+][CP][P-].
169 P Okay [T][AC].
170 P Eight plus eight is sixteen [T+][CP][P-].
171 P And eight plus eight is sixteen [T+][CP][P-].
172 P So sixteen plus sixteen would be (um) thirty two [T+][CP][P-].
173 P (Plus the thr*, carry) plus we carry the three [T+][CP][P-][SC].
174 P (Would be) would be thirty five [T+][CP][P-].
175 P Okay [T][AC].
176 P So nine and nine is eighteen [T+][CP][P-].
177 P (Plus, twenty s*) plus another nine is twenty seven [T+][CP][P-][SC].
178 P Plus another nine (is twenty se*, er) is thirty six [T+][CP][P-][SC].
179 P Plus six (is) would be forty two [T+][CP][P-].
180 P Plus three would be forty five [T+][CP][P-].
181 P One plus four would be five [T+][CP][P-].
182 P So five thousand five hundred and fifty six [T+][P-].
183 P No wait [T][AC].
184 P (Er) fifty five dollar/s and fifty six cent/s [T+][P-][SC].
185 = sp.6
186 =[-][WA]
187 P Number six [R+].
188 P (Um) Ned is saving twenty dollar/s a week to buy a tape deck [R+].
189 P He already save/ed sixty dollar/s [R+].
190 P The tape deck cost/3s two hundred and twenty [R+].
191 P How many more week/s will it take before he has enough money to buy the tape deck [R+]?
193 P Okay [T][AC].
194 P So (um, Ned is saving twenty dollars a week to buy) okay [T][AC].
195 P (So) so it would be sixty times seven [T+][P-][EC].
196 P Seven times zero is zero [T+][CP][P-].
197 P Seven times six is forty two [T+][CP][P-].
198 P (It/'d take, um) I mess/ed it up [T][SE].
199 P It/'d be sixty times twenty [T+][P-][EC].
200 P Zero and zero [T+][CP][P-].
201 P Zero times six is zero [T+][CP][P-].
202 P Two times zero [T+][CP][P-].
203 P Two times six is twelve [T+][CP][P-].
204 P So it/'d take a hundred and twenty week/s [T+][P-].
205 = asked if could stop because a end of page -- reminded that there were more problems on next page
207 = sp.7
208 =[-]
209 P Okay [CAIC][CATE].

210 P Jean pay/ed three hundred and sixty nine dollar/s for a thirty five m m camera [R+].
212 P She also bought a special lens for two hundred ninety seven dollar/s, a tripod for forty seven and twenty nine dollar/s, and two roll/s of film for three twenty nine a roll [R-].
215 P What was the total cost [R+]?
216 P So three hundred sixty nine plus two ninety seven plus forty seven twenty nine plus three twenty nine and three twenty nine [T+][P+][EC].
218 P So nine and nine is eighteen [T+][CP][P+].
219 P Plus another nine [T+][CP][P+].
220 P Twenty eight [T+][CP][P-].
221 P Okay [T][AC].
222 P Two plus nine is eleven [T+][CP][P-].
223 P Plus seven is eighteen [T+][CP][P-].
224 P Plus six equal/3s twenty six [T+][CP][P-].
225 P Okay [T][AC].
226 P So eight plus nine is seventeen [T+][CP][P-].
227 P Plus seven is twenty seven [T+][CP][P-].
228 P Plus six is thirty three [T+][CP][P-].
229 P Six plus two would be eight [T+][CP][P-].
230 P Plus four is twelve [T+][CP][P-].
231 P Plus three would be fifteen [T+][CP][P-].
232 P So one hundred fifty three dollar/s and sixty eight cent/s [T+][P-].

