APPLICATIONS FOR KEYBOARDING WITH STUDENTS WITH MOTOR DYSFUNCTION

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ABSTRACT

This study used the word processor as a tool for written output to examine the effects of an experiential 'Write to Read' program on typing performance, decoding strategies and successive processing in learning disordered children with motor dysfunction.

A case history approach was taken in view of the small number of subjects available, and in order to adequately describe each individual's unique and complex cognitive motor profile. Subjects involved in the study were three male students in a Junior Learning Assistance Class in a Lower Mainland British Columbia school district elementary school. Each of the students had a history of poor motor performance, poor handwriting and delayed reading ability.

The three subjects were involved in an eight week intervention program which taught keyboarding and word processing techniques using the 'Write to Read' program, a systematic method of training the motor skills required.

It was hypothesized that, if the learning disabled student with poor motor skills could use the word processor as an adjunct to handwriting, the improved legibility would facilitate consistent decoding by the student of his own work, reinforcing acquisition of early reading skills.

Within the case history format, a theoretical frame of reference based on the simultaneous - successive information processing model was chosen and a limited time series design measured the effects of the intervention on successive processing as determined by a block sequencing task (Das, Kirby and Jarman, 1980).

The data was collected for each student and graphed for visual inspection, graphic analysis and statistical analysis. One subject showed a stable and significant intervention effect, and no stable trends or significant results for successive processing were found in the other two subjects. Rates of word processing output increased over the course of the study and the number of errors declined.

All subjects made progress in measures of decoding and word analysis.

Implications for future research and professional practice were described.

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CHAPTER 1

INTRODUCTION

Typing as an adjunct to manuscript writing in the development of "spelling, reading and composition" (Conrad, 1935, p. 264) has been perceived as a valid educational tool in the literature since the early 1930s.

It is not clear why the use of typing as an instructional milieu has not received a more enthusiastic response in programming for basic skills instruction, although the pragmatic reader can make tentative hypotheses. What it may really boil down to is that the mighty pen was on the scene long before Underwriter designed the first typewriter. This inexpensive, replaceable, low maintenance tool is usable by the majority of the school-aged population. Since school programs do not require keyboarding skills, there has not been real reason to learn these skills for performance of school tasks. One cannot overlook the curriculum planning within the school system in which the academic students take academic courses and the vocational students learn to type.

It seems logical to assume that the demand for keyboarding skills has been limited to a specific population of business students and that, until recently, the majority of students had no real need to learn these skills, as there was no arena for their application in the work place.

The effects of the microcomputer on the daily lives of the population has, however, created that demand. Future-minded parents now send their

children off to computer camp to learn BASIC instead of canoeing and reef knots.

The myriad applications of the microcomputer are becoming clear to educators in business, mainstream teaching and special education. Increased frequency of computer teaching in the schools has benefited many students. This paper will address the applications of the microcomputer and word processing programming to the reinforcement of basic reading and writing skills of students with histories of motor dysfunction and attentional deficits which manifest as poor printing skills and delayed reading skills.

The development of printing skills, which can act as an activity for the development of attention in reading for normal children, is a slow and laborious process for the children with motor dysfunction and presents no ceiling for success.

However, children with educational diagnoses of visual motor and attentional deficits are often placed on an experiential writing to read program in order to establish a meaningful framework for the focus of attention on decoding and comprehension in reading.

Despite marked effort, the quality of performance in writing is never equivalent to the peer group performance. It would seem that continuous practise does not necessarily orient the child to the task, but, rather, feeds into underlying impulsivity through failure and diminishing frustration tolerance.

The clear, consistent result offered by the use of a keyboard eliminates this visual motor performance aspect of the writing task and may facilitate the process of attention to decoding in reading through writing.

The nature of typing on a keyboard is such that it presents the simultaneous visual stimulus of the letters, enabling the student to focus attention on the features of one letter/stimulus at a time rather than laboring through the motor sequence of creating the aspects of the letters and words.

Theoretical Models

In order to develop a consistent approach for development of strategies for remediation of dysfunction, it is helpful to adopt an appropriate theoretical framework in order to explain observed behavioral responses.

Simultaneous and Successive Synthesis Model

The work of Das, Kirby and Jarman (1979) and Luria (1966a, 1966b) provides a theoretical and empirically sound model of information processing and task analysis based on a simultaneous and successive synthesis approach to learning.

Kirby and Das (1978) delineate the distinctive elements of this approach:

> "Simultaneous processing can be characterized as involving the synthesis of separate elements into groups that generally have spatial overtones, with all the portions of the synthesis being surveyable or accessible without dependence on their position within the synthesis. This type of processing is required, for instance, in the formation of any holistic gestalt, or in the discovery of the relationships among two or more objects. Successive processing on the other hand, involves the integration of separate elements into groups whose essential nature is temporal. Portions of this synthesis are accessible only in the temporal order of the series - each element is dependent on the

> preceding elements. Successive processing is necessary for the formation or production of any ordered series of events" (p. 59).

The model links successive synthesis with motor and auditory modalities, and simultaneous synthesis with the visual modality.

Further research hypothesizes that the simultaneous, spatial modality may be a function of the right brain, while the sequential, temporal modality may be based in the left brain. Kraft, et al (1980), in investigating EEG records of children, reported greater right hemispheric processing during assimilation of information with a definite shift to the left during retrieval and verbal/logical expression of information. High reading scores were related to greater inter-hemispheric processing, or the ability to shift from one mode of processing to the next.

Jarman (1980) argued, however, based on his analysis of paradigmatic and syntagmatic associations within the study of language function, that this hemispheric interpretation of brain function was unsophisticated. His findings indicated that these functions were not consistently lateralized into consistent and predictable hemispheric locations.

Gordon (1980) hypothesized a developmental lag in left brain function as the basis for dyslexia. The ability to perceive the serial order of auditory or visual stimuli was thought to be dependent on temporal or sequential processing. Dysfunction within the sequential modality created learning difficulties in reading, mathematics and other abilities involving analytical processes. Learning-disabled individuals were "locked in" to a simultaneous mode of processing, thereby rendered unable to utilize the intermodal shift required for successful learning.

The key to sequential learning was proposed to lie with the ability to selectively attend to critical variables of presented stimuli (Reid and Hresko, 1981).

A longitudinal study based on the simultaneous and successive synthesis framework used task analysis and empirical validation to establish a series of tasks designed to tap simultaneous and successive ability in an early identification of learning-disabled children project (Jarman and Das, 1980).

This theoretical model proposed that task information is presented to sensory modalities in a successive or simultaneous manner. The tasks themselves were categorized as mnestic, perceptual and conceptual.

The nature of output or task response can also be simultaneous or successive.

> "Simultaneous output depends at all points on what has already been done, such as... in the drawing of a circle; even though some of the circle may be complete, the balance of the drawing depends upon the completed part in order to produce a correct figure. Successive output is temporal in nature and does not depend upon previous responses as directly; for example, recall of a digit in a set does not depend functionally upon all of the previously recalled digits" (Jarman and Das, 1980, p. 30).

Process Disorder Model

Reid and Hresko (1981) proposed a process disorder model in the theoretical discussion of learning disability. These were divided into modal and non-modal disorders.

Modal disorders manifested themselves as dysfunction at the inter-sensory integration level or difficulty with the interaction between input and output. These were related to sensory modes of reception.

Non-modal disorders were based on the ability to attend to critical variables of presented stimuli. This dysfunction of selective attention may be the basis for the academic learning behaviors of the learning-disabled population. The constellation of these learning behaviors included the inability to process sequentially-presented information, lack of generalization between learning situations, lack of awareness of cause and effect, and the inability to learn by inference. Selective attention deficits prevented the individual from synthesizing a meaningful network out of discrete, symbolic or non-meaningful information received from the environment.

Using the theoretical frame of reference described, the clinical remediator can proceed to devise strategies for teaching the learning-disabled individual.

One of the effective strategies described by Reid and Hresko (1981), has been to switch the order of presentation of information. Rather than teach in a temporal, sequential way, the remediator presented the information in a simultaneous way. For example, teaching through experience, learning by doing, emphasized the simultaneous mode of learning (Wittrock, 1978). Once the meaningful framework evoked by the experiential situation was established, the additional data was applied to it. In this way, conceptual learning took place.

Task Analysis of Printing and Keyboarding Using the Model of Simultaneous and Sequential Synthesis

The underlying process of handwriting is visual motor integration (Beery, 1982). According to the task analysis of Jarman and Das (1980), the process of visual motor integration is simultaneous in nature.

The nature of the motor aspect of handwriting is sequential (Kirby and Das, 1978) and impaired motor performance loads an additional sequencing variable on to the requirements for successful task performance.

Changing the motor nature of printed output by placing the letters on a keyboard format eliminates the sequenced motor aspect of printing and changes the motor task into targetting the appropriate letter choice, a much simpler motor requirement.

By simplifying the motor requirement, the task emphasis returns to the visual simultaneous input and conceptual simultaneous processing output described by the Jarman and Das (1980) task analysis chart (Fig. 1, p. 3). This places the learning disabled student in an area of relative strength: simultaneous synthesis.

The letter-symbol choices are arranged in a visual display which can be translated into a meaningful framework using strategies described in Chapter 2 of this paper.

By breaking the task into its component parts and problem-solving for facilitation according to the theoretical framework of simultaneous and successive synthesis, the complex task of printed output can be brought within the processing capacity of the child with motor dysfunction and learning disabilities.

Use of keyboard and word processing combinations cannot eliminate the sequential aspects of printing words. Words are, by their nature, a sequence of letters. It remains for the remediator to discover a meaningful way to present a reading and writing task which allows motor skill automation (Stelmach and Larish, 1980) to reinforce the sequenced aspects of the task.

The "Write to Read" typing program is a written reading program which uses a word family and phoneme recognition approach. Finger positions are allocated on the keyboard and typing of word families involves consistent finger/key allocation. For example, in the first lesson, the student must type, RED, FED, LED, WED, BED repeatedly and then type the sentence "Ted had a red bed".

The program emphasizes the goal of "ed" sound symbol sequence being reinforced by the motor "e-d" becoming more automatic with practise.

The use of the word processor technology to back up the keyboard is a further simplification of a complex task. In its simplest form, the word processing function allows the student to correct his errors on the monitor and facilitates error-free printed output. The conventional typewriter does not offer such ease of error correction and, as it does not offer the more complex editing functions of the word processor, can be considered a more limited keyboard milieu.

As learning disabled students characteristically fail to generalize between learning environments, it seems wise to initiate the students onto a keyboard system that will taken them as far as possible into the area of written language, making the word processor the technology of choice to reinforce basic reading and writing skills.

Summary

The use of microcomputer and word processing technology to reinforce basic reading and writing skills can be task-analyzed according to the simultaneous-successive synthesis model of information processing described by Das, Kirby and Jarman (1979), and applied to a population of students with motor dysfunction and attentional deficits.

CHAPTER 2

LITERATURE REVIEW

Historical Perspective

It is still necessary to learn to type in order to 'keyboard'. Traditionally, typing is taught at the secondary level. Some educators have advocated for its inclusion in primary grades on the basis that gains can be achieved in motor ability, writing, spelling and language skills (Whitmill, 1973; Erikson, 1972).

Evidence points out that fine motor skills necessary for typing are intact in primary students (Whitmill, 1973) and that elementary students can compete successfully with high school students on various complex tasks "including a six-page manuscript with quotations, footnotes and bibliography" (Whitmill, 1973, p. 41).

In order for these skills to be taught at the elementary level, performance objectives need to be established. Erikson (1972) proposed a 'criterion-referenced instructional model' which emphasized:

"1. specification of performance goals

2. pre-assessment of the learner

3. provision of adequate instruction that includes validation of the learning through proper repetition and with measurement against some criterion

4. selection of appropriate evaluation procedures that emphasize self-motivation of the learner through the reinforcement that he gets from his own learning and progress as measured by his ability to meet minimum performance goals as well as individualized performance goals" (p. 20).

Erikson (1972) pointed out that

> "at the elementary school level the notion persists that all that is necessary is to put the youngster at a typewriter with a typing book, and perhaps some tapes, and he can learn to typewrite. Anyone who has ever worked with elementary school youngsters will attest to the fact that they are eager learners and that they are especially motivated when the learning involves a thing to be manipulated such as a typewriter. The fact is... that elementary school pupils learning to typewrite... need the... guidance of a... teacher if they are to achieve at a level that bears a relationship to their potential to achieve. To do less is to short change the learner" (p. 20).

Performance goals were related to: 1) basic typing skill, 2) selected typing applications, 3) typing and language arts learning (Erikson, 1972).

Use of a keyboard for output with regular stream children was advocated for on the following basis:

"1. Learning to type fascinates children bored with regular class.

2. A typing program adds uniqueness to remedial reading.

3. Incidental reading takes place in the typing lessons such as reinforcement of the basic sight words.

4. Spelling is aided through the typing lessons.

5. The child experiences frequent success through short lessons and praise" (Seltzer, 1978, p. 13).

The use of the keyboard in the classroom as a motivator in the practice of basic skills has been recognized (Seltzer, 1978; Erikson, 1978; Tetrault, 1970).

Despite the general air of positivism, few studies were available for analysis. Tetrault (1970) studied fourteen first graders using performance within the 24 to 54%^{ile} on the Gates Reading Readiness Tests as criterion for inclusion in the study.

Positive results from this pilot study (using electric typewriters and dictation equipment with a regular phonics program and basal readers) led to a longer study in the following year. Students were randomly assigned to two groups. One group received regular reading instruction, the other group used technical aids to reinforce reading.

At mid-term, a 'significant gap' between groups in spelling, letter recognition, word reading and study skills as measured by the Stanford Achievement Test, was noted in favor of the technical aids group. It is not evident what criteria were used to measure significance or if the Standard Achievement Test was an appropriate measure to be administered three times in six months.

At mid-term, the groups switched programs and went on to complete the term. Findings indicated that the "group using the equipment during the second half of the term was about even with the group that had used it in the first half" (p. 116). No attempt was made to differentiate results in terms of relative gains made by the first group who may have had an initial benefit in having clear reinforcement of basic skills through technical aids at the outset of the program. One wonders what the progress of a group who received only one or the other types of intervention would have been under similar conditions.

Empirical nightmares such as this characterize the literature, but are usually followed by educationally sound, pragmatic ideas for program implementation.

While this is, indeed, helpful to the educator in the classroom, the use of keyboarding as an adjunct to manuscript writing remains subject to

the whims and passing fancies of the art of education without an empirical basis for this kind of intervention.

Tate (1935) reported a study she carried out with 'retarded' students to "determine the usefulness of the typewriter in remedial instruction in reading and language in the intermediate grades" (p. 481).

Two matched groups (on grade equivalents of the Standard Achievement Test and intelligence quotients from the California Test of Intelligence) were selected from Grades 4, 5 and 6. Groups were identified by choosing the children falling below the 50th%ile of each class group.

Scores on subtests of Paragraph Meaning, Word Dictation and Language Usage and Dictation (Spelling) were compared between groups. While differences did not achieve statistical significance, the experimental group fared better than the controls in ranked order of Language, Dictation, Paragraph Meaning and Word Meaning.

The author concluded that, although statistically insignificant, the study indicated the merits of keyboard use as an intervention tool in the remediation of reading and spelling, mentioning student motivation and teacher participation as another positive aspect of the study itself.

Conrad (1935) conducted a two-year study on typing in the primary grades. Her rationale was straightforward and precise:

> "- children are interested in the machine,
> - it requires little muscular development,
> - it does not strain immature muscles,
> - children can express ideas in writing by a motor pressure rather than a more controlled movement,
> - it should help the child with poor motor control,
> - it should assist the left-handed child - the results are accurate, quickly obtained and are very satisfying,
> - it apparently ties up closely with reading" (p. 256).

The study sampled 150 children in the Horace Mann School in the northeastern United States. Two classes of Grades 2, 3 and 4 were paired on chronological and mental age (no measures reported). One group used typewriters for written work, the other group used manuscript writing.

Gains in favor of the experimental group were reported in written speed and output speed, however, grade differences were noted and attributed to general maturational progress. The Grade 2 children's performance was not as clearly differentiated between typing and manuscript writing, while the Grade 4 group showed a greater disparity of output rate in favor of the typewriter.

Merrick (1941) found that students with low handwritten composing rates made the greatest "growth and facility of expression" (p. 294) when handwritten and typewritten composing rates were compared. This author did observe that "pupils at the younger level, particularly the little boys, lost time early in the year partly through inattention and partly because they ran out of something to say before five minutes passed" (p. 295).

Cowles (1983) pointed out that, in the rage for applying technology to education, the basic issues of whether children can develop adequate keyboarding skills had not been addressed to his satisfaction.

In a study designed to examine the relationship between typing skill development and motor proficiency, a random sample of 24 children was selected with equal numbers of five, six, seven and eight year olds, and equal numbers of males and females in each group.

The group was assessed for motor proficiency on the Bruininks-Oseretsky Test of Motor Proficiency and the teaching program used was "Touch to Type" by Nash and Geyer (1983).

The students' work was collected daily and 30-second timings were scored for speed and accuracy, and recorded at regular intervals. Students were observed daily over 20 observations on task behavior.

Pearson r's and Spearman rho's were calculated to determine the nature of the relationship between motor proficiency and typing performance. Statistically significant correlations were not found.

Clinical observations indicated more off task behavior in the five and six year old group, but that the typing program experience was generally positive. The students were motivated and enjoyed the class.

Students were able to learn to type correctly (this typing program stresses finger placement and speed). The five to six year old group were able to output words, the seven to eight year olds were able to type words and sentences. This seemed to be more related to reading ability than to motor skill, however, motor skill was more related to the success of the seven to eight year old group in output rate.

This study was one of the more articulate ones in terms of experimental design. The group was selected randomly and matched for sex and age. Further examination of off task behavior in the five to six year old group would have given the reader more insight into the basis for the off task behavior. Was the task too demanding or not meaningful enough? Was the behavior seen in other learning situations? Did it improve with increased teacher's viligance?

The size of the sample was relatively small. Further studies could include matching across the groups for reading ability in order to examine the effect of motor proficiency on typing skill more clearly.

These studies indicated that the motor proficiency for acquiring keyboarding skills was intact in elementary school-aged children and that these children were able to approach the complex task of using the typing process to increase speed of output. The development of typing proficiency seemed to correspond with a general maturational process of motor skill as well as reading ability in the age range selected for the study, and was not just related to motor proficiency.

The literature stressed the positive effect of keyboard use on student motivation and emphasized the facilitative effect on output for students with poor motor control (Conrad, 1935; Tate, 1935). However, no studies were done with students with poor motor control.

Related Research

Computer-Aided Instruction and Word Processing Applications

Kolich (1985) discussed the advent of the microcomputer in the school system and described the incorporation of technology into the instructional curriculum. Three areas of computer-aided instruction (CAI) were identified. Drill and practise from the first stage was built upon in the second stage by the incorporation of the aspect of decision-making which can be programmed into software. The third stage was determined to be tutorial, an interactive systematic instructional sequence. The author indicated that this format placed the student at the controls of his own learning experience.

Hummel (1985) reported on the function of computer application to drill and practice. When using the microcomputer/word processor combination for written output, he notes that "these children need

systematic training in typing and word processing in order to realize the potential benefits of integrating word processing in composition instruction" (p. 559).

Hoffman (1986) used a Piagetian frame of reference to suggest that the microcomputer created an environment for learning which allows the individual to interact with the information in a self-directed way. This provided the basis for increased generalizability of knowledge.

Rosegrant (1985) described an ongoing four-year study in which word processing software was used with 12 learning-disabled students (criteria unknown for determining diagnosis of learning disability). The students were ranged in age from six to ten years of age. The purpose of the intervention was to facilitate acquisition of basic reading and writing skills.

These children demonstrated poor mastery of handwriting, were generally unhappy about their handwriting appearance, were often unable to read what they had written, and showed poor spatial organization of the text on the page. The group was also noted to "often lose their train of thought when writing and showed fatigue in the writing process" (p. 113). This frustration led the author to suggest that the group demonstrated "decreased amounts of risk-taking, exploration, strategy-creating and hypothesis testing" (p. 113).

The study involved use of a word processing program which had been interfaced with a synthesized speech program as the class' principal reading and writing instrument. Children were encouraged to be as self-directed as possible, with a "read - text" mode which highlighted the words on the screen as the voice synthesizer reproduced the written text.

During the first six months of this program, each child had made 12 months of gain in reading level, however, the measures used were not indicated. Reading sub-skills showed improvements in increased use of phonics in decoding skills as well as an increase in sight word vocabulary. It would have been more enlightening for the reader if the author had described the measures used to assess progress in reading level.

Rosegrant discussed four essential factors in the use of the microcomputer to facilitate acquisition of the basic skills of reading and writing in learning-disabled students:

"1. To provide visual, auditory and motoric modes of support... use of the cursor provided daily exercise at visual tracking without any sense of practice.

2. To lower risks encountered in making errors.

3. To provide a high degree of control over reading and writing tasks.

4. To provide a meaningful learning context in which exploration and analysis of written language can occur" (p. 115).

While concrete results were not reported in the study, weaknesses can be noted in the wide age range of students and the small sample of students studied.

This study was valuable in its description of the students' task approach as well as the detailed explanation of the intervention program.

Written Language

Fredriksen (1981) viewed language as the essential component in learning to write and breaks down the task of writing into its component parts as follows:

"1. a cognitive activity

2. a particular form of language and language use

3. a communicative process

4. a contextualized, purposive activity" (p. 2).

From the perspective of this study, it seems expedient to add a fifth consideration:

5. a specific and precise motor activity.

Fredriksen drew on the work of Piaget when he proposed that

> "cognitive demands of writing are similar to those required by other symbol-making activities... writing might be similar to (i.e. continuous with) symbolic activities in pretend play, drawing and story telling, and dissimilar to (i.e. discontinuous with conversational language... that differs in its social interactional support for sustained language production" (p. 10).

and went on to differentiate further between oral and written language. Without the immediate listener reaction, and social and conversational cueing inherent in conversational language, the writer must clearly differentiate between an intended meaning and what is actually stated in print. He must anticipate the reader's reaction in absentia and determine "levels of communicative competence (which) are reflected in young writer's ability to estimate the levels of inference required to read what they write" (p. 11).

From this perspective, written language was presented as a distinct and separate identity evolving as a result of increasingly complex cognitive and linguistic interactions.

Woodruff (1986) studied the effects of word processing on the writing ability of students in an enriched program in order to determine what the differences in focus of attention between enriched and average students was

within the framework of the task, and determined that the writing skill of the student was the determining factor in the quality of assistance offered by the word processor. Enriched students focused on compositional style and theme development, however, the average students performed better on punctuation. The enriched students were more able to use the advanced edit functions of the word processor to organize and develop their compositions.

The overlapping parameters of cognition, language and written language and motor skill presents a complex picture. The authors who are pursuing linguistic and cognitive consequences of writing are not addressing the motor-disabled group of writers and motor skill in written output is taken for granted in this field of literature. This focuses the need for the development of basic writing and reading skills even more saliently for the motor dysfunction population when the vitality of written output is examined.

The development of written language to its fullest extent would seem to be a basic academic goal, however, it is initially dependent on the physical writing process itself.

Attention and Reading

The normal reader spent less attentional capacity in decoding of individual words and thus was able to go beyond this into reading for comprehension and meaning. The microcomputer's inherent ability to be programmed for activities which sustain attention made it a method of choice in reading instruction for learning-disabled populations (Torgeson, 1983).

Torgeson (1983) in establishing priorities for application of microcomputers for education of the learning disabled identified "the primary locus of difficulty for poor readers... at the individual word rather than discourse level of processing" (p. 235).

Major word reading difficulties of the learning disabled reader were identified as poorly-established phonetic basis for decoding new words and a low rate for reading of individual words including familiar words (Torgeson, 1983).

Applications of the Word Processing Model

MacArthur (1986) found that application of the word processor for written work in the classroom resulted in increased motivation for writing as a result of the neat copy achieved as well as the immediate results offered by the editing power of the computer. He noted that:

> "students work by typing rather than handwriting... producing better looking copy... (this is) easier for LD and other students with poor handwriting."

Various authors (MacArthur, 1986; Woodruff, 1986) have observed primitive technical skills for typing and editing in students using word processing in the classroom, but this did not interfere with motivational aspects, and as this was a skill and not an ability, it was proposed that these skills could be developed in order to contribute to a higher level of integrated functioning.

It would be naive to assume that the learning disabled (LD) student with poor handwriting could switch to another mode of output with ease. This overlooks the basic process disorder inherent in the student's approach to cognitive and organizational tasks.

MacArthur (1986) examined types of errors made by LD students in using two different word processing software programs.

The subjects were two groups of four LD students from a summer remedial reading clinic. Age range was 9.6 years to 12.2 years, spanning grades 4 to 6. These children were of average intelligence as measured by the WISC-R, PPVT and Detroit Tests of Learning Aptitude with all scores (except two invalid scores from two English as a Second Language (ESL) students falling within one standard deviation of the mean. Standardized testing of reading ability (tests not described) showed that the students were 1.9 to 3.2 years behind their age peers. All the students, except two who attended private schools, had been identified by their schools as learning disabled. None of the students had previous experience with word processing.

The two programs which were examined were Milliken Word Processor (Milliken, 1984) and Cut and Paste (Electronic Arts, 1983).

Milliken used a desk top graphic analogy as a four choice menu for writing tools, files, typewriter and help. This was better for the students who understood that they could press the escape button (ESC) until they got back to the desk graphic for menu choices.

In contrast, Cut and Paste presented highlighted menus and the students manipulated the arrow keys to highlight the menu of their choice and then pressed the return button to choose. This was a more complex sequence and also required more reading skills. The students had more difficulties.

Overall, the Milliken program was more suited to the group's organizational abilities, although one student took the desk top analogy

quite literally and tried to file two stories in the same computer file (as in file folder) thereby erasing his first story.

The investigators kept detailed notes on planned and actual instruction as well as narrative notes detailing student errors, questions, successful use of word processing functions and affective responses.

Typing skills were at the two-handed "hunt and peck" level resulting in an output speed of 10 to 20 letters per minute, although this rate was not frustrating for the children. Typing errors included spacing errors and the use of CAPS LOCK instead of SHIFT for single capital letters.

The children also adopted inefficient habits when using the cursor. They found it hard to switch to the ↑ or ↓ arrows preferring to use the → or ← arrows repeatedly to get to other lines.

No problems were encountered using the delete key (DEL), although once the students figured this function out, they tended to ignore the arrow functions for individual word correction and deleted entire words for retyping when single letters could have been replaced using a more sophisticated approach using the arrow keys.

Other error types involved the concepts of space on the screen. Some children felt they had to use the space bar in order to create a space for a letter to be inserted and would then erase it instead of trusting the computer function to manipulate the spaces.

The abstraction of the three types of empty space on the computer was difficult for the students. There were spaces as defined by the space bar, no visible representation of "return" and null spaces at the ends of lines where the words wrapped around.

The authors noted four error types which indicated the student's confusion about manipulating space:

1. Attempted to move the cursor into the null space and then did not understand why it would not work.
2. Typing 'return' at the end of a line instead of relying on the wrap around feature.
3. Use of the space bar instead of 'return' to get to the next line.
4. Typing a series of spaces to make a blank line instead of 'return'.

These errors make the screen format look acceptable, but do not reproduce in printing and reformatting.

Insertion of blank lines and splitting lines, and paragraphs was most difficult for these students to comprehend.

Based on these observations, the authors felt that the programs which employ modeless editing were most appropriate for these students as the system was always in insert, the arrow keys directed the cursor and the delete key erased the letter to the left of the cursor. Programs which employed separate modes for cursor movement or delete functions were not appropriate as they were confusing to the students (Apple Bank Street Writer). Structure of the program was best when simplest so students can "create a mental map".

This was consistent with the findings of Gordon (1980), and Reid and Hresko (1981) who suggested a simultaneous visual mode of learning for children with learning disabilities.

Students had persistent difficulty with confusion about the space aspects of the computer and insisted on retaining approaches which made the text on the screen look presentable but were unable to predict or plan ahead based on what the printout would look like.

The students' responses continued to be enthusiastic and they wrote continuously albeit at a slow rate. Compositions were longer on the word processor than when using handwriting. The excitement of being able to print error-free work had a compelling effect on these students, and they maintained an enthusiastic approach to the task throughout the study.

This study provided specific anecdotal data on task approach and task behavior. More numbers of subjects could have generated more information on individual differences and small, well matched groups could have contributed some statistical data using methods designed for small populations (Hersen and Barlow, 1976; Revusky, 1967).

The descriptive nature of the study was appropriate and provided insight into the problem solving difficulties experienced by students with learning disabilities.

Remediation Approaches

The literature does indicate some support for use of word processing to reinforce basic reading and writing functions in children with learning disabilities. Insight into the nature of process disorders when formulating the organizational framework for the software program for word processing was instrumental to the success of student task approach.

It is important to maintain this insight into the nature of process disorders when teaching the learning-disabled child with motor dysfunction to orient himself to the keyboard.

The "Touch to Type" (Curriculum Associates, 1981) program presented a color-coded layout to assist with letter key location. The children may

also wear colored dots on the fingers allocated to each colored area of the keyboard in order to reinforce correct use of all fingers in typing.

"Keyboard Town" (Gallagher, 1961) reinforced keyboard layout memory by using the analogy of a community with a Home Keys Street, uptown and downtown, and way up town to correspond to the four rows of keys.

Fingers rested initially at Home Keys Street and the isolated finger movement was taught by having the character associated with the letter name move to uptown and downtown locations which employed the initial consonants of the letter keys. For example, the fifth finger rested on "A" in middle town. Ann went downtown to feed the zebras at the zoo and uptown to visit Mr. QWERT's house, a large house which occupies half of the space in uptown.

Visual maps were presented to reinforce the image of Keyboard Town and a diagonal road intersected the town to indicate the differentiation between keys struck by the left hand and keys for the right.

Given the difficulties with finger sequencing abilities of learning-disabled students with motor dysfunction (Gaddes, 1980), it may be unrealistic to expect the students to use all fingers, particularly the fourth and fifth fingers which are difficult to isolate; however, the use of two hands to split the keyboard may assist in speed of letter key location and an ordered sequence of digit introduction may proceed as follows: bilateral index fingers, index fingers and thumbs, leading to the introduction of the third finger as automaticity of finger-key association develops.

Techniques which reinforce memory of the spatial organization of the keyboard and encourage bilateral hand use would seem appropriate for this

population in order to reinforce speed and accuracy of typing, and in order for the student to progress at his own maximal rate in developing competence on the keyboard.

Use of the word processor would provide a neat, consistent, error-free, written output for students with motor dysfunction. The student would be taught strategies with which to approach the task of learning keyboarding skills and these strategies should be consistent with the student's cognitive-motor profile.

The visual motor aspect of output is thus de-emphasized and the anxious or discouraged student may proceed with the cognitive aspects of the task in a relatively motor-free environment.

Summary

The review of the literature showed a majority of studies to have poorly defined parameters regarding student populations studied. The use of vague and subjective measures of clinical change reflected a paucity of academic rigor, particularly in the earlier studies on the development of keyboarding skills in elementary school children (Tate, 1935; Conrad, 1935).

The facilitative effect of keyboard use on written output for students with poor motor control was discussed by the earlier authors (Conrad, 1935; Tate, 1935), but no data were reported for this specific population.

Studies describing microcomputer/word processor combinations for written output are more specific in describing student populations as being learning disabled or from the normal student population. Rosegrant (1985) described her learning disabled student's poor handwriting mastery, but did

not give any details regarding any history of motor incoordination or physical disability. It is not known whether any consideration was given to these factors when determining the most appropriate means for intervention.

MacArthur (1986) provided a valuable insight into error types made by LD students in using two different word processing software programs. Typing skills were described at the two-handed 'hunt and peck' level. The study focused on the conceptual nature of the task and did not examine or isolate any student difficulties which may have been motor in nature.

None of the studies examined or described a systematic method of training the motor skills required for teaching children with learning disabilities and motor dysfunction keyboarding skills on a word processor. This approach would require insight into the nature of the child's learning disability as well as the nature of his motor dysfunction.

The studies did describe a motivational factor inherent in word processor use which seemed to be related to the production of perfect copy. This is valuable to the teacher-clinician, but no specific measures related to motivation and self-esteem were reported, and the findings were based on general observation (Tetrault, 1970; Seltzer, 1978; Erikson, 1978; Rosegrant, 1985; MacArthur, 1986).

None of the studies interpreted their data or analyzed the tasks required of the students according to a theoretical framework such as the simultaneous-sequential information process model.

The use of a descriptive approach is invaluable in programming effectively for children with complex learning needs, as demonstrated by MacArthur (1986) and Rosegrant (1985).

Several authors commented on motor maturation as a factor in keyboarding skills development (Conrad, 1935; Cowles, 1983) as well as suggesting that ability in written language and reading were factors afflicting output rate.

Cowles (1983) also indicated that off tasks behavior was one of the critical variables affecting the development of speed and accuracy of output.

Information on effects of keyboarding on reading, written language and attention was inadequate and required further study.

Erikson (1972) and Kolich (1985) both commented on the need for a structured and systematic training in order to maximize keyboard skills, although neither compared performance between groups of students who were trained and students who practised their own 'hunt and peck' methods. Indeed, most studies of learning disabled students on keyboards tended to allow the students to randomly approach the keyboard without any letter key location orientation except for random visual scanning and hit or miss targetting. It would seem important to minimize the frustrations inherent in this method. As no studies reported any difficulty, the question raised is was there really no difficulty or has the foundation task of motor training of LD students in keyboard use been overlooked?

CHAPTER 3

STATEMENT OF THE PROBLEM

This study undertook to examine the applications of teaching keyboarding skills on a word processor to learning-disordered children with motor dysfunction.

There has been much discussion in the literature regarding use of the word processor as a tool for written output. Studies have examined the applications for the gifted student population in development of writing skills and written language (Woodruff, 1986, 1982b) as well as the difficulties encountered by the learning-disabled population when learning to use the word processor (MacArthur, 1986).

Although Rosegrant (1985) described the quality of handwritten output of her learning-disabled population as illegible and lacking in spatial organization, there is a paucity of information available which describes the application of word processing techniques for the learning-disabled student with motor dysfunction whose written output is compromised by the inability to grade motor responses, poor postural control, fine motor dysfunction, difficulty with bilateral motor coordination and motor sequencing.

It was hypothesized that, if the learning-disabled child with motor dysfunction could be taught to use the word processor as an adjunct to practise of handwritten output, the improved legibility of the letters and words would facilitate consistent decoding by the student of his own work, reinforcing acquisition of early reading skills.

A systematic training method which incorporated knowledge of the child's learning disability as well as the nature of motor dysfunction was required in order to facilitate the student's approach to the complex task of keyboarding and word processing.

CHAPTER 4

METHOD

Subjects

Three boys, aged 6.9 to 8.10 years of age served as subjects. The diagnosis of motor dysfunction was based on each child's medical history, medical diagnosis and motor assessment.

All three boys had histories of slow motor development and poor academic performance. Two of the boys had been diagnosed with minimal cerebral palsy and were receiving weekly occupational therapy at school from a community-based therapy agency.

A review of the records of the school performance of each student showed discrepant skills in psychological testing and documentation of erratic clinical profiles of learning and attention. The boys' handwriting skills were poor and reading levels were two years behind for two of the subjects, and showed delayed acquisition for the youngest subject, who was in Grade One.

Written approval for conducting the study was obtained from the principal of the school which the subjects attended. Once written approval was obtained, the parents were sent information letters and consent forms.

In order to comprehend the nature and etiology of the child's motor dysfunction, a detailed examination of each child's medical and developmental history was undertaken.

The details of the case histories are presented in the Appendices (see Appendix A, F and K), and the relevant features will be presented in this chapter.

Subject #1

Name:	C.M.
Date of Birth:	July 28, 1977
Chronological Age:	8.10 years
Date:	June 1, 1986

C.M. was apprehended at birth as a result of his natural parents' non-compliance to methadone therapy for their heroin addiction. He was treated for severe heroin withdrawal during his first weeks of life and was discharged from Intensive Care to foster care.

C.M. had neurological and behavioral sequelae as a result of his prenatal birth history and was followed closely during infancy and early childhood by a medical team of specialists.

He was diagnosed with minimal cerebral palsy and exotropia of the left eye, receiving ongoing physiotherapy, infant stimulation and speech therapy. C.M. demonstrated ongoing delays in motor, adaptive, language and behavioral skills. He was noted to be irritable, resistant to introduction of new toys or different ways to manipulate familiar materials.

C.M. developed nocturnal seizures at 2½ years of age and was placed on medication. He is still on medication for seizure control.

C.M. attended special needs pre-school, but went onto an integrated day care setting with a 1:1 special needs worker. He spent his kindergarten year in the day care program and was integrated into the kindergarten class at his local school for the last three months. He then repeated kindergarten on a full-time basis, the following year.