Appendix G

Coded Transcript of NL Student Number 17

Mon May 06 10:57:57 1996
A:\consub17.all

ALL ENTRIES

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  1 $
  2 + 2-2-96
  3 + protocol
  4 = cp.1
  5 =[+]
  6 T Twenty four plus eight [R+].
  7 T Eight plus four is twelve [T+][CP][P+].
  8 T Carry the one [T+][CP][P+][SI].
  9 T One plus two is three [T+][CP][P+].
 10 T The answer is thirty two [T+][P+].
 11 = cp.2
 12 =[+]
 13 T Next problem [T].
 14 T (Eighty six) no that/'s eleven [T][EC].
 15 T Thirty six minus eleven [R+].
 16 T Six minus one is five [T+][CP][P+].
 17 T And three minus one is two [T+][CP][P+].
 18 T The answer is twenty five [T+][P+].
 19 = cp.3
 20 =[+]
 21 T Next problem [T].
 22 T Two hundred and three plus one hundred and fifty four [R+].
 23 T Four plus three is seven [T+][CP][P+].
 24 T Zero plus five is five [T+][CP][P+].
 25 T Two plus one is three [T+][CP][P+].
 26 = cp.4
 27 =[+]
 28 T Next problem [T].
 29 T Sixty four times seven [R+].
 30 T Four times seven is twenty eight [T+][CP][P+].
 31 T Six times seven is forty two [T+][CP][P+].
 32 T Plus two is forty four [T+][CP][P+].
 33 T The answer is four hundred and forty eight [T+][P+].
 34 = cp.5
 35 =[+]
 36 T Next problem [T].
 37 T Five thousand three hundred twenty four plus three thousand six hundred
      and seventy nine [R+].
 39 T Four plus nine is thirteen [T+][CP][P+].
 40 T Carry the one [T+][CP][P+][SI].
 41 T One plus two is seven [T-][CP][P-].
 42 T I mean one plus two is three [T+][CP][P+][SC].
 43 T Plus seven is ten [T+][CP][P+].
 44 T Carry the one [T+][CP][P+][SI].
 45 T One plus three is four [T+][CP][P+].
 46 T Plus six is ten [T+][CP][P+].
 47 T Carry the one [T+][CP][P+][SI].
 48 T One plus five is six [T+][CP][P+].
 49 T Plus three is nine [T+][CP][P+].
 50 T The answer is nine thousand three [T+][P+].
 51 = cp.6
 52 =[+]
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53 T Next problem [T].
54 T Fifty divide/ed into three hundred [R-].
55 T (You, you di*) fifty cannot divide X three [T][P+][EC].
56 T So you go to the next column [T+][P+][SI].
57 T Fifty does not go into thirty either [T+][P+][EC].
58 T You gotta go to the next column [T][P+][SI].
59 T Fifty divide/d into (three, thr*) three hundred is I/'m going to guess four [T+][P+][EC].
61 T Four times five is twenty [T+][CP][P+].
62 T (And then four times, is twenty) and then four times zero is zero [T+][CP][P+].
64 T Came out with two hundred [T+][P+].
65 T And you could fit two more [T+][P+][EC].
66 T So (let/'s say) let/'s put six [T+][P+][SI].
67 T Six times zero equal/3s zero [T+][CP][P+].
68 T And six times five equal/3s thirty [T+][CP][P+].
69 T Three hundred minus three hundred equal/3s zero [T+][CP][P+].
70 T The answer is six with the remainder of zero [T+][P+].
71 = cp.7
72 =[+]
73 T Next problem [T].
74 T One hundred seventy four subtract/ed by ninety six [R+].
75 T (You cannot take four away) you cannot take six away from four [T][P+][EC][SC].
77 T So you go to the next column [T+][P+][SI].
78 T Cross the seven out and put a six above it [T+][CP][P+][SI].
79 T Fourteen minus six equal/3s eight [T+][CP][P+].
80 T (Six minus) oh you cannot subtract nine minus six [T-][P+][EC].
81 T So you cross out the one [T+][CP][P+][SI].
82 T Put a zero above the one [T+][CP][P+][SI].
83 T And you turn it to sixteen [T+][CP][P+][SI].
84 T And (six minus) sixteen minus nine equal/3s seven [T+][CP][P+][SC].
85 T The answer is seventy eight [T+][P+].
86 = cp.8
87 =[+]
88 T Next problem [T].
89 T Five divide/ed into (three hundred) three thousand four hundred and seventy [R-][SC].
91 T Can/'t divide five into three [T+][P+][EC].
92 T So you put a zero above the three [T+][CP][P+][SI].
93 T (You can) you can divide (three) five into thirty four about (let/'s see) six time/s [T-][CP][P+][EC][SC].
95 T Five times six equal/3s thirty [T+][CP][P+].
96 T And thirty four minus thirty equal/3s four [T+][CP][P+].
97 T Bring the seven down [T+][CP][P+][SI].
98 T (And five into forty seven) let/'s see [T][AC].
99 T (Nine times) wait [T][AC].
100 T (Um) nine times five equal/3s forty five [T+][CP][P+].
101 T Forty seven minus forty five equal/3s two [T+][CP][P+].
102 T Bring the zero down [T+][CP][P+][SI].
103 T (Put) wait [T][AC].
104 T (Five into twenty equal/3s) let/'s see [T][AC].
105 T (Go/3s) five go/3s into twenty four time/s [T+][CP][P+][EC].