C.M. was referred to occupational therapy for evaluation of his fine motor and perceptual motor development. He was noted to be distractible in school, had problems with prehension, and poorly established hand dominance and poor basic concepts. Visual motor skills were significantly poor (VMI:

2.10 years, at a chronological age of 5.6 years and Motor Accuracy scoring at 2.1 standard deviation below the mean).

C.M. was referred for ongoing occupational therapy at a community therapy agency.

Psychological testing (September 1983) found the boy's behavior and functioning pattern to resemble that of a severely learning-disordered youngster. His educational needs required a highly individualized program in a setting designed for students with multiple learning handicaps. Priorities for planning were on controlling behavior, increasing attention span, development of perceptual and cognitive abilities and acquiring basic academic skills. The recommendation was made that the multisensory approach be used extensively.

C.M. was placed in a small class setting at his local school the following year. He continued to demonstrate poor printing and visual motor skills. Reversals and sequencing errors persisted in his printing and organization of letters into word groupings, and spacing between words were areas of difficulty. Attentional deficits continued to interfere with learning and output.

Subject #2

Name:	O.R.
Date of Birth:	August 3, 1979
Chronological Age:	6.10 years
Date:	June 1, 1986

O.R. is the youngest son of a single parent who has a university education and works in the Computer Systems Technology field.

When O.R. was initially diagnosed with minimal cerebral palsy and bilateral club feet, his mother raised funds from various service clubs in order to take him for patterning therapy at the Institute for the Achivement of Human Potential in Philadelphia, Pennsylvania.

O.R. spent his kindergarten year at a Special Needs Day Care where he exhibited a discouraged approach to tasks and had difficulty with activities requiring fine motor control. Day Care recommendations on graduation noted that areas for improvement were writing, pencil control, self-confidence, and alphabetic and numerical sequences.

Psychological testing placed O.R. within the normal range with poor perceptual motor performance and visual motor integration. At the end of Grade One, O.R. still required 1:1 assistance for fine motor skills, had no real understanding of numbers greater than ten, and was reading at the third level of the Ginn Reading program. The child was still quite play-oriented and the school-based team recommended retention.

Subject #3

Name: I.R.
Date of Birth: October 18, 1977
Chronological Age: 8.7 years
Date:

This boy's history of English as a second language, bilateral conductive hearing loss and extended school absenteeism have complicated the interpretation of his results of psychological and language testing.

His performance skills were noted to fall into the low average range and verbal performance was affected by his ESL background and was not felt to be indicative of his potential.

I.R.'s visual motor abilities fell at the 3rd%ile on the Test of Visual Motor Integration at a chronological age of 5.10 years. He had difficulty following instructions and had poor coordination in craft activities. He was noted to have specific weakness in language and fine motor areas.

I.R. was placed in an Observation Class after an unsuccessful kindergarten year and was placed in a Junior Learning Assistance Class the following year, as he required a small class setting. Printing was poor and he had trouble with spacing between the words. He was described as distractible and continued to work at a low reading level.

Summary

Three boys with learning deficits, motor dysfunction, visual motor integration difficulties and poor printing, who were reading at an early Grade One level, acted as subjects in this study which took a case history approach to examine the applications of teaching keyboarding skills on a word processor to children with learning and motor dysfunction.

Subject #1's medical history revealed the most severe motor involvement with abnormal gait, immature prehension, poorly established hand dominance and severe difficulty with visual motor integration.

Subject #2 had a moderate amount of motor difficulty with fine motor deficits, poor pencil skills and visual motor delay.

Subject #3 presented with a motor skill delay in fine and gross motor areas, but the medical and developmental history did not indicate specific neurological involvement.

Design

Given the unique cognitive-motor profiles of the population under consideration, an experimental design approach to the problem was insufficient. The number of students in the study was very small, and on close scrutiny of the academic and developmental histories of each student, they were poorly matched in etiology and severity of motor dysfunction as well as academic performance.

A case history approach was chosen to place all the critical factors affecting the students into perspective. This approach also allowed the investigator to generate insights into new hypotheses based on clinical observations and situational analyses during the study.

The observational data were gathered in a naturalistic setting, the classroom, and provided for documentation and interpretation of a broad range of phenomena.

A single case limited time series was utilized to examine the effects of the word processing intervention on a block sequencing task, measuring successive processing. These results formed one aspect of the data obtained during the study.

The design was chosen because of the small number of subjects as well as the unique nature of the cognitive-motor profiles of the individual subjects (Hersen and Barlow, 1976).

The study was presented within the case history format and included an ABAB intervention design. Each phase lasted two weeks and eight contacts were made with the students in each phase.

The A phase provided a baseline measurement of performance on the dependent variable, Knox Cubes, a block sequencing task. Testing of the dependent variable was administered daily.

During the B phase, the block sequencing task administration continued and the 'Write to Read' intervention (Nash and Geyer, 1981) was introduced using the classroom word processor as a writing tool. The effects of the intervention are reflected if performance on the dependent variable shows a stable, positive trend during the B phases of the design (Towney and Gast, 1984).

The intervention was withdrawn after two weeks and the A phase was reintroduced for the next two weeks in order to reestablish baseline performance of the dependent variable. The last B phase reintroduced the 'Write to Read' intervention, in order to determine if the student's ability to perform a sequencing task would be affected by the keyboarding task. Comparison between phases was afforded by the ABAB design.

Specific data collection as to bilateral hand use, positioning, application of word processor command sequences and visual recognition of errors was made daily during the intervention B phases and recorded under 'Clinical Observations'. Daily scoring of letters per minute and errors in typed and handwritten samples was also done during the B phases of the design.

The students were assessed to determine baseline performance on the Bruininsks-Oseretsky Test of Motor Proficiency, Durrell Reading Analysis and the Developmental Test of Visual Motor Integration (VMI).

The Word Analysis subtest of the Durrell Reading Analysis was readministered at the end of the study.

In order to teach the word processing and keyboarding skills effectively, and to develop an approach consistent with theoretical considerations for teaching learning-disabled students, a task analysis approach based on the simultaneous and successive processing model was

taken. A meaningful, conceptual framework was applied to the keyboard display and reinforced by cueing to reinforce motor learning.

Measures

The Bruininsks-Oseretsky Test of Motor Proficiency was used to provide a comprehensive battery of subtests to assess motor function.

The Developmental Test of Visual Motor Integration (VMI) was used to provide a measure of visual motor integration.

The Durrell Analysis of Reading Difficulty was used to assess reading levels and to provide insight into the children's word analysis ability. The word analysis subtest was readministered at the end of the study.

Knox Cubes, a subtest of the Arthur Point Scale of Performance, was utilized to act as a measure of successive processing.

Bruininsks-Oseretsky Test of Motor Proficiency

This battery is comprised of eight subtests which measure gross and fine motor aspects of motor development. The subtests measure: Running Speed and Agility, Balance, Bilateral Coordination, Strength, Upper Limb Coordination, Response Speed, Visual Motor Control, and Upper Limb Speed and Dexterity.

Performance on these subtests is expressed as a gross motor composite, a fine motor composite and a battery composite. These scores can be expressed in standard scores or percentiles. Performance on subtests is expressed in standard scores, age equivalents and stanines. The mean of the standard score measurement is 15 with a standard deviation of 5.

Evidence of construct validity is presented in the manual based on correlation of test scores with chronological age (.57 to .86 with a median of .78), internal consistency of the subtests (between item point scores and subtest point scores: median range of .65 to .87 and between item point scores and total point scores: median range of .86 to .56, and factor analysis of the subtest items with varimax rotation.

The manual presents studies which indicate that normal subjects perform significantly better than populations of mildly retarded, moderately to severely retarded and learning disabled subjects. These learning disabled students were classified on the basis of enrollment in special education programs and were two years below grade level in reading. Populations in these studies were small ($\prec$ 100 subjects).

Reliability was established through test-retest reliability coefficients and standard error of measurement. These were found to be satisfactory (Bruininsks, 1978).

Developmental Test of Visual Motor Integration (VMI)

This is a measure of visual motor integration and "is a sequence of twenty-four geometric forms to be copied with pencil on paper (Beery, 1982, p. 11).

Studies to determine interrater reliability, test-retest reliability have found the reliability to be good (Beery, 1982).

The VMI correlates well with chronological age (.89) and motor skill (.76). The correlation between the VMI and readiness tests has ranged around .50 (Beery, 1982).

Raw scores are converted into percentile ranks, standard scores and age equivalents. Standard scores have a mean of ten with a standard deviation of three.

Durrell Analysis of Reading Difficulty

This comprehensive assessment allows the examiner to observe and analyze the student's difficulties in oral reading and word recognition.

The analysis provides assessment and measurement of ten areas of reading ability: Oral Reading, Silent Reading, Listening Comprehension, Word Recognition/Word Analysis, Listening Vocabulary, Pronunciation of Word Elements, Spelling, Visual Memory of Words, Auditory Analysis of Words and Word Elements, and Prereading Phonics Abilities Inventories.

The authors state that its validity is attested to by its widespread clinical use since its inception in 1932. Studies involving subtests used in Grade 1 reading measurement in September found correlations with reading achievement at the end of the school year as follows: Syntax Matching (.60), Writing Letters (.60), Identifying Phonemes (.60) and Naming Letters (.55).

Reliability studies for the grade levels of Oral and Silent Reading using reading rate as the factor for determining grade level found correlations between Oral Reading of .85 and between Silent Reading of .80.

The Kuder-Richardson Formula #21 was used to establish the reliabilities of the rest of the subtests and presented a range of correlations from .97 (Spelling-Intermediate) to .63 (Visual Memory of Words-Primary). The population studied was a randomly chosen group of 200 children taken from Grades 2 to 6.

Knox Cubes

Knox Cubes test is a subtest of the Arthur Point Performance Scale, a measure incorporating five subtests. Each subtest is separately standardized and the scores are combined into a single point scale (Buros, 1953).

Jarman and Das (1980) task analyzed the Knox Cubes subtest and found it to be a measure of successive visual processing.

The dependent variable was a stratified sample of 55 items. These items were based on the Knox Cubes sequencing task. Block sequence patterns incorporating sequences of 2, 3, 4, 5 and 6 were generated at random from the pool of possible combinations and each level was equally represented in the sample. The patterns were placed on cards, shuffled and selected at random during each administration of the dependent variable. In this way, the practise effect was eliminated.

The materials consisted of four 1" square cubes made out of plain wood and glued to a wooden base at half-inch intervals.

Verbal directions were chosen to make the instructions as clear as possible.

The examiner tapped the top of the first block and the second block with the index finger and said:

> "You tap the blocks I tap. If I tap this one (#1), then you tap this one too."

If the child did not automatically tap, then his finger was physically moved to tape the first block and the examiner said:

> "If I tap these (#1, then #2), which ones do you tap?"

The blocks were tapped at a rate of one per second. Once the child clearly understood the directions, the examiner proceeded with the test items saying:

"Touch the blocks just like I do." (Miller, 1982)

Procedures

Working at the Computer

An Apple IIe computer and printer with Milliken word processing software (Milliken, 1984) comprised the equipment used. The keyboard was divided into two halves, left and right, by a red pencil held diagonally between T and Y, G and H, B and N. This physical barrier provided tactile cueing for redirecting the students toward correct bilateral hand use. A visual reinforcement of the left-right keyboard split was reinforced by placing red adhesive dots on the keys "Y", "H" and "N". The right hand did not cross this line and the left hand typed all the keys to the left of it.

At the beginning of each session, the software was in place and the initial desk graphic of the Milliken program was on the screen.

Students were required to access the writing mode of Milliken, a two stage sequence including selecting the 'write' menu from the initial menu and then choosing 'write', once the menu appeared.

The 'Write To Read' (Nash & Geyer, 1981) program card was placed in a stand to the left of the monitor and angled for easy visibility. The tutor was seated to the student's right.

The student's attention was then drawn to the first word of the 'Write to Read' card and he was asked to say the word in order to place the letter sequence of the word into the meaningful framework of language. If the

student was successful, he was asked what the meaning of the word was and to put it into a sentence if this was appropriate to the understanding of the child. For example, to explain 'led' as the past tense of 'lead' was considered too complex. The student then typed a line of each word following the same procedure. As he typed the tutor provided the phonetic association with the initial consonant or blend and the word ending in order for the student to hear the sound-symbol association.

For example, the word 'red' was sounded out 'ruh-ed' by the tutor for the first three trials of the typing of the series of the word. This method was consistent with the Glass analysis method for decoding which was being used in regular classroom work.

Initial blends, such as 'brim', were sounded out as 'br' as the student typed the corresponding letters and not as 'buh'-'ruh'.

The student then typed the sentence from the 'Write to Read' card, having first sounded out and read the sentence. Errors in spacing or typing were brought to the student's attention if he did not observe them himself and he was asked to use the arrows to move the cursor and the delete functions in order to correct the sentence. The student then typed the sentence again without intervention from the tutor and was expected to recognize his own errors in typing and spacing and correct them. This sentence was timed by the tutor and scored for errors of letters and spacing.

The student then printed his work on the printer, a four stage sequence which involved going back to the desk graphic menu, selecting 'T' for type menu, selecting the correct response on the type menu (#4) and pressing 'return' to activate the printer.

Once the work was typed, the student then wrote the sentence again in his own handwriting and this was also timed by the tutor and scored for errors of letters and spacing.

If the student could not say the word, it was decoded by the tutor. For example, "'RED', The first letter says 'ruh'. These letters say 'ed'. Ruh-ed. Red."

If the student did not know the meaning of the word, the tutor gave him an example, in order to place the letter sequence of the word into a meaningful framework of language.

If the student was unable to provide a sentence using the word, the tutor provided a sentence in order to give meaning to the word in the context of a sentence.

The students were oriented to the visual map of the keyboard by telling a simplified version of the Keyboard Town Story (Gallagher, 1961) at points B#1 and B#5 of each B phase a total of four times during the intervention phases, placing emphasis on the initial consonant of the words chosen to represent the letter keys (banana, buh; tough, tuh).

Directions regarding the way, way uptown keys were not given (%, $, #). The major emphasis was on the location of the downtown, Home Keys Street, uptown and the diagonal road cutting through the town. The cues 'downtown, Home Key Street, uptown and Mr. Qwert's house' were used when necessary to limit the scanning time taken by the child to locate the letter keys.

Details of the Keyboard Town letter keys (i.e., Sad Sam, Frank and George) were not used as cues during the typing of the Write to Read words

and sentences, as this was judged to be potentially confusing to the students.

Cueing for which hand to use for which letter key was provided by presenting the physical barrier to the hand as it tried to cross the line and the words, 'Try the other hand'. If necessary, the words "This hand types on the left side of the line, this hand types on the right side of the line," were reinforced with a tap on the dorsum of the corresponding hands.

Verbal and tactile cues were provided together or simultaneously or not at all, according to the judgement of the tutor.

Later on in the program, the students were asked to decide themselves which hands were to be used correctly.

CHAPTER 5

RESULTS

Analysis of Dependent Variable Data

This evaluation was done through visual analysis of mean level lines and trend lines (using the split middle method) for stability or variability. The effects of the intervention were reflected if performance on the dependent variable showed a stable positive trend direction during the intervention (B) phases of the design (Towney and Gast, 1984).

The data from measurements of the dependent variable were plotted on line graphs to allow visual inspection of changes of levels and trends of performance across the phases of the time series.

Using a fifteen percent (15%) stability criterion, the acceptable stability range for levels and trends was calculated on the highest data point value of each of the phases. Eighty-five percent (85%) of the data points must fall within the acceptable criterion range for the trend to be considered stable (Towney and Gast, 1984).

Statistical analysis was done using the "C statistic" treatment of the data (Tryon, 1982).

Subject #1

Discussion of Test Results

C.M. scored below the first percentile of the battery composite of the Bruininsks-Oseretsky Test of Motor Proficiency. Gross and Fine Motor Composite scores also fell below the first percentile. He had a history of

epilepsy and continued to take medication. He had retained some primitive movement patterns associated with minimal cerebral palsy (see video, Appendix E).

All subtest scores were markedly below the mean (see Appendix C) and indicative of gross and fine motor coordination deficits.

The Developmental Test of Visual Motor Integration placed C.M. below the third percentile (see Appendix C).

The Durrell Reading Analysis placed C.M.'s reading skills at the low Grade One level with the exception of the Sounds in Isolation subtest which was performed at the mid Grade One level. C.M. was given a letter grade of 'B' in the Pre-reading Phonics Abilities Inventories (see Appendix C). Performance on the Word Recognition/Word Analysis subtest showed that C.M. recognized two words on the flash phase and no further recognition of any words on the analysis phase, although he was able to recall the initial consonant of each word during the flash phase. C.M. pronounced the phoneme of the initial consonant and then substituted another word beginning with the same initial consonant during the analysis phase of the word list.

The Word Recognition/Word Analysis subtest was readministered at the end of the study.

C.M. recognized seven words in the word list and decoded one more word (morning) during word analysis. His approach to analysis was erratic, but he attempted to break the words down, being unable to combine the sounds back into words (father = fat-r).

On other examples, C.M. added extra sounds (tree = t-o-eek, name = nam-k-eek).

On one example, C.M. looked at the first and last letter, and made a guess based on that configuration (sleep = stop. 'That's s, that's p, stop.'), substituting one of his sight words.

On retesting at the end of the program, C.M.'s overall performance on this subtest placed him at the low Grade One level with a quantitative gain in decoding strategies, but no reliable word analysis skills emerging. His sight word vocabulary had improved.

Clinical Observations During Word Processing

C.M. #1

C.M.'s task approach was impulsive, and he demonstrated an irritable and frustrated affect which swung quickly to recognition reflex laughter when he was successful with a strategy or made a connection between events.

He was distractible and fatigued easily. Initially, he started every statement with a refusal to attempt the task, followed by an immediate attempt at the task.

C.M. was reticent to try a new approach to problem-solving and this was particularly noted in his difficulties conceptualizing the function of the return key to initiate the next line as opposed to the use of the directional arrows, preferred use of the CAPS LOCK key instead of the shift key for capitalization, and deletion of entire words for correction in lieu of the use of the directional arrows to move the cursor in and out of the words, with deletion and insertion of specific letters or spaces using the space bar.

He struggled to master cursor movement using the directional arrows as he had difficulty with grading his pressure on the keys, and this made locating the cursor at specific locations on the screen initially quite

difficult. He had no difficulty understanding where to place the cursor in order to make a change on the screen. C.M.'s facility with cursor movement increased steadily throughout the study. At the end, he was observed to make appropriate choices between correctional strategies.

C.M. preferred to use one hand for typing, but could be directed toward bilateral hand use in order to facilitate targetting speed. This intervention was withdrawn on days when C.M. was particularly agitated, as it was judged to be too intense and complex for C.M. to cope with on these days. C.M.'s difficulty with bilateral coordination, seen in formal testing, may have been the basis for this reticence. He was able to coordinate hand movement for three letter words which had the initial consonant letter key on one side of the keyboard and the other two letters on the side. He had difficulty with three letter words which required R-L-R or L-R-L sequenced hand use. C.M. also appeared to be guided by the auditory, phonetic decoding strategy used during the intervention. For example, PEN was decoded as P-EN and C.M. seemed to use one hand for P and the other for EN, typing EN as a unit.

Words of four letter sequences which were split in half by the L/R keyboard orientation were subject to letter reversals and C.M. eventually insisted on a one-handed approach to these letters in order to get them in the right sequence. He rejected his newer keyboarding strategy as the degree of difficulty of the letter sequence increased.

C.M. was able to correct his errors by visual inspection. During the first intervention phase he overlooked errors in spacing, capitalization and spelling, but by the end of the second phase, he was typing error-free copy.

This was in marked contrast to his printing which was erratic, distorted and characterized by reversals, mixed upper and lower case letters, and poor spacing between words. Inspection of errors in the handwritten sample was impulsive and unreliable.

C.M. had mastered the word processing commands at the end of the second intervention. The command sequences required reinforcement at the beginning of the second intervention, as they had not been retained completely during the second baseline phase.

Difficulties with letter recognition (b/d, l/i) persisted during word processor use, but output of reversed letters was eliminated and the consistent appearance of the letters allowed C.M. a better opportunity to correct his errors by visual inspection. The relative facility of correction on the word processor served as a basis for motivation in correction of errors.

C.M. initially was confused about typing lower case letters from upper case keys.

He had some difficulty scanning for letter key locations and seemed to be assisted by Keyboard Town cues.

At the end of the study, C.M. was spontaneously using two hands for typing. He did switch into a one-handed approach (preferring right, but also using left), and was alternating one-handed and two-handed approaches during sentence copying.

C.M. did not show much enthusiasm for placing the words on the word list into language contexts. These words and sentences were not particularly meaningful for him.

He used verbal mediation spontaneously as a strategy to guide himself through sequenced operations.

Mean Rates, Number of Errors and Error Types in Word Processing and Handwriting

Each intervention phase was divided in half and the mean rate (letters/minute) for word processing and handwriting was calculated. The mean rates within intervention phases were then compared.

In the first intervention phase, Subject #1's rate of word processing decreased by a mean rate of -0.43 letters per minute. This reflects a minimal decrease. In the second intervention phase, the mean rate increased by 5.37 letters per minute (see Table I).

The rate of word processing at the end of the second phase was highest of all previous rates. The word processing rate had fallen off at the initial phase of the second intervention (see Table I).

These results reflect an overall improvement in rate of word processing and a drop in rate of output following the second baseline phase.

The mean number of errors in word processing increased slightly (0.75) during the B_1 intervention phase. No errors were noted in the B_2 intervention phase indicating an overall decrease in errors over the course of the study and mastery of the word processing aspect of the task (see Table II).

The mean rate of handwriting increased in intervention phase B_1 by +2.16 letters per minute but decreased in intervention phase B_2 by -1.73 letters per minute. The mean rate of handwriting at the end of the B_2 intervention was the lowest of all previous mean rates. This represents a decline in handwriting speed over the course of the study (see Table II).

The mean number of errors in handwriting increased during intervention B_1 and decreased during intervention B_2. The mean number of errors represents a trend of fewer errors in handwriting over the course of the study (see Table II).

Subject #1

Table I

Mean Rates (letters/minute) of
Word Processing and Handwriting

Intervention Phase	B1				B2			
Mean Rates	$\bar{X}1$	(Day 9-12)	$\bar{X}2$	(Day 13-16)	$\bar{X}3$	(Day 25-28)	$\bar{X}4$	(Day 29-32)
Word Processing	11.37		10.94		8.23		13.60	
Handwriting	10.97		13.13		10.42		8.69	
Difference Between Means	$(\bar{X}_1 - \bar{X}_2)$				$(\bar{X}_3 - \bar{X}_4)$			
Word Processing	-0.43				+5.37			
Handwriting	+2.16				-1.73			

Table II

Mean Number of Errors in
Word Processing and Handwriting Samples

Intervention Phase	B1				B2			
Mean Number of Errors	$\bar{X}1$	(Day 9-12)	$\bar{X}2$	(Day 13-16)	$\bar{X}3$	(Day 25-28)	$\bar{X}4$	(Day 29-32)
Word Processing	1.25		1.25		0		0	
Handwriting	5.5		6.0		6.75		4.0	
Difference Between Means	$(\bar{X}_1 - \bar{X}_2)$				$(\bar{X}_3 - \bar{X}_4)$			
Word Processing	0.0				0			
Handwriting	+1.5				-2.75			

Subject #1

Table III

Error Types in Word Processing Samples

Intervention Phase	B_1									B_2						
Day	9	10	11	12	13	14	15	16	25	26	27	28	29	30	31	32
Error Free			x	x			x		x	x	x	x	x	x	x	x
Reversals																
Upper Case																
Omissions																
Letter Errors								1								
Extra Letters																
Capitalization Errors						1										
Punctuation Errors																
Spacing Errors	1	2		2	2		1									
Total	1	2	0	2	2	1	1	1	0	0	0	0	0	0	0	0

Subject #1

Table IV

Error Types in Handwriting Samples

Intervention Phase	B_1								B_2							
Day	9	10	11	12	13	14	15	16	25	26	27	28	29	30	31	32
Error Free																
Reversals	5								1							
Upper Case	4										1			1	1	
Omissions					3			4	2							
Letter Errors			2	1	4	1	4	2	2	6	2		1			2
Extra Letters												1				1
Capitalization Errors		1														
Punctuation Errors		1														
Spacing Errors	3		2	3			5	1	3	4	5		2	1	5	2
Total	12	2	4	4	7	1	9	7	8	10	8	1	3	2	6	5

Subject #1

Table V

Correlation of Block Sequencing Scores Between Baseline and Intervention Phases

		B_1	B_2
A_1	.731	2.86*	-
A_2		.92	3.10*

*p .01

There was no significant trend in the A_1 baseline phase.

There were significant trends between the first baseline and intervention phases, and between the second baseline and intervention phases.

C statistic treatment of A_1 B_2 phases was not carried out as this procedure only allows for comparison between adjacent phases (Tryon, 1982).

Data for Block Sequencing Task - Subject #1

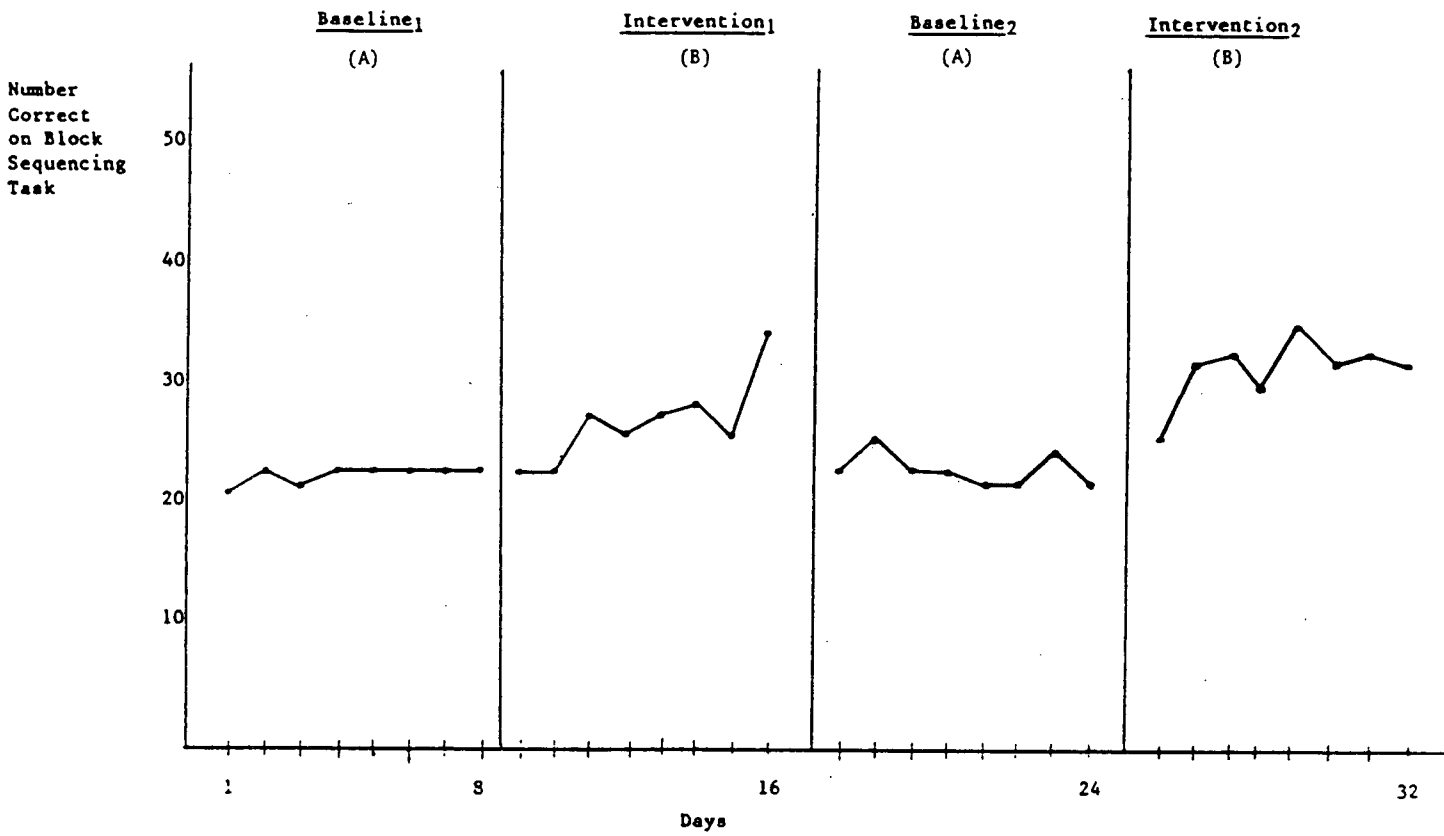


Figure 1

Trend Lines for Block Sequencing Task - Subject #1

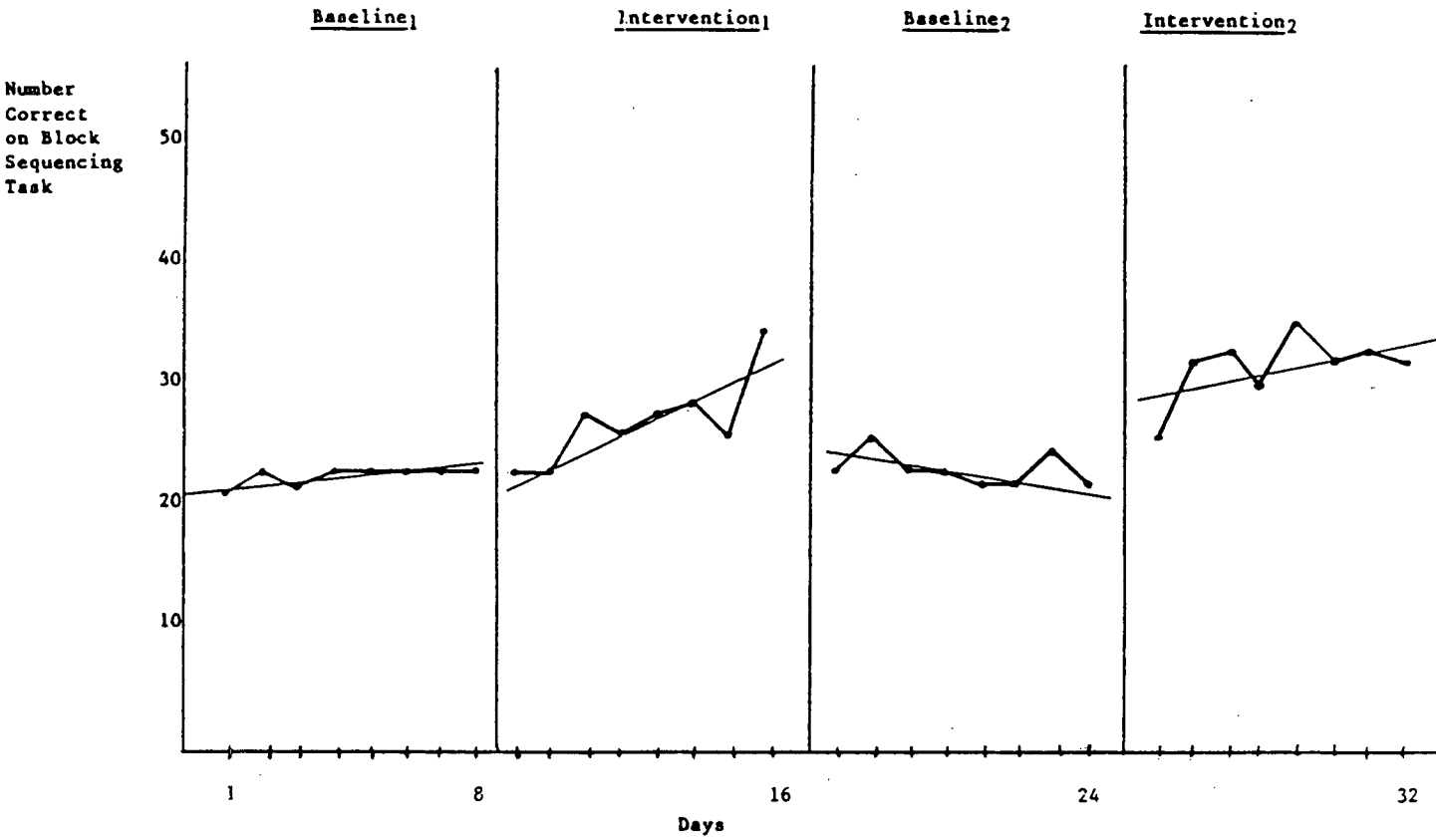


Figure 2

Within Conditions Analysis

	A_1	B_1	A_2	B_2
Trend Stability	Stable	Stable	Variable	Variable
Percentage Stability	(100%)	(100%)	(75%)	(75%)

Between Adjacent Conditions Analysis

	B_1/A_1	A_2/B_1	B_2/A_2
Change in Trend Direction	positive	negative	positive
Change in Trend Stability	stable to stable	stable to variable	variable to variable
Percentage of Overlap of Data Points	25%	50%	12.5%

Mean Level Lines for Block Sequencing Task - Subject #1

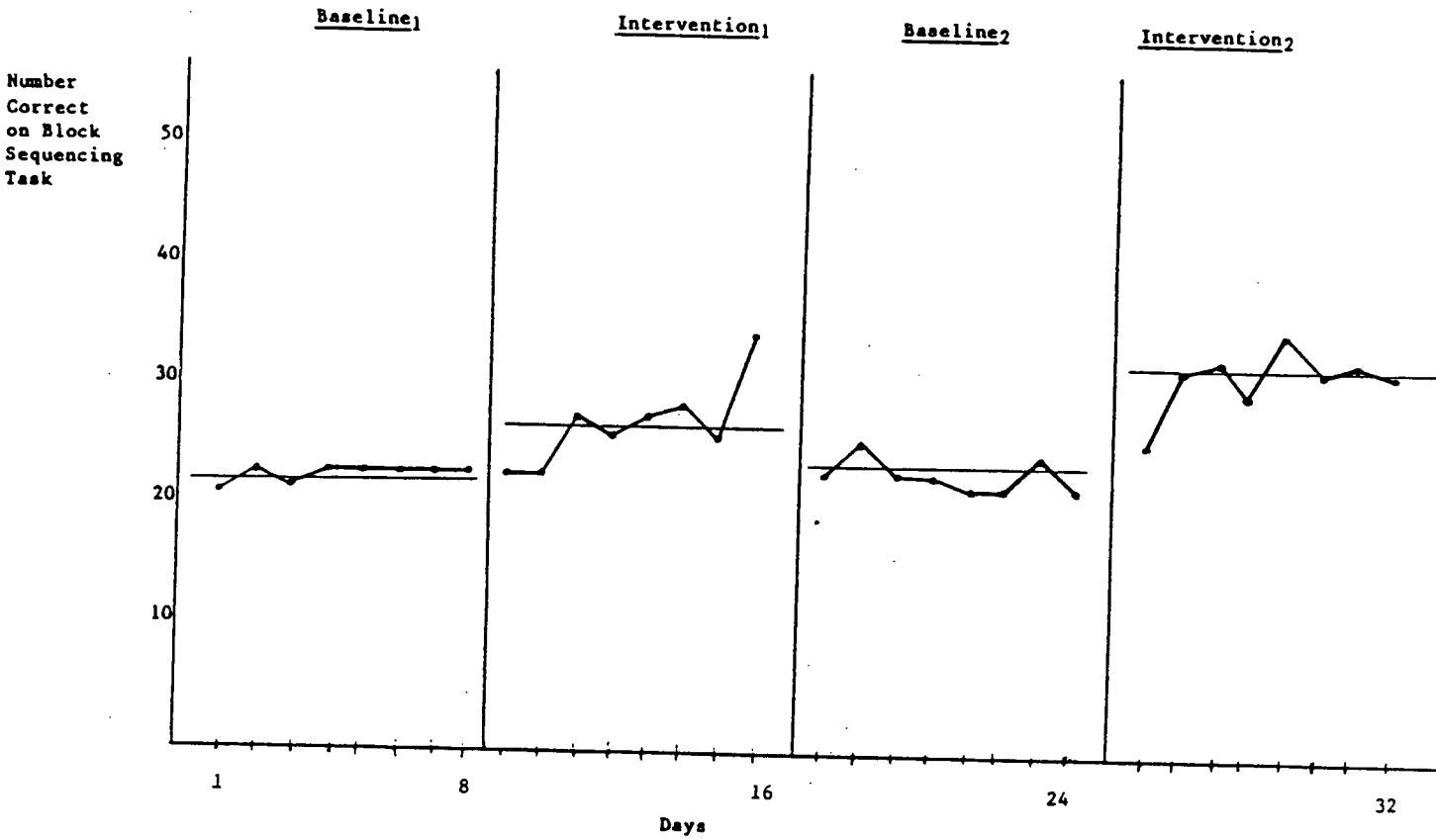


Figure 3

Within Conditions Analysis

	A_1	B_1	A_2	B_2
Level Stability	Stable	Variable	Stable	Variable
Percentage Stability	(100%)	(62.5%)	(87.5%)	(87.5%)
Range of Data Points	(21-23)	(23-34)	(22-26)	(26-35)
Level Change	+2	+9	-1	+4

Between Adjacent Conditions Analysis

	B_1/A_1	A_2/B_1	B_2/A_2
Change in Level	(23-23)	(34-23)	(22-26)
	0	-11	+4

Discussion of Visual Analysis of Graphic Data

The data presented in Figure 1 represent a positive change in performance on the block sequencing task when the computer keyboard intervention (B) was initiated.