106 T And four times five equal/3s twenty [T+][CP][P+].
107 T So you subtract twenty from twenty [T+][CP][P+][SI].
108 T And then you get zero [T+][CP][P+].
109 T The answer is six hundred and ninety four with the remainder of zero [T+][P+].
111 = cp.9
112 =[+]
113 T Next problem [T].
114 T Five hundred twenty three times four [R+].
115 T Three times four equal/3s twelve [T+][CP][P+].
116 T (Two times four) next one [T].
117 T Two times four equal/3s eight [T+][CP][P+].
118 T Plus one [T+][CP][P+].
119 T Nine [T+][CP][P+].
120 T Five times four equal/3s twenty [T+][CP][P+].
121 T The answer is two thousand ninety two [T+][P+].
122 = cp.10
123 =[+]
124 T Next problem [T].
125 T Nine thousand six hundred and seventeen subtracted from seven thousand five hundred and eight [R-].
127 T (Seven minus eight) you cannot subtract seven minus eight [T][P+][EC][SC].
128 T So you go to the next column [T+][P+][SI].
129 T Cross out the one and put a zero [T+][CP][P+][SI].
130 T Seventeen minus eight equal/3s nine [T+][CP][P+].
131 T Zero minus zero equal/3s zero [T+][CP][P+].
132 T Six minus five equal/3s one [T+][CP][P+].
133 T And seven minus nine equal/3s two [T-][CP][P+].
134 T The answer is two thousand one hundred and nine [T+][P+].
135 = sp.1
136 =[+]
137 T Conrad bought thirteen post card/s, but only had stamp/s for seven of the card/s [R+].
139 T How many more stamp/s did he need [R+]?
140 T All right [T][AC].
141 T So if he had thirteen post card/s (and) but he only stamp/s for seven of the card/s [T].
143 T How many more stamp/s did he need [T]?
144 T All right [T][AC].
145 T So you/'d subtract thirteen from seven [T-][P+][EC].
146 T (Or you) yeah thirteen minus seven [T+][P+][EC][SC].
147 T Three minus seven [T-][CP][P+].
148 T You cannot do that [T+][P+][EC].
149 T So you cross out the one in the next column [T+][CP][P+][SI].
150 T Put a zero above it [T+][CP][P+][SI].
151 T And it turn/3s into thirteen [T+][CP][P+].
152 T Thirteen minus seven equal/3s six [T+][CP][P+].
153 T So he need/3s six more stamp/s [T+][P+].
154 T Kay [T][AC].
155 = sp.2
156 =[+]
157 T kay [T][AC].

158 T Next problem [T].
159 T Sandy work/ed four hour/s a day at the town library [R+].
160 T (One week) In one week she work/ed six day/s [R+].
161 T How many hour/s did she work that week [R+]?
162 T (On that one you/'d) six times four [T+][P+][EC].
163 T All right [T][AC].
164 T Six times four equal/3s twenty four [T+][CP][P+].
165 T So the answer would be twenty four hour/s [T+][P+].
166 = sp.3
167 =[+]
168 T Next problem [T].
169 T Jeff and Bob start/ed reading their book/s on the same day [R+].
170 T Jeff read six page/s a day and Bob read four page/s a day [R+].
171 T How many more page/s had Jeff read than Bob after six day/s [R+]?
172 T All right [T][AC].
173 T Jeff read six page/s a day [T].
174 T Bob read four page/s a day [T].
175 T How many page/s after six day/s [T]?
176 T All right [T][AC].
177 T So for Jeff you/'d have to times (six) six page/s times six [T][P+]
[EC].
178 T So the answer for that would be thirty six [T+][CP][P+].
179 T So if he would have read thirty six page/s in six day/s [T].
180 T Okay [T][AC].
181 T Bob read four page/s a day [T].
182 T So he/'d be four times six [T][P+][EC].
183 T And that equal/3s twenty four [T+][CP][P+].
184 T (So the answer is) then how many more page/s read than Bob [T]?
185 T All right [T][AC].
186 T So then you subtract thirty six from twenty four [T-][P+][EC][SI].
187 T Six minus four is two [T+][CP][P+].
188 T And three minus two is one [T+][CP][P+].
189 T So the answer is twelve page/s [T+][P+].
190 = sp.4
191 =[+]
192 T Next problem [T].
193 T A shipping clerk has seventy two book/s to pack in box/s [R+].
194 T Each box will hold eight book/s [R+].
195 T How many book/s does he need [R-]?
196 T Well if he has seventy two book/s to pack into box/s [T].
197 T And each box will hold eight book/s [T].
198 T All right [T][AC].
199 T Seventy two book/s to pack in box/s [T].
200 T Hold eight book/s [T].
201 T (Then you would divide seventy two) no [T][EC].
202 T You divide eight into seventy two [T-][P+][EC].
203 T (You cannot) you cannot divide eight into seven [T+][P+][EC].
204 T So you put a zero above it [T+][CP][P+][SI].
205 T And eight into seventy two equal/3s nine [T+][CP][P+][EC].
206 T (Nine times eight, nine, nine) nine times eight equal/3s seventy two
[T+][CP][P+].
208 T Seventy two minus seventy two equal/3s zero [T+][CP][P+].
209 T So you/'d have a remainder of zero [T+][P+][EC].