The acceptable stability range for levels and trends was calculated on the highest data point value of each of the phases of the time series using a fifteen percent (15%) stability criterion. Eighty-five percent (85%) of the data points must fall within the acceptable criterion range for the trend to be considered stable (Towney & Gast, 1984).

Subject #1 established a baseline with a stable trend and stable level in the A_1 phase. Introduction of the computer keyboard intervention (B) in the B_1 phase resulted in a stable improving trend in performance on the block sequencing task. Days 9 and 10 reflect continued baseline performance. On the third day of intervention (Day 11), there was improved performance on the block sequencing task when compared to the last day of the baseline condition (Day 8). Performance on the last day of the first intervention (Day 16), was higher than on the first day of the intervention (Day 9). This indicated a positive effect on block sequencing during the intervention phase.

Withdrawal of the computer keyboard intervention (B) resulted in a decaying, variable trend in performance on the block sequencing task. There was an abrupt deterioration in performance between phase B_1 and phase A_2 reflecting a return to baseline performance upon withdrawal of the intervention program (B). This is reflected in the mean levels of both baseline phases.

Re-introduction of the intervention program (B) resulted in an improving variable trend in performance on the block sequencing task. The first day of the second intervention phase (Day 26) indicated an improvement in block sequencing over the last day of the second baseline phase (Day 24). The final day of the second intervention phase (Day 32) showed higher performance than on the first day of the second intervention phase (Day 25). The mean level of the second intervention phase was higher than the first intervention indicating a stronger performance in block sequencing in the second phase (Figure 3). The last three data points (Days 30, 31, 32) indicate a stabilizing level in performance on the block sequencing task during the second intervention.

There was a 25% overlap in the number of correct response on the block sequencing task between conditions A_1 and B_1. The data points from the first two days of intervention (Days 9 and 10) reflect a continuation of baseline performance and thus overlap with data in condition A_1. Elimination of these data points from the range of data points in condition B_1 resulted in a 0% overlap in data points and a strong positive effect on the block sequencing task performance during the first intervention phase.

A 50% overlap in data points between conditions A_2 and B_1 was seen. Data points from Days 17, 19 and 20 overlap with the initial baseline level of condition B_1 causing a greater percentage of data point overlap. Elimination of the baseline data points from the range of data points in B_1 resulted in a 12.5% overlap. This was interpreted as a return to baseline performance and, given the change in trend direction, strong negative effect on performance on the block sequencing task after withdrawal of the intervention program.

Twelve and one-half percent of the data points between phases B_2 and A_2 overlapped and reflected a marked improvement in block sequencing performance with the re-introduction of the intervention program (B), given the change in trend condition.

Subject #2

Discussion of Test Results

O.R.'s performance on the Bruininsks-Oseretsky Battery Composite placed him below the 1%ile rank. The Gross Motor Composite was also below the 1%ile rank and the Fine Motor Composite score was at the 8th%ile. These scores were indicative of gross and fine motor dysfunction. Tonal anomalies consistent with minimal cerebral palsy with club feet were observed (see video, Appendix J).

The Visual Motor Control and Upper Limb Speed and Dexterity subtest scores were within the average range; however, the Fine Motor Composite Score was pulled down by the score on the Response Speed subtest, which measures hand response to a moving visual stimulus.

The Developmental Test of Visual Motor Integration results placed O.R. at the 25th%ile rank and his copied forms showed poor spatial orientation.

Results on the Durrell Analysis of Reading Difficulty placed O.R. at the low Grade One level on all subtests with the exception of Listening Comprehension, which placed him at the low Grade Three level.

The Pre-Reading Phonics Inventories were scored with a letter grade of A/B.

Initial performance on the Word Recognition/Word Analysis subtest showed five words recognized during the flash phase with no further words recognized during the analysis phase.

O.R. recalled initial consonants, but substituted word guesses beginning with the same phoneme or gave up on the word.

This subtest was readministered at the end of the study.

O.R. now recognized nine words in the flash phase and eight more words during analysis. His successful analysis attempts seemed to be based on sounding individual letters out and combining the sounds into words. Unsuccessful, but logical attempts revealing ignorance of irregularities or more complex phoneme combinations included: away: a-wee, children: kilun, other: on-er.

O.R.'s overall performance on this subtest placed him at the low Grade One level with quantitative and qualitative gains in word recognition and analysis. His sight word vocabulary had improved.

Clinical Observations During Word Processing

O.R. #2

O.R. presented as a passive child with a flat unresponsive affect. He tended to 'come alive' verbally in front of the word processor, but would revert into passivity when confronted with a complex task.

He had great difficulty with maintaining postural tone when sitting at the keyboard. This, in turn, affected his ability to grade his hand movements and he made a lot of grading errors in the initial stages of the study. As a result, he was required to use the cursor frequently to delete long rows of repeated letters and required the direction of the cursor to specific locations.

The rearrangements of O.R.'s seating helped him sit upright and seemed to improve his ability to grade his finger pressure. This child took every opportunity to lean against something for postural support.

O.R. initially preferred to use one hand for targetting, but responded to cueing, seeming particularly responsive to tactile cues in the early stages of the intervention. He did not require any direction for bilateral hand use in the study.

O.R. seemed to understand the word processing commands, but had some difficulty remembering the sequences. He frequently sought adult assistance and was subsequently encouraged to find his answer on the visual display, and even to make a few errors in order to find his way through the command sequences.

O.R. had difficulty with three letter words requiring alternate hand sequences and four letter word sequences were initially subject to reversed order. O.R. managed to persevere with the two-handed approach and correct

reversal errors with visual inspection, using the directional arrows to lcate the corrective cursor at specific locations. On occasion, he used a total delete approach to correct, but generally used the more complex strategy.

O.R.'s printing was poorly organized in space, but did not include reversals or gross distortions; however, the lack of spacing made the handwritten samples difficult to read. He made errors in capitalization in the written sample and letter size was very inconsistent, giving the appearance of capital letters in mid sentence. He tended to make punctuation periods into circles and this added to the general confusion.

On one lesson, O.R. used a dash between words on the written sample to replace the space bar position in the typed copy. Most of his errors in the typed samples were spacing errors, but at the end of the study, O.R. had typed error-free copy for four consecutive lessons.

O.R. had no difficulty scanning for letters on the keyboard. He enjoyed the Keyboard Town story, but never required additional cueing for letter key location.

O.R. read through the word lists using the decoding strategy modelled by the tutor. This evolved into a sight word response. Increased ability on the Write to Read word lists did not generalize into the classroom, according to his teacher.

O.R. seemed to enjoy placing the words into a meaningful language context, and often came up with several meanings for the words.

Mean Rates, Number of Errors and Error Types in Word Processing and Handwriting

Each intervention phase was divided in half and the mean rates (letters/minute) for word processing and handwriting was calculated. The mean rates within intervention phases were then compared.

In the first intervention phase, Subject #2's rate of word processing decreased by a mean rate of -0.3 letters per minute. This reflects a minimal decrease.

In the second intervention the mean rate increased by 2.14 letters/minute.

The word processing rate had increased at the initial phase of the second intervention and the rate of word processing at the end of the second phase was the highest of all the previous rates. These results reflect a steady gain in rate of word processing throughout the study.

The mean number of errors decreased slightly (-0.5) over the course of the study.

Subject #2

Table VI

Mean Rates (letters/minute) of
Word Processing and Handwriting Samples

Intervention Phase	B1		B2	
Mean Rates	$\bar{X}1$ (Day 1-4)	$\bar{X}2$ (Day 5-8)	$\bar{X}3$ (Day 1-4)	$\bar{X}4$ (Day 5-8)
Word Processing	10.51	10.81	12.53	14.67
Handwriting	12.41	9.68	10.72	16.77
Difference Between Means	$(\bar{X}_1 - \bar{X}_2)$		$(\bar{X}_3 - \bar{X}_4)$	
Word Processing	-0.3		+2.14	
Handwriting	-2.73		+6.05	

Table VII

Mean Number of Errors in
Word Processing and Handwriting Samples

Intervention Phase	B1		B2	
Mean Number of Errors	$\bar{X}1$ (Day 1-4)	$\bar{X}2$ (Day 5-8)	$\bar{X}3$ (Day 1-4)	$\bar{X}4$ (Day 5-8)
Word Processing	0.75	1	0.25	0
Handwriting	2	2.25	2.5	0.25
Difference Between Means	$(\bar{X}_1 - \bar{X}_2)$		$(\bar{X}_3 - \bar{X}_4)$	
Word Processing	+0.25		-0.25	
Handwriting	+0.25		-2.25	

Subject #2

Table VIII

Error Types in Word Processing Samples

Intervention Phase	B_1								B_2							
Day	9	10	11	12	13	14	15	16	25	26	27	28	29	30	31	32
Error Free			x	x			x		x	x	x		x	x	x	x
Reversals																
Upper Case																
Omissions																
Letter Errors	1															
Extra Letters																
Capitalization Errors	1											1				
Punctuation Errors		1														
Spacing Errors					1	2		1								
Total	2	1	0	0	1	2	0	1	0	0	0	1	0	0	0	0

Subject #2

Table IX

Error Types in Handwriting Samples

Intervention Phase	B_1								B_2							
Day	9	10	11	12	13	14	15	16	25	26	27	28	29	30	31	32
Error Free			x			x					x			x	x	x
Reversals																
Upper Case				2			1						1			
Omissions	1									1						
Letter Errors	1											1				
Extra Letters																
Capitalization Errors	1	1		1				1								
Punctuation Errors	1															
Spacing Errors					1		1		2	5						
Total	4	1	0	3	1	0	2	1	0	6	0	1	1	0	0	0

Subject #2

Table X

Correlation of Block Sequencing Scores
Between Baseline and Intervention Phases

		B_1	B_2
A_1	1.92*	1.03	-
A_2		1.13	.235

*$p < .05$

There was no significant trend in the A_1 baseline phase (p .05). No other significant trends were noted between phases of the dependant variable.

Because of the trend in the initial baseline, a comparison series between the A_1 and B_2 phases was created to determine if the trend in the treatment phase departed from the trend set in the baseline phase. No significant trend was found.

C statistic treatment of A_1 B_2 phases was not carried out as this procedure only allows for comparison between adjacent phases (Tryon, 1982).

Data for Block Sequencing Task - Subject #2

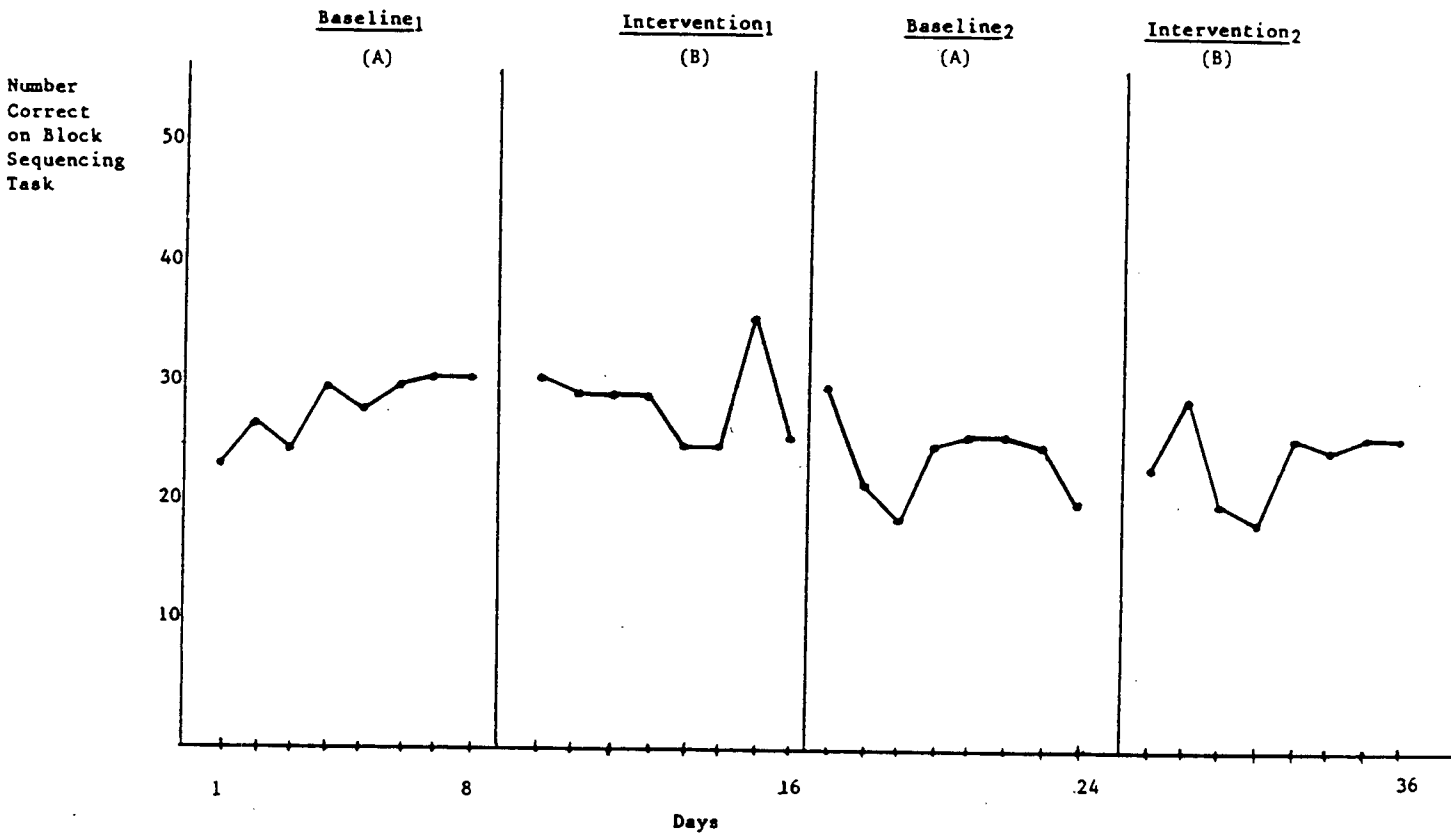


Figure 4

Trend Lines for Block Sequencing Task - Subject #2

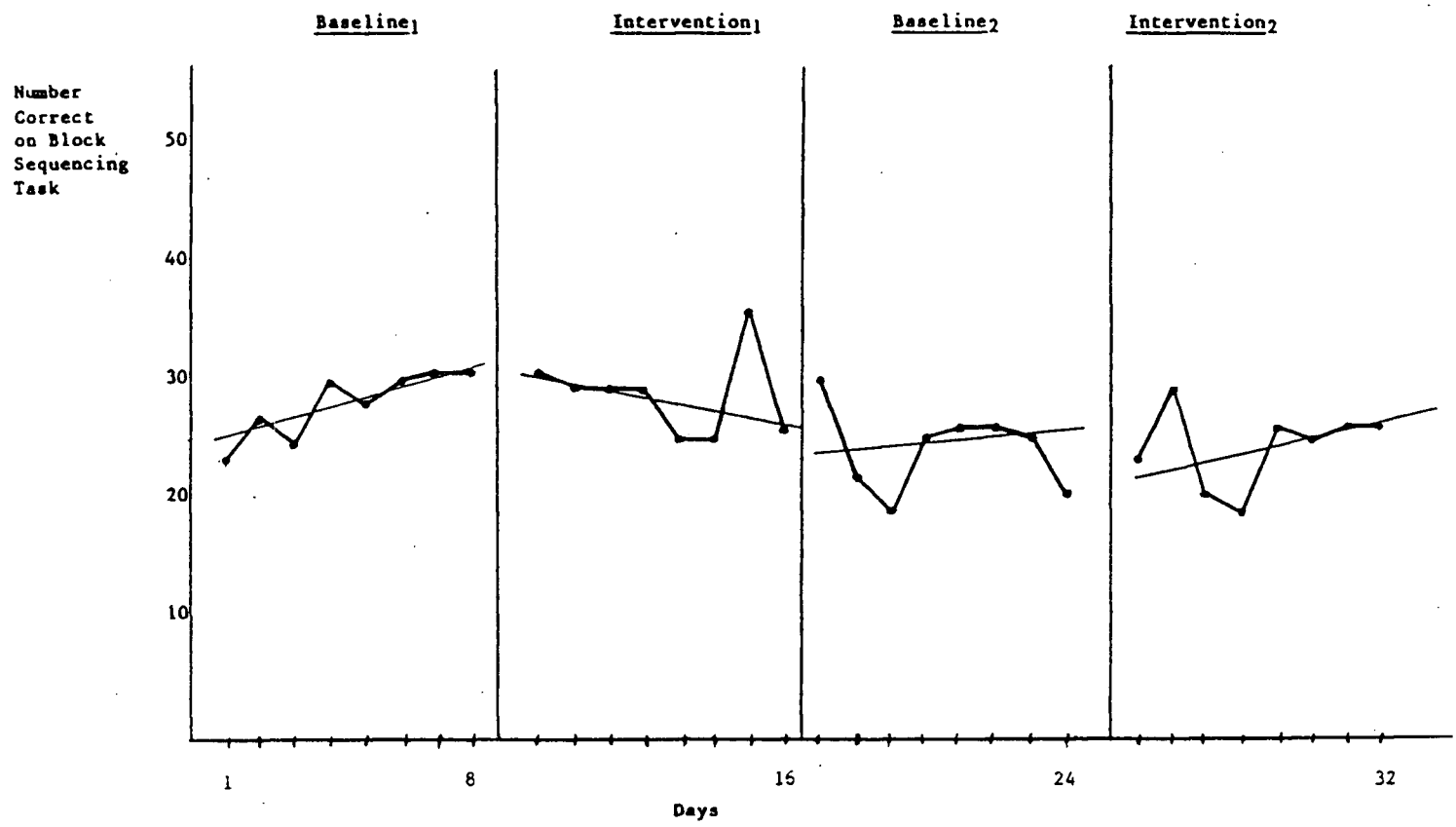


Figure 5

Within Condition Analysis

	A_1	B_1	A_2	B_2
Trend Stability	Stable	Variable	Variable	Variable
Percentage Stability	(100%)	(50%)	(50%)	(62.5%)

Between Adjacent Conditions Analysis

	B_1/A_1	A_2/B_1	B_2/A_2
Change in Trend Direction	negative	positive	positive
Change in Trend Stability	stable to variable	variable to variable	variable to variable
Percentage of Overlap of Data Points	87.5%	62.5%	100%

Mean Level Lines for Block Sequencing Task - Subject #2

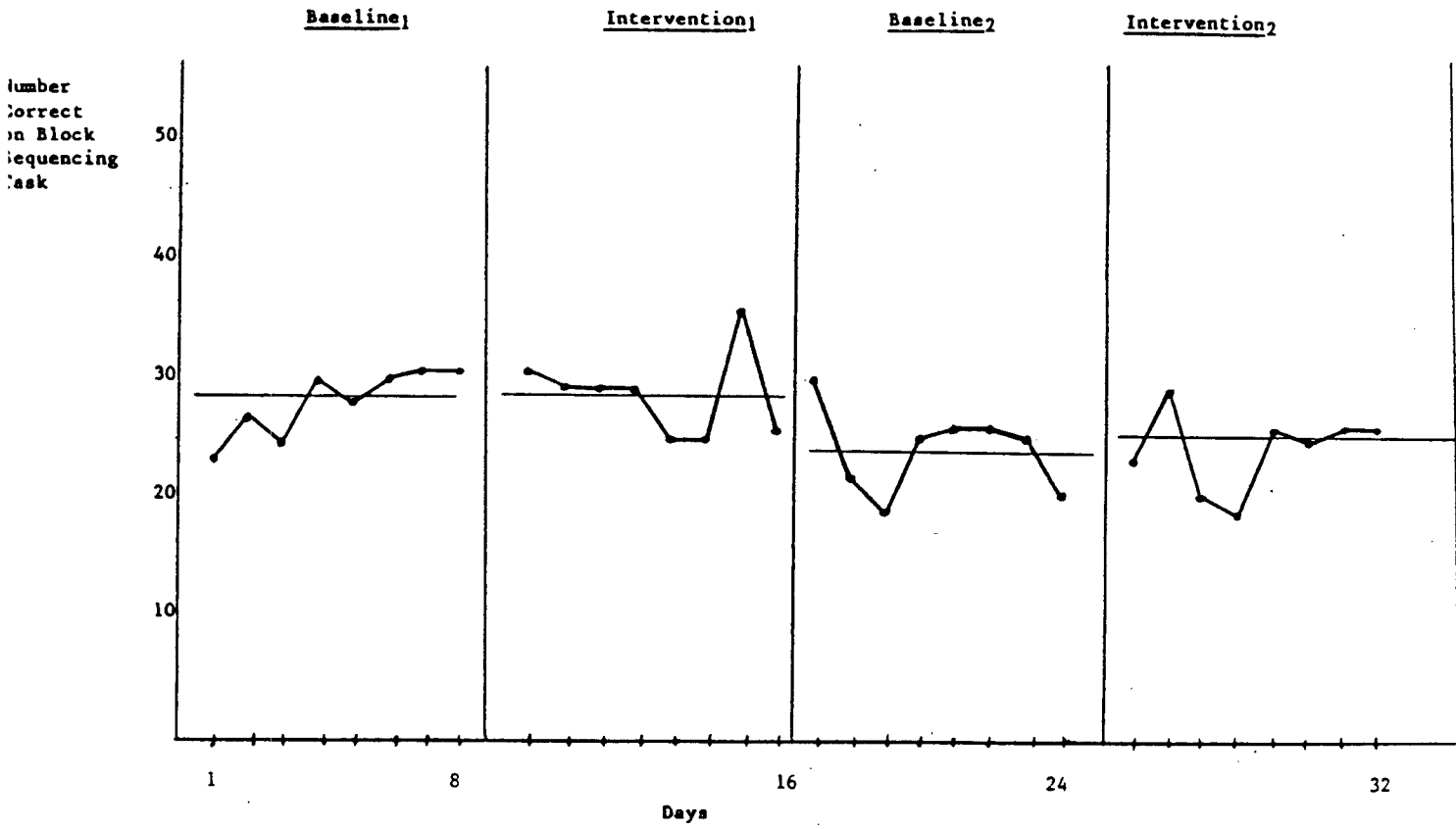


Figure 6

Within Conditions Analysis

	A_1	B_1	A_2	B_2
Level Stability	Variable	Variable	Variable	Variable
Percentage Stability	(50%)	(37.5%)	(0%)	(62.5%)
Range of Data Points	(23-32)	(25-36)	(15-31)	(18-30)
Level Change	+9	-6	-15	+3

Between Adjacent Conditions Analysis

	B_1/A_1	A_2/B_1	B_2/A_2
Change in Level	(32-32)	(26-31)	(16-23)
	0	+5	+7

Discussion of the Visual Analysis of Graphic Data

The data presented in Figure 4 do not represent any positive change in the performance of the block sequencing task when the computer keyboard intervention (B) was introduced.

Subject #2 was initially intrigued by the block sequencing task, but lost interest during the course of the study. The data seemed to reflect his motivation or attention to the task rather than his block sequencing ability.

The acceptable stability range for levels and trends was calculated on the highest data point value of each of the phases of the time series using a fifteen percent (15%) stability criterion. Eighty-five percent (85%) of the data points must fall within the acceptable criterion range for the trend to be considered stable (Towney & Gast, 1984).

The data points in the A_1 phase showed a stable improving trend with the data on Day 8 showing a higher value than the data on Day 1. This indicated that Subject #2 failed to establish a baseline performance on the block sequencing task prior to the first intervention phase. Introduction of the intervention program (B) produced a variable, decaying trend in block sequencing performance. The data on Day 15 reached an isolated peak, but did not reflect the overall change in trend direction between phases: positive to negative. This did not reflect a change in the direction of the intervention objective. Performance on the last day of intervention (Day 16) was lower than on the first day of intervention (Day 9). This indicated a negative effect on block sequencing performance during the intervention phase.

Withdrawal of the computer keyboard intervention (B) resulted in an improving variable trend in block sequencing performance. Again, this contrary to the anticipated direction of trend of data. There was a drop in performance on Days 17, 18 and 19, but this improved only to drop off again on Day 24. Subject #2 failed to establish a baseline in either baseline phase of the time series design and the mean level in the second intervention was lower than the mean level of the first intervention.

The second intervention phase showed an improving but variable trend in performance on the block sequencing task. The data point of first day of the second intervention phase (Day 25) was higher than the data point of the last day of the second baseline (Day 24), and performance continues to improve on Day 26, which was in the direction of the anticipated trend of data points, but performance deteriorated in the following days. Although there was some improvement in performance, the mean level of performance in the second phase never reached the mean level of the first phase indicating poorer performance on the block sequencing task in the second intervention phase.

Subject #3

Discussion of Test Results

IR scored at the 4th percentile on the battery composite of the Bruininsks-Oseretsky Test of Motor Proficiency and this was indicative of significant dysfunction. The Gross Motor Composite score was at the 1%ile. Balance being a subtest of particular weakness and strength subtest falling within the average range. All other gross motor subtests fell below the mean (see Appendix M).

Upper Limb Coordination was within normal limits, this subtest measures ball skills and fine coordinated hand movement.

The Fine Motor Composite placed IR at 7%ile, with visual motor control, and upper limb speed and dexterity scoring in the average range. The score on response speed was very low and may have affected the composite score.

Given IR's history of middle ear infection, the observer may question if there were longlasting effects on IR's balance and if this could be the basis for IR's poor gross motor performance. Bilateral coordination was also an area of weakness. Complex language demands of the test instructions may have played a part in the subtest performance, but clinical observation (see video, appendix) indicates difficulty with motor planning and motor sequencing.

Results on the VMI place IR below the 3rd percentile. Although IR's printing is appropriately sized and fairly legible, this ability does not seem to have generalized to the copying of unfamiliar forms. IR was slightly impulsive and tended to rush through the task and this may have affected his performance somewhat.

Form 11 on the VMI revealed segmentation at the mid point, indicating some difficulty with crossing midline (Beery, 1982).

Raw scores convert to an age equivalent of 5.7 years at a chronological age of 8.7 years.

The majority of subtests on the Durrell Reading Analysis place IR at the low to mid Grade One level, with Listening Comprehension and Listening Vocabulary, as areas of relative strength, scoring at the low Grade Two level. It should be noted that these areas came out as strengths in a 1:1 testing situation and may not reflect the boy's classroom performance in view of his documented conductive hearing loss.

IR performed at the low Grade One level on the subtests measuring sounds in Isolation and Sounds in Words. Visual Memory of words and word recognition subtests were slightly better at the mid Grade One level and indicating that IR may have made most gains using a sight word approach to reading.

IR scores at the low Grade One level on the Word Recognition/Word Analysis subtest. He recognized familiar sight words on the initial recognition phase, but did not succeed in reading any other words on the analysis phase of the subtest.

While IR recognized and recalled the initial consonants of the words, he was unable to identify in the recognition phase.

He tended to substitute another word beginning with the same consonant with no regard for word form (father = fun, mother = morning, tree = the). He did try 'away' ('ow') but was unable to complete the word.

IR did not recognize consonant blends (sleep = see, tree = the) or 'ch' (children = c).

IR tended to be anxious and impulsive throughout this part of the assessment, and this may have affected his performance.

Reassessment on the Word Recognition/Word Analysis subtest at the end of the intervention placed IR at the low Grade One level.

Qualitative examination of his approach to the task reveals that he was able to recognize four more words on List A (Grade One reading level) and made enough progress on the analysis of List A to begin List 1 (above Grade One reading level) where he recognized three words.

IR tended to look at the whole word (father = fa-r) and to attempt more difficult words (morning) during analysis.

He made more effort to work through words using consonant blends during analysis (seep = sleep, drets = dress) and tried to work out the 'ch' sound (chair = cup-ch-chop), although not always correctly (pleased = plastic, plaster). IR was willing to risk making errors.

He still utilized his original strategy of initial consonant recognition and guessing the rest of the word (around: afternoon), but this had extended to use of consonant blends (breakfast; br-bird, pleased; plastic, plaster). He was very attentive and impulsivity had diminished.

IR was willing to risk making errors on the reassessment of Word Analysis, although his performance still placed him at the low Grade One reading level.

Clinical Observations During Word Processing

IR #3

I.R. initially presented with a flat affect and made little eye contact with the tutor. As he experienced success on the word processor, he became more spontaneous in his manner.

He mastered the word processing sequences rapidly, having had some previous experience on the classroom computer.

I.R. initially preferred a one-handed approach, but switched easily to bilateral hand use. He required minimal cueing, and typed three and four letter sequences with equal facility, alternating hands easily.

I.R. tended to type rapidly and made initial spacing errors. These were corrected by visual inspection without cueing. He tended to delete the whole word if he discovered the error before he had typed ahead any distance. If his error was imbedded in the middle of a sample, he used the more complex method of cursor movement, using the directional arrows. This strategy was quite pragmatic.

I.R.'s handwriting was legible and well spaced. He tended to mix upper and lower case letters in his written samples.

I.R. frequently left out entire words in the handwritten sentence and could not recognize his errors on visual inspection, although he recognized them easily on the typed sample and did not omit words at all when typing.

I.R. participated well in placing the words in a meaningful language framework. He was quite concrete in his approach to sentence formation, tending to choose one format and apply it to every word (I am a...., A _____ can....).

I.R. enjoyed the Keyboard Town story, but did not require further cueing for letter key location.

Discussion

Each intervention phase was divided in half and the mean rate (letters /minute (lpm)) for word processing and handwriting was calculated. The mean rates within intervention phases were then compared.

In the first intervention phase, Subject #3's rate of word processing was stable (-.03 lpm) and handwriting rate decreased by -6.39 lpm.

In the second intervention, the mean rate of word processing increased by 7.24 lpm and handwriting increased by 3.09 lpm.

The word processing and handwriting rates had increased at the initial phase of the second intervention, and the rate of both handwriting and word processing at the end of the second phase was the highest of all previous rates. These results reflect a steady gain in rate of word processing and an overall gain in rate of handwriting.

It is not clear what may have caused the drop in handwriting rate at the end of the first intervention, although Subject #3 may have been overly precise in his handwriting attempts during this time and this may have taken more time.

The mean number of errors remained fairly stable across the intervention phases with a minimal gain (+0.25) in error rates in handwriting and word processing in the first intervention phase and error free copy in the word processing sample of the second intervention phase. There was a slight gain in error rates in the handwriting sample (+0.5) in the second intervention phase and this may have reflected some small error increases due to increased speed of output in handwriting.

Subject #3

Table XI

Mean Rates (letters/minute) of
Word Processing and Handwriting Samples

Intervention Phase	B1				B2			
Mean Rates	$\bar{X}^1$	(Day 9-12)	$\bar{X}^2$	(Day 13-16)	$\bar{X}^3$	(Day 25-28)	$\bar{X}^4$	(Day 29-32)
Word Processing	13.47		13.44		18.58		25.82	
Handwriting	21.67		15.28		25.17		28.26	
Difference Between Means	$(\bar{X}_1 - \bar{X}_2)$				$(\bar{X}_3 - \bar{X}_4)$			
Word Processing	-.03				+7.24			
Handwriting	-6.39				+3.09			

Table XII

Mean Number of Errors in
Word Processing and Handwriting Samples

Intervention Phase	B1				B2			
Mean Number of Errors	$\bar{X}^1$	(Day 9-12)	$\bar{X}^2$	(Day 13-16)	$\bar{X}^3$	(Day 25-28)	$\bar{X}^4$	(Day 29-32)
Word Processing	0		0.25		0		0	
Handwriting	2.5		2.75		1		1.5	
Difference Between Means	$(\bar{X}_1 - \bar{X}_2)$				$(\bar{X}_3 - \bar{X}_4)$			
Word Processing	+0.25				0			
Handwriting	+0.25				+0.5			

Subject #3

Table XIII

Error Types in Word Processing Samples

Intervention Phase	B_1								B_2							
Day	9	10	11	12	13	14	15	16	25	26	27	28	29	30	31	32
Error Free	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
Reversals																
Upper Case																
Omissions																
Letter Errors						1										
Extra Letters																
Capitalization Errors																
Punctuation Errors																
Spacing Errors																
Total	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

Subject #3

Table XIV
Error Types in Handwriting Samples

Intervention Phase	B_1								B_2							
Day	9	10	11	12	13	14	15	16	25	26	27	28	29	30	31	32
Error Free			x										x	x	x	
Reversals																
Upper Case																
Omissions				4	3		2	2							2	
Letter Errors						1										
Extra Letters																
Capitalization Errors	2	1		1	1											1
Punctuation Errors	1	1					1		1			1				
Spacing Errors						1				1	1					
Total	3	2	0	5	4	2	3	2	1	1	1	1	0	0	2	1

Subject #3

Table XV

Correlation of Block Sequencing Scores
Between Baseline and Intervention Phases

		B_1	B_2
A_1	1.99*	.812	-
A_2		.482	.752

*$p < .05$

There was no significant trend in the A_1 baseline phase ($p < .05$). This occurred because Subject #1 was not attending to the task and the examiner intervened strongly. Subject #1 then appeared to comprehend the language demands of the task.

Because of the trend in the initial baseline, a comparison series between the A_1 and B_1 phases was created to determine if the trend in treatment phase departed from the trend set in the baseline phase. No significant trend was found.

C statistic treatment of A_2 B_2 phases was not carried out as this procedure only allows for comparison between adjacent phases (Tryon, 1982).