210 T (What would) oh [T][AC].
211 = sp.5
212 =[+]
213 T Next problem [T].
214 T What would the total cost of seven pair/s of sock/s for four dollar/s a pair and a shirt for nine eighty nine [R+]?
216 T (Well) seven pair/s of sock/s [T].
217 T Four dollar/s [T].
218 T (So) four dollars/s a pair [T].
219 T So seven times four dollar/s [T+][P+][EC].
220 T All right [T][AC].
221 T So seven times four dollar/s [T+][P+][EC].
222 T See now [T][AC].
223 T All right [T][AC].
224 T Zero times zero equal/3s zero [T+][CP][P+].
225 T Zero times zero equal/3s zero [T+][CP][P+].
226 T Zero times seven equal/3s zero [T+][CP][P+].
227 T And zero times seven equal/3s zero [T+][CP][P+].
228 T And four times seven equal/3s twenty eight [T+][CP][P+].
229 T (So the answer would be twenty eight) well no [T][EC].
230 T (The, he) twenty eight dollar/s worth of sock/s [T+][P+].
231 T And then plus a shirt (for nine ninety ni*) for nine eighty nine [T+][P+][EC][SC].
233 T So you/'d add nine eighty nine to twenty eight dollar/s [T+][P+][EC][SI].
234 T And zero plus nine equal/3s nine [T+][CP][P+].
235 T Zero plus eight equal/3s eight [T+][CP][P+].
236 T Eight plus nine equal/3s seventeen [T+][CP][P+].
237 T And one plus two equal/3s three [T+][CP][P+].
238 T The answer is thirty seven dollar/s and eighty nine cent/s [T+][P+].
239 = sp.6
240 =[+]
241 T Next problem [T].
242 T Ned is saving twenty dollar/s a week to buy a tape deck [R+].
243 T He has already save/ed sixty dollar/s [R+].
244 T The tape deck cost/3s two hundred and twenty dollar/s [R+].
245 T How many more week/s will it be before he has enough money to buy the tape deck [T]?
247 T All right [T][AC].
248 T He already has save/ed sixty dollar/s [T].
249 T First off I/'d divide twenty into (two hundred) two hundred twenty [T][P+][EC][SC].
251 T Twenty divide/ed into two does/n't go [T+][P+][EC].
252 T So you put a zero above the two [T+][CP][P+][SI].
253 T Twenty divide/ed into twenty two go one time [T-][CP][P+][EC].
254 T So you put twenty under the twenty two [T+][CP][P+][SI].
255 T Subtract it [T+][P+][EC][SI].
256 T (And then the answer/'d be t*) bring the zero down and you have twenty [T+][CP][P+][SI].
258 T (Twenty, the) how many time/s will twenty go into twenty [T]?
259 T That/'d be one too [T+][P+][EC].
260 T And one times twenty equal/3s twenty [T+][CP][P+].
261 T And you subtract the two [T+][CP][P+][SI].