Data for Block Sequencing Task - Subject #3

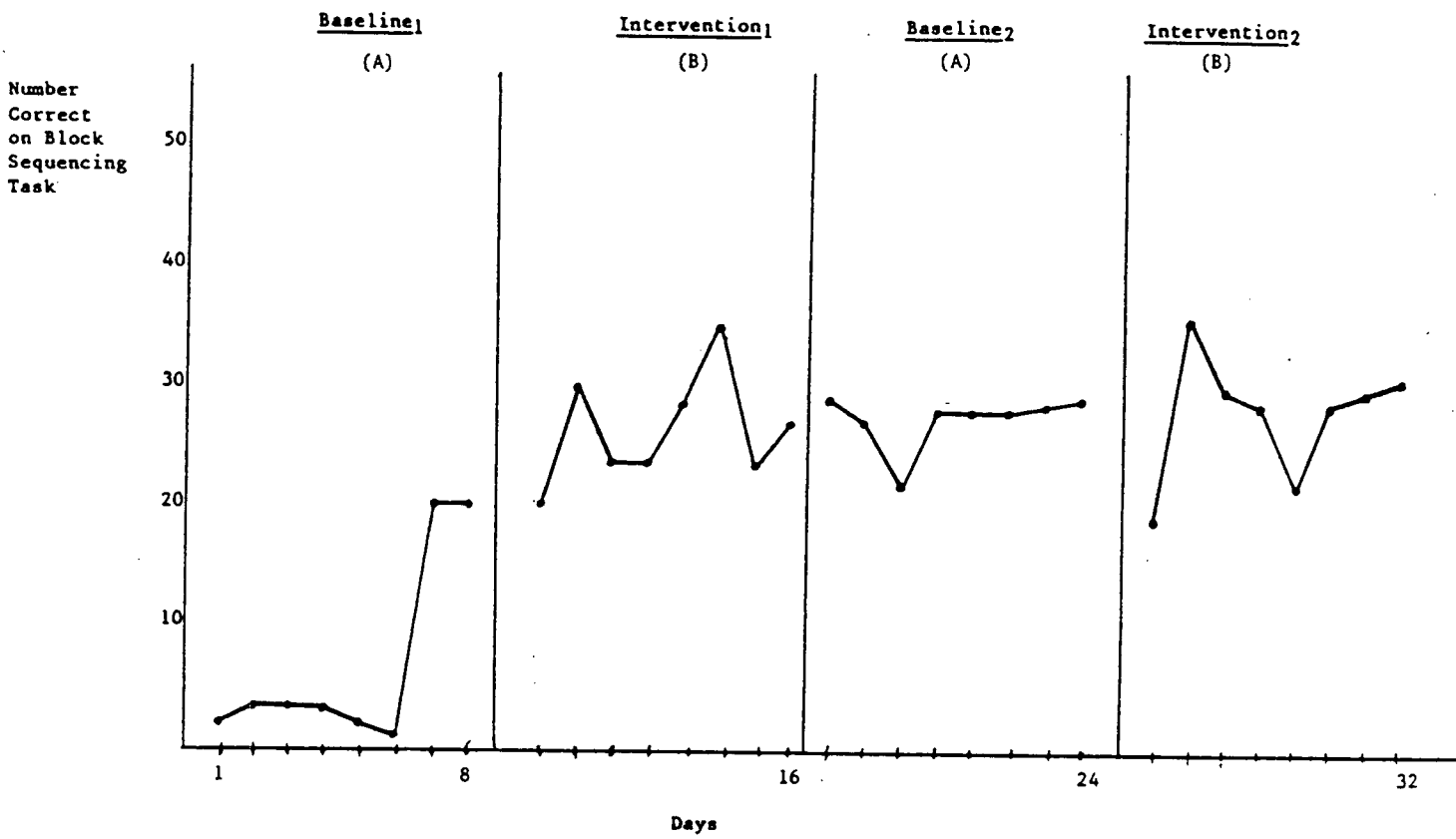


Figure 7

Trend Lines for Block Sequencing Task - Subject #3

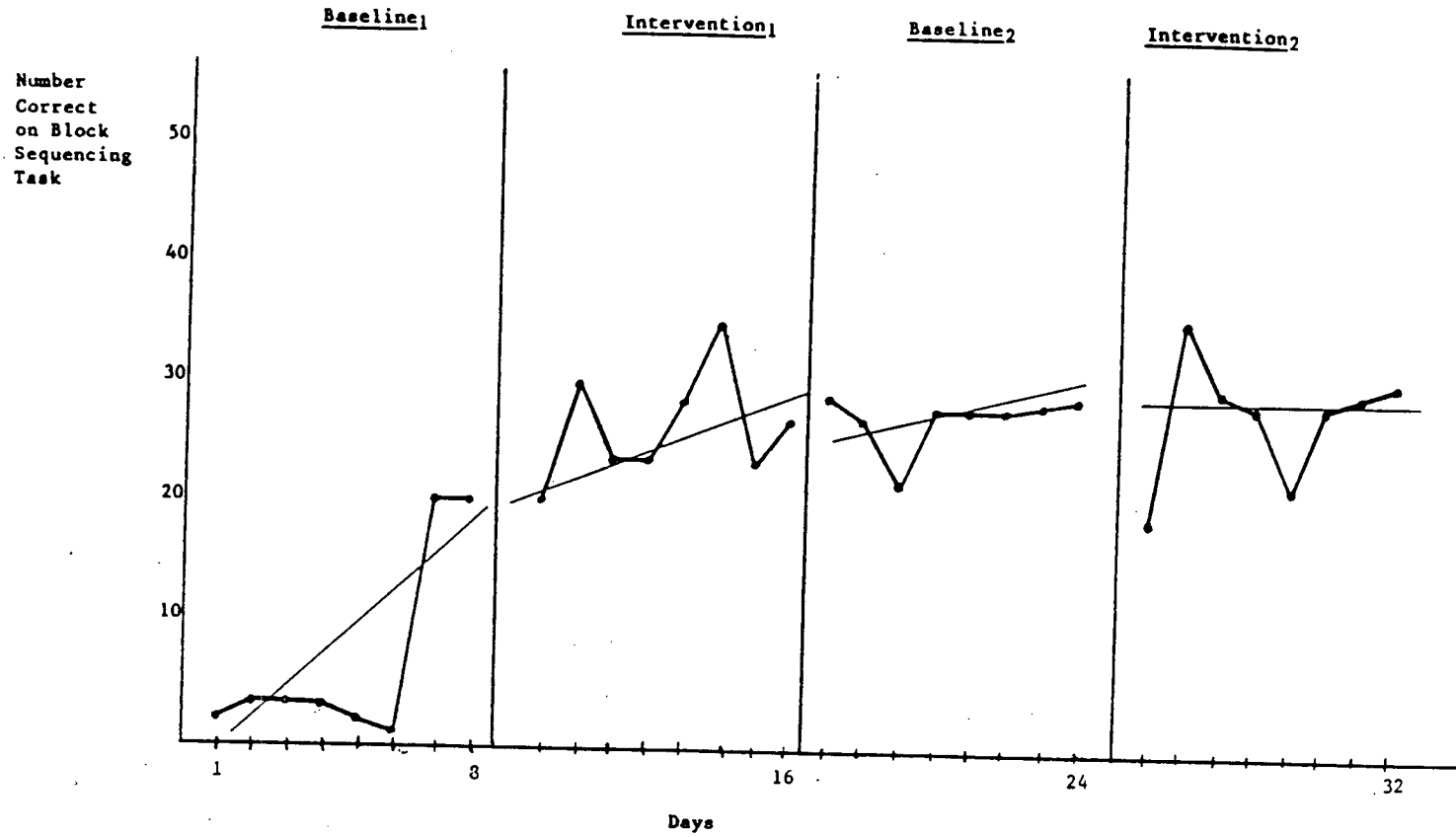


Figure 8

	A_1	B_1	A_2	B_2
Trend Direction	Improving	Improving	Improving	Zero Celleration
Trend Stability	Variable	Variable	Variable	Variable
Percentage Stability	(75%)	(75%)	(75%)	(62.5%)

Between Adjacent Conditions Analysis

	B_1/A_2	A_2/B_1	B_2/A_2
Change in Trend Direction	None	None	Decaying
Change in Trend Stability	Variable to Variable	Variable to Variable	Variable to Variable
Percentage of Overlap of Data Points	12.5%	37.5%	37.5%

Mean Level Lines for Block Sequencing Task - Subject #3

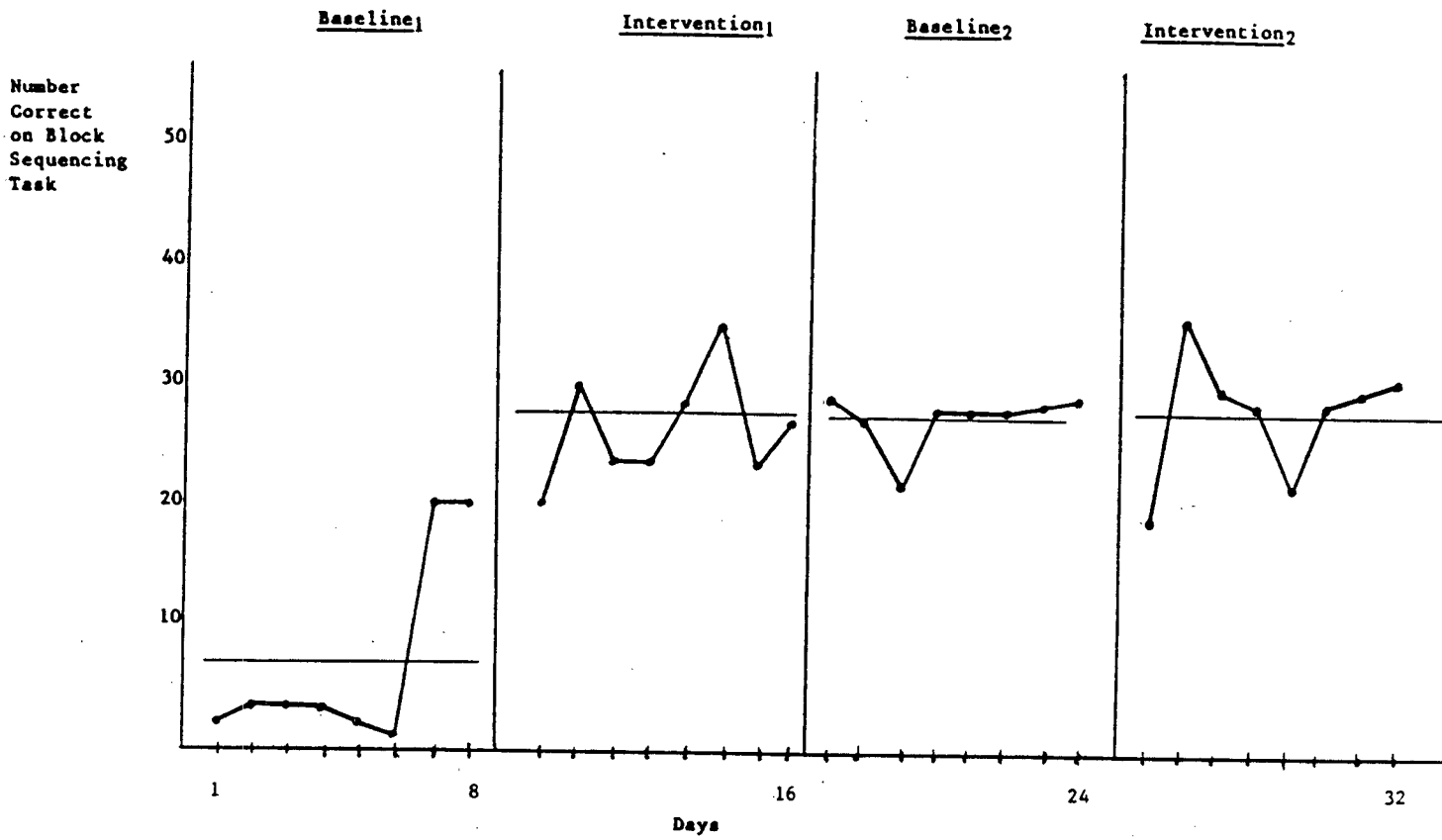


Figure 9

	A_1	B_1	A_2	B_2
Level Stability	Variable	Variable	Stable	Variable
Percentage Stability	(0%)	(25%)	(87.5%)	(50%)
Range of Data Points	(1-20)	(25-35)	(22-29)	(17-35)
Level Change	+20	+10	+7	+18

Between Adjacent Conditions Analyses

	B_1/A_1	A_2/B_1	B_2/A_2
Change in Level	(20-20)	(26-29)	(29-17)
	0	+3	-12

Discussion of Visual Analysis of Graphic Data

Subject #3 was often impulsive and off task, and the data seemed to reflect his attention to the task rather than his block sequencing ability.

The data presented in Figure 7 indicate a positive change in the performance of the block sequencing task before the computer keyboard intervention (B) was introduced. There was no return to baseline in the second baseline phase (A_2) when the intervention (B) was withdrawn and reintroduction of the intervention (B) in the second intervention phase did not produce a positive change in trend direction as anticipated.

The acceptable stability range for levels and trends was calculated on the highest data point of each of the phases of the time series using a fifteen percent (15%) stability criterion. Eight-five percent (85%) of the data points must fall within the acceptable criterion range for the trend to be considered stable (Towney and Gast, 1984).

There were two apparent baselines established in the A_1 phase. This phenomenon resulted from strong intervention by the tutor to ensure that the subject understood the language requirements of the task. This intervention occurred on Day 7.

The first baseline phase (Day 1 to 6) showed a stable trend with zero celeration, that is, no positive or negative change in direction, and a stable level. The last phase of the baseline (Day 7 to 8) showed an abrupt level change (1 - 20) followed by trend of zero celeration and stable levels. This second baseline may have been a more accurate reflection of the baseline levels of Subject #3's performance as it occurred after the tutor's intervention to establish the language requirements of the task.

Introduction of the intervention program (B) on Day 9 produced a positive variable trend with 75% stability of data points. This reflected an improvement in performance on the block sequencing task which was in the direction of the intervention objective; however, the trend did not reach the percentage stability criterion (85%).

The level stability was quite variable (25%) indicating peaks on data points for Day 10 and Day 14.

Withdrawal of the intervention (B) on Day 17 failed to establish a return to baseline performance. A positive, variable trend continued, although the level stabilized considerably (87.5%) and the level change dropped from +10 in B_1 to +7 in A_1, indicating a smaller range of data points.

These data seemed to reflect a learning curve or a practice effect on the dependent variable, as there was no return to the initial baseline performance level.

The final intervention produced a slope of zero celeration which indicated a decaying trend in performance which was not in the direction of the intervention objective. Subject #3 was often impulsive and off task at this point and the data seemed to reflect his attention to the task rather than his block sequencing ability. Trend stability (62.5%) and level stability (50%) were variable and there was a marked change in level (-12) between phases A_2 and B_2. The recovery on Day 26 may have been associated with increased motivation associated with the reintroduction of the intervention (B), but the rest of the data points do not reflect any positive effect.

Summary of Main Findings

Each subject was observed and measured in the following areas: decoding and word analysis as measured by the Durrell Reading Analysis, sequencing ability as measured by Knox cubes, rate of output and error number, and type in handwriting and word processing, the ability to successfully locate and target letter keys on the keyboard with bilateral hand use using the Keyboard Town framework as well as motor training technique, and the ability to incorporate simple word processing commands required within the situation. Motor skills were assessed and a video recording was made of these.

Subject #1

Retesting and decoding of word analysis skills as measured by the Durrell Reading Analysis subtest showed that C.M. had gained several decoding strategies, but was still showing difficulty in using these strategies for reliable word analysis. His attention to the whole word had improved as he was able to go beyond the initial consonant in sounding words out, but his tendency to guess impulsively and become anxious still interfered with decoding and word analysis skills. In contrast, sight vocabulary had improved over the course of the intervention and this may have been a function of using the consistent script of the word processor for visual recognition of sight words instead of trying to read his own, spatially confused, handwriting.

C.M. showed statistically significant positive trends in sequencing ability as measured by Knox cubes during the intervention phases of the

limited time series experimental design. His performance on Knox cubes returned to baseline when the intervention was withdrawn.

The rate of output in word processing showed an overall improvement indicating increased awareness of letter key location and automaticity of targetting responses. There was a decrease in the mean number of errors in the samples (see Tables I and II).

Error types in the first intervention phases including spacing errors, capitalization errors and letter names. There were no uncorrected errors in output during the second phase and this reflected C.M.'s improved ability to recognize and correct his written output using word processing strategies (see Table II). At the end of the study, C.M. was familiar with the required word processing commands, and was fairly independent although he was unable to problem solve his way out of unfamiliar situations (Appendix D).

These results indicate some increased attention to some of the details of handwritten output (reversals, omissions, capitalization and punctuation) during the intervention phases. Interestingly, the decrease of spacing errors in word processing did not generalize to handwritten performance.

C.M. responded to cueing from the Keyboard Town framework as well as to techniques for motor training (tactile cueing and a physical barrier to split the keyboard to facilitate bilateral hand use). C.M. was the only subject who required cueing from Keyboard Town, and was only able to tolerate motor training within the limits of his irritability (see Appendix D).

At the end of the study, he was able in incorporate bilateral hand use into his spontaneous approach to the task (see Appendix D).

Motor skills fell below the first percentile of the battery composite of the Bruininsks-Oseretsky Test of Motor Proficiency. Sequenced finger opposition was particularly poor, and this may have been reflected in output rate on the keyboard.

Subject #2

O.R.'s decoding and word analysis abilities remained at the low Grade 1 level with quantitive and qualitative gains in word recognition and analysis. His sight vocabulary had improved.

He showed initial gains in sequencing ability as measured by Knox cubes in the baseline phase of the limited time series but no stable trends or statistically significant results were noted during the intervention.

The rate of output in word processing showed an improvement over the course of the study (see Table V) and the mean number of errors declined minimally over the period of the study, although error rate was minimal to begin with.

O.R. did show a decrease in spacing errors (see Table VIII) as well as punctuation and letter drops having only one capitalization error for the entire second intervention.

O.R.'s handwriting rate increased over the course of the study, and the mean number of errors dropped (see Tables V and VI).

Misplaced upper case letters as well as capitalization errors decreased in the handwritten samples of the second intervention). There was an initial increase in spacing errors in the second intervention phase

but this dropped off immediately (see Table IX). O.R. used verbal mediation during handwriting to space his words and this may have been as a result of having to make a target selection on the keyboard for spacing between words and thus directing his attention to spacing.

O.R. did not require additional cueing from the Keyboard Town framework, although he was interested in it when it was presented. He responded well to the cues intended for motor training, and was able to perform bilateral and hand approach without cueing after several trials (see Appendix I). At the end of the study, he utilized bilateral hand use spontaneously for keyboarding.

O.R.'s timid affect was revealed in his approach to independence using the required word processing commands. He relied on adult direction, but could initiate some common sequences independently when required to do so.

O.R. overcame his postural difficulties by repositioning his chair as suggested by the tutor. This arrangement was satisfactory for the duration of the study, and improved grading of key pressure and targetting considerably (see Appendix I).

His motor skills were poor and sequenced finger opposition was not intact, which may have affected the rate of word processing output (see Appendix J).

Subject #3

I.R.'s performance on the Durrell Word Analysis retest placed him at the low Grade 1 level, and showed an increase in word recognition and a willingness to risk making errors on more difficult words and sound blends.

He was very attentive and impulsivity had diminished. He showed a more spontaneous affect and increased eye contact.

I.R. showed no stable or significant trends in sequencing ability as measured by Knox cubes during the intervention phases of the limited time series experimental design. Performance did not return to baseline upon withdrawal of the intervention and tended to level off over the phases of the experimental design.

There was as a steady gain in handwritten and word processing output rate. Word processing errors were minimal throughout the study. I.R. produced error-free typed copy throughout the study.

The error rate in the handwritten samples decreased (see Table XIV). I.R.'s tendency to omit letters in copying decreased during the second intervention, as did his errors in capitalization.

I.R. did not require additional cueing from the Keyboard Town framework and required minimal intervention for motor training. I.R. was the least physically-involved student of the three subjects (see Appendix M), and sequenced finger opposition was intact (see Appendix O). This intact ability may have been reflected in output rate on the keyboard.

CHAPTER 6

CONCLUSIONS

Discussion

This study explored the effects of teaching students with learning disabilities and histories of motor dysfunction how to use the microcomputer/word processor combination to augment poor handwriting skills.

Previous studies of learning disabled students using word processing made the assumption that a two-handed 'hunt and peck' approach was sufficient to learn keyboarding skills. On closer examination of the underlying requirements for successful keyboarding performance, several critical issues became evident.

In order for the students to maximize their performance, it seemed necessary to minimize the time spent 'hunting' for letter key locations. To this end, the students were oriented to the Keyboard Town (Gallagher, 1961) program which placed the letter-key locations into a visual and anecdotal framework. This was an important step in organization of the task to suit the learning requirements of the student and was based on the information processing theory which indicated that learning disabled students functioned better when information was presented in a simultaneous, visual, experiential modality (Wittrock, 1978) and in as meaningful a context as possible (Reid and Hresko, 1981).