262 T And you get zero [T+][CP][P+].
263 T The answer is eleven with a remainder of zero [T+][P-].
264 T Next problem [T].
265 T (Ned) no, no, no that/'s not the answer [T][P+][EC].
266 T (So we) all right [T][AC].
267 T (If that/'s how many he/'ll have) eleven week/s [T].
268 T (And if he/'s already save/ed, twenty) all right [T][AC].
269 T Twenty into sixty equal/3s three [T+][CP][P+].
270 T (So, if) and then three minus eleven would equal eight [T-][CP][P+].
271 T (So he/'d have, eight more, eight more week/s before, he/'d have enough more, he/'d have) it/'d take another eight week/s for him to have enough money to buy the tape player [T+][P+].
274 = sp.7
275 =[-][CANC]
276 T John pay/ed three hundred and sixty nine dollar/s for a thirty m m camera [R+].
278 T She also bought a special lens for two hundred ninety seven dollar/s, (and a) and a tripod for forty seven dollar/s and twenty nine cent/s, and two roll/s of film for three hundred dollar/s and twenty nine cent/s a roll [R+].
281 T What was the total cost [R+]?
282 T All right [T][AC].
283 T You would first off add three hundred sixty nine dollar/s plus two hundred ninety seven dollar/s and forty seven dollar/s and three twenty nine [T+][P+][EC][SI].
286 T All right [T][AC].
287 T And then you would add all of it [T+][P+][EC].
288 T Zero plus zero equal/3s zero [T+][CP][P+].
289 T Zero plus nine equal/3s nine [T+][CP][P+].
290 T Zero plus zero equal/3s zero [T+][CP][P+].
291 T Plus zero equal/3s zero [T+][CP][P+].
292 T Plus two equal/3s two [T+][CP][P+].
293 T All right [T][AC].
294 T Nine plus seven equal/3s sixteen [T+][CP][P+].
295 T (Plus) and then I/'d skip down [T][SI].
296 T I/'d skip seven because that/'d be too hard for me to add [T][SE].
297 T So sixteen plus three equal/3s (nine, twenty nine, er) nineteen [T+][CP][P+].
299 T And then plus seven equal/3s twenty six [T+][CP][P+].
300 T So twenty six [T+][CP][P+].
301 T Two plus six equal/3s eight [T+][CP][P+].
302 T Plus nine equal/3s seventeen [T+][CP][P+].
303 T Plus four equal/3s twenty one [T+][CP][P+].
304 T Next one [T].
305 T Two plus three equal/3s five [T+][CP][P+].
306 T Plus two equal/3s seven [T+][CP][P+].
307 T The answer is seven hundred and sixteen dollar/s and twenty nine cent/s [T+][P-].
309 = sp.8
310 =[-][CANC]
311 T Kim jog/ed around a (rectagular) rectangular field three hundred thirty seven meter/s long and two hundred twenty five meter/s wide [R+].
313 T How far did she jog in one lap around the field [R+]?

314 T All right [T][AC].
315 T If she jog/ed around a rectangular field (thirty) three hundred thirty seven meter/s long [T].
317 T (Twenty five) two hundred twenty five meter/s wide [T].
318 T How far did she jog in one lap around the field [T]?
319 T All right [T][AC].
320 T (You) first off you/'d add three hundred thirty seven with two hundred twenty five [T+][P+][EC].
322 T All right [T][AC].
323 T (Um) all right [T][AC].
324 T Meter/s long [T].
325 T Two hundred twenty five meter/s wide [T].
326 T Hmm [T][AC].
327 T Wait [T][AC].
328 T You/'d add the two [T+][P+][EC].
329 T Seven plus five equal/3s twelve [T+][CP][P+].
330 T One plus three equal/3s four [T+][CP][P+].
331 T Plus two equal/3s six [T+][CP][P+].
332 T Three plus two equal/3s five [T+][CP][P+].
333 T The answer is five hundred sixty two meter/s [T+][P-].

Appendix H

Research Protocol Clearance

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-3899
616 387-8293

WESTERN MICHIGAN UNIVERSITY

Date: November 2, 1995

To: Jennifer Shepard Crouse

From: Richard Wright, Chair

Re: HSIRB Project Number 95-10-11

This letter will serve as confirmation that upon review of your memo dated October 30, 1995, your research project entitled "Self-talk of students with language or learning disabilities and their peers" has been **approved** under the **Full** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you must seek specific approval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: November 2, 1996

xc: Nickola Wolf Nelson, SPA

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