The assumption that this group of students would be able to adopt a two-handed approach to the keyboard also seemed to be worthy of more

intensive investigation. The bilateral motor coordination required to use two hands successfully is not necessarily present in students with difficulties with motor planning and poor coordination. In order to facilitate motor performance for these students, a system of tactile, visual and verbal cues was established. By directly addressing the instruction of the motor requirements of the task, speed and accuracy of typing were improved.

Since studies of regular students learning keyboarding skills had emphasized the need for drill and practise the literature regarding learning disabled students did not, an effort was made to determine if drill and practice would help the LD student develop keyboarding skills. In order to keep the drill as meaningful as possible for the students, the Write to Read program (Nash and Geyer, 1981) was selected as the program of choice. This series of writing and reading tasks adopted a decoding of word families approach to reading which was consistent with the reading program being taught in the classroom.

Breaking down the keyboarding task into its component parts and restructuring the task presentation in a way which incorporated knowledge of the student's motor and learning disabled task approach was a vital link to establishing the foundation requirements of keyboarding, thus facilitating maximum mastery for the student.

It was hypothesized that the unloading of the successive motor requirements of handwriting and the application of a meaningful conceptual framework to the visual display on the keyboard would result in improvement on successive processing, measured by a block sequencing task.

Subject #1, the most severely neurologically involved student, showed statistically significant positive trends in successive processing during the intervention phases.

The other two subjects showed initial gains in the baseline but no stable trends were observed during intervention. This may have been due to the introduction of a new situation or the initial excitement of being in a 1:1 situation.

In retrospect, the performance on the block sequencing task may have been a result of the task itself, a repetitive, meaningless exercise which focussed on the subject's weaknesses, diminishing motivation in task approach. This was particularly evident in Subject #2's graphic data which was erratic and seemingly unrelated to whether the intervention was taking place or not. Subject #3's graphic data may have reflected a gradual learning of the block sequencing task itself, since there was no return to baseline in block sequencing performance on withdrawal of the intervention. A comparison between rate of output and error types in word processing and handwriting was made and detailed clinical observations were made of how the students were able to master the word processing command sequences for the functions required in the 'Write to Read' program.

It is not clear why, in that case, the results of Subject #1 reached statistical significance. Das, Kirby and Jarman (1979) point out the limitations of using a complex remedial program to improve processing abilities as there is no way to account for the mutability of factors within the remedial program. However, it is plausible that the treatment, broadly conceived, had an intervention effect. One way to test for this would be to allow the student to approach the keyboard in a random,

unsystematized way for written output and measure the dependent variable in a time series design.

The intervention was carried out in a 1:1 tutorial situation under maximum conditions of rapport and this may have provided Subject #1 with the impetus to persevere at the block sequencing task. The pattern of data may also reflect subject's motivation to stay on task during the computer intervention phases based on the strong motivating effect of working on the word processor (MacArthur, 1986). Certainly, all three subjects were delighted to work on the computer and, during the course of the study, performance of the block sequencing task was perceived as a necessary evil in order to get on to the word processor.

All of the subjects made gains in the number of words decoded correctly in the final administration of the Durrell Word Analysis subtests, although none of the subjects progressed beyond an early Grade 1 reading level during the eight weeks of the study. The improvement observed may be attributed to a practise effect. The gains made in reading were most encouraging, given the severity of reading delay in each child and may have been related to the experiential writing to read using the consistent visual output of the word processor as a reading stimulus in lieu of the student's own handwriting.

Subject #2 and Subject #3 were able to incorporate bilateral hand use into their keyboarding approaches, however, Subject #1 showed difficulty incorporating bilateral hand use into letter sequences greater than three. He appeared more able to attend to the letter sequences when using a one handed approach and this finding may be worthy of future consideration and

study for children with histories of a marked delay in lateralization of hand function.

Subject #1's history of motor dysfunction indicated the most severe neurological involvement. This reinforces the importance of determining the nature of the student's motor dysfunction and understanding how this affects task performance. Subject #1 was also taxed by the tactile cueing in the intervention program, and became irritable, showing aversive reactions to light touch. Knowledge of the boy's neurological deficits played an essential role in making the clinical judgement of how to grade the intervention program in order to minimize this neurologically-based irritability.

All of the subjects made initial errors in word processing which were consistent with those described by MacArthur (1986), particularly errors which reflected a lack of understanding of space and other errors which indicated an unwillingness to relinquish a familiar but primitive strategy in favor of a new, more complex one. The subjects became familiar and competent with word processor commands, and there was an increase in speed of output as well as a low error rate, reflecting mastery of the motor foundations of the keyboarding task which was the goal of the intervention program.

The students were more likely to recognize errors in spelling or spacing on the word processor than in the handwritten samples. This may have reflected an ability to recognize errors when the letters are consistently reproduced in typed format than in the erratic handwriting of the child. Certainly, attention to letters on the screen was greater than to letters in the handwritten sample and this is consistent with Torgeson's

(1983) observations of the effects of the computer on attention in learning disabled children. The fact that the errors can be erased completely with a perfect copy of written work produced may be the critical aspect for successful task performance by these students who have spent several years erasing and perfecting handwritten copy which is never up to the peer standard established in the classroom. Subject #2 and #3 improved the quality of handwritten performance in terms of spatial orientation of letters and words, and attention to errors. Subject #1, in contrast, showed no improvement in handwritten performance, showing increased frustration at his handwriting. He really preferred to use the word processor for its legibility and consistent output.

Word processing applications for written output in learning disabled students with motor dysfunction should not be viewed as a panacea. The learning profiles these children bring to the task determines that this task, like all the others, is subject to the limitations of selective attention, sequencing and temporal order. As Whitmill (1973) pointed out, keyboarding functions do require a specific teaching approach, to establish sound understanding and techniques.

The motivational, experiential and interactive nature of the word processor make it a task which was well suited to the educational needs of the students who participated in this study. While the motor demands are not as complex as those required in handwriting, there are specific motor requirements in the task and these are affected by the motor abilities of the child. These include grading of key pressure, targetting of letter keys and postural control. The degree of motor dysfunction will determine how effectively the student will function within these limitations.

Assessment of motor skills and techniques for motor training play a major role in determining which students will be able to use the word processing system effectively.

Careful clinical observation of the student's task performance showed that the boys with histories of neurological dysfunction (Subjects #1 and #2) did have difficulty learning the motor requirements of the keyboarding task and benefitted from specific training procedures. Even very basic task requirements such as maintenance of good postural control required attention. The child without specific neurological involvement but with a history of general motor delay and delay in handwriting development had less motoric difficulty, but was able to use the drill and practice gained in the intervention program to improve speed and accuracy of written output.

Teaching problem-solving skills and planning strategies for identification and remediation of errors in written output for word processing and formating reinforced the organizational skills and planning ability of the students. Subject #1 began to demonstrate strategy formation by scanning the sentences for capital letters before initiating typing, indicating inhibition of impulse control and the development of strategies for task approach in application of word processing commands. Subject #2 used verbal mediation to help him remember spacing on the word processor and also used this strategy in some of his later handwriting samples. Thus, the practice on the word processor improved handwriting performance in this student through increased attention to critical details.

Limitations of the Study

The interpretation and generalizability of the results of this study is limited by the small number of subjects. A case history approach was taken to place all the critical factors affecting the students into perspective. While the findings cannot be generalized to subjects other than those involved in the study, the detailed clinical observations did indicate that aspects of the keyboarding task did require specific training. These observations may form the basis for future intervention with students with similar disability profiles.

The case history approach is observer subjective with no interrater reliability which predisposes the findings to distortions based on observer bias. However, in this case, detailed clinical observations of task performance allowed the reader to assess the conclusions the author came to, thus limiting the amount of observer bias within the study.

The study spanned a relatively short period of time to measure well established changes in performance with regards to output rate and decoding in reading performance, however, a valuable intervention method for teaching keyboarding and word processing to learning disabled students with motor dysfunction was examined and found to have value for further study.

The dependent variable was too sensitive to subject motivation and impulsiveness, and this must be taken into consideration for the purposes of measuring successive processing in this study. Comparisons of error rate and output speed in handwritten and word processed writing samples generated data which reflected changes in the subjects' attention to critical details of the writing task over the course of the study.

These changes may have become more marked over a longer period of intervention. Use of the information processing model for task analysis and in determining a method of intervention was useful for this descriptive study.

Implications for Future Research and Professional Practice

The results of this study indicated that learning disabled students with motor dysfunction were able to learn simple word processing commands and keyboarding skills which enabled them to produce perfect copy in writing tasks. The different students benefitted in a variety of ways from an intervention program designed to address their learning and motor needs.

Future research could establish validity and reliability of these findings using a larger population of learning disabled students with motor dysfunction. The dependent variable should be more meaningful to the population. Pictorial memory as described by Jarman and Das (1980) was found to measure successive processing and may have provided a more motivating and appropriate stimulus as a dependent variable with this population of learning disabled students. Testing could also extend to measures of attention. Students could be matched for attention, reading level and motor skill level. This would necessitate a relatively small number in the sample, but the nature of the abnormal cognitive-motor profiles lend themselves to small 'n' treatment (Hersen and Barlow, 1976) onto further descriptive studies such as this one.

The implications for professional practice involved the use of the word processor as a basic organizing tool for written output. Students who were previously at a disadvantage in their ability to perfect written work

were better able to present legible work by learning a task which involves learning and applying organizational skills in a meaningful context. Skill mastery contributes to student self-esteem and may influence classroom behavior.

In order to facilitate maximal success in task performance, it is essential that the motor skills of the child be assessed and, if necessary, techniques which reinforce motor learning be utilized to teach keyboarding skills. The occupational therapist with a professional background in task analysis, motor training and adaptation of technical aids and environmental factors to maximize motor performance plays a vital role on the educational team for this purpose.

Once the basic skills of word processing are established, it remains to be seen if there is an effect on written language as indicated by Woodruff (1986) or on attention and decoding in reading as suggested by Torgeson (1983).

An intervention program which involved students typing and formatting their own work, such as journal writing, would be more in keeping a meaningful, experiential approach and be more significant to the child. This kind of intervention would be the logical follow-up to the 'Write to Read' intervention program examined in this study which emphasized the important techniques for learning keyboarding skills and could form the basis for an ongoing classroom program which utilizes the word processor as an adjunct to handwriting skills on a daily basis in order to reinforce and firmly establish fluency and automaticity of word processor use.

Summary

The word processor program provided a motivating experiential and interactive means for written output for the students with learning and motor deficits who participated.

Careful clinical observation showed that the students did have difficulty with some aspects of motor learning associated with the task. These difficulties were dealt with in an intervention program designed to meet the students' specific learning and motor needs.

This intervention merits incorporation into educational programming for similar children as it specifically addresses their motor and cognitive needs.

The study represents a valuable addition to the study of microcomputer/word processor applications for children with learning disabilities and motor dysfunction.

APPENDIX A

SUBJECT #1: CASE HISTORY

APPENDIX A

Subject #1: Case History

Name:	C.M.
Date of Birth:	July 28, 1977
Chronological Age:	8.10 years
Date:	June 1, 1986

C.M. is the only child of a couple addicted to heroin, the father in his mid-fifties, the mother aged 19. The mother took eight to ten caps of heroin per day throughout the pregnancy. Both parents refused methadone therapy for their addiction and, because of this non-compliance, the child was apprehended at birth and placed in temporary foster care.

The child was born by normal delivery at 36 weeks gestational age by dates with a birth weight of 2820 grams, length of 56.5 cm, head circumference of 36.5 cm. On examination, gestational age was found to be 37 weeks. Apgars were nine at one minute and ten at five minutes, with no resuscitation required.

He was not jittery at birth, but became extremely so after 24 hours. He was treated with paregoric (tincture of camphorated opium) which caused little improvement, and this was replaced within a few weeks by Phenobarb, 3.75 mg, twice a day. He remained in intensive care in hospital for six weeks and was discharged to foster care.

Physical examination (January 5, 1978) at six months of age by a paediatric neurologist, found minimal jitteriness and exaggerated primitive reflexes. The head was normocephalic with head circumference at the 25%ile, length at the 25%ile, weight at the 25%ile. Papillary reactions

were normal, no external opthalmoplegia or facial assymetry were noted. Corneal reflexes were normal.

The head was well supported in sitting. The child was able to lift his head in prone to 90°. He engaged his hands at midline and was following objects through 180°. He had a spontaneous smile, made small throaty noises and did not laugh or excite.

Sensation to pinprick was normal by withdrawal. Tone was slightly increased in upper and lower extremities. Deep tendon reflexes in all muscle groups in the upper extremities and knees were increased without asymmetry.

Plantar responses in hands and feet were observed. Primitive reflexes of Asymmetric Tonic Neck (ATNR) and Symmetrical Tonic Neck (STNR) were noted, but variable as were placing and supporting reactions. The stepping reflex indicated a scissoring gait and the Landau response was partially developed. Palmar creases were normal as were the anterior fontanelle space and the inner canthal separation.

The problem list generated at that time included:

"**Problem #1** Minimal and improving signs of cerebral palsy with scissoring gait and increased deep tendon reflexes. Jitteriness and hypertonicity (especially marked during the Phenobarb medication period for 4.5 months until the foster mother stopped it) had disappeared.

Problem #2 Developmental assessment on the Gesell at six months of age showed gross and fine motor skills of a 4 to 16 week old infant, language skills of a four week infant, and personal social skills of a 16 week old infant."

The neurologist felt that these mild neurological signs would improve and would require long term neurological follow-up.

C.M. (at eight months) was seen by the orthopedic surgeon for external rotation of the right lower extremity. At that time it was noted that he was unable to sit and was beginning to roll in and out of prone and supine. Some primitive crawling was noted and the foster mother felt that the baby was moving all extremities equally well, and was easier to care for.

Increased tone was noted in all joints with limited abduction of both hips in flexion and in extension, and abductor limitation to 30^{o}. Knees, ankles and feet all had full range of motion. X-rays showed hips to be well located with good acetabular development.

No intervention was recommended at this time, with a future plan of stretching exercises and Dennis Brown boots and bar, in which foot orientation places the hips in internal rotation.

A referral to Opthamology (April 7, 1978) was made for an intermittent divergent strabismus being more marked on the left. Medical advice at this time was that optimal timing for corrective surgery was after two years of chronological age and any consideration for surgery was to be postponed until after that time. C.M. was eight months old at this time.

Because of the question of adoption, the opthamologist advised that he anticipated a good result with surgery, good vision from each eye and possibly normal depth perception.

Electroencephalogram (EEG) Report of May 11, 1978 indicated some potentially abnormal cerebral potentials in this child with possible cerebral palsy. However, resting, waking and sleep recordings were within normal limits.

Paediatric cardiology assessment (May 16, 1978) took place when C.M. was 9.5 months old. He was noted to be certainly slow with possible

cerebral palsy. He had been slow to gain weight although he ate well. He drank from a bottle over 30 minutes, played with the bottle but would not hold it and was reluctant to hold food in his hands.

He did not crawl and did not like it on his tummy, had never turned blue and demonstrated at Grade I-II/Vi systolic murmur in the pulmonary area. Electrocardiogram (ECG) showed right ventricular hypertrophy.

The cardiologist's impression was that some children had this ECG for no reason in infancy and there was some chance that this would change with time.

The follow-up neurological report (June 27, 1978), when C.M. was 11 months old, found mild signs of spastic deplegia with increased deep tendon reflexes in supinators, biceps and knees. Infantile postural responses for placing and supporting were intact and stepping still showed scissoring in vertical suspension.

The Landau reflex was now present and parachute reactions were present forwards and laterally but not backward. This performance was consistent with a developmental age of seven months.

Head circumference and weight were now at the third %ile and length was at the 10%ile.

C.M. had been enrolled in the Infant Development Program (IDP) at this time.

Medical problem list at this time listed:

Problem #1 Developmental Retardation

Plan Continuation with IDP to reinforce parent's ideas.

Problem #2 Mild Cerebral Palsy

Plan Physiotherapy assessment and home treatments.

Problem #3 Left exotropia

Plan Follow with the opthamologist

A recommendation was made for x-ray for wrists for bone age in view of the findings of short stature and developmental delay.

The next follow-up neurological report (February 16, 1979) noted that there had been regular attendance at the Infant Development Program and a home physiotherapy program. The foster mother's only concern at this point was the child's constipation which she managed well with suppositories. The foster parents were indicating at this time that they wanted to adopt this boy.

At a chronological age of 18 months, a Gesell assessment revealed personal/social skills at the 10 month level. He could only indicate his needs by crying. Fine motor skills were around 11 to 12 months. In Gross Motor areas he was able to sit unsupported, stand holding on and could pull to stand. No nursing or unsupported standing (eight to nine month skills) were noted on this examination.

Language was the most delayed although hearing was felt to be clinically intact. The child was not vocalizing dada, baba, gaga, tata, etc., and used monosyllabic "ous" and aws", a six to eight month skill.

There was still evidence of mild spastic diplegia and hypertonicity, and hyper reflexia in the pelvis and hips.

Medical Problem List (February 16, 1979)

Problem #1 Developmental Retardation

Diagnosis of interuterine growth retardation (IUGR) secondary to maternal heroin addiction, alcohol and other drugs. Intellectual capacity was significantly compromised as a result.

Plan A referral for audiogram was made secondary to language findings.

Problem #2 Spastic Diplegia

Plan Continue with physiotherapy.

Problem #3 Left exotropia

Now resolving on its own. There was no amblyopia of the divergent eye clinically.

An EEG report (February 20, 1979) showed "abnormal and paroxysmal activity during sleep, especially in arousal, without clear cut discharges". These findings were still within normal limits.

On February 21, 1979 (chronological age 18 months), the x-ray for bone age showed a skeletal age of 14 to 15 months, between 1.5 and 2.0 standard deviation below the mean for the child's chronological age.

The opthamologist (April 27, 1979) found the exotropia in reasonable control and no treatment was recommended. It was noted that the child was difficult to examine and would be seen again in one year.

The Infant Development Program report (May 23, 1979) reported that the family had been involved in the program for 13 months and had been coming to the play group once a week over the past three months. Intervention had included bimonthly home visits by the infant worker and monthly joint

visits with the consulting physiotherapist. C.M.'s chronological age was 21 months at this time.

Test behavior on the Gesell indicated that C.M. screamed when new activities were presented, needed time to adjust to new activities, needed lots of praise and would still only work when on the foster mother's lap.

Adaptive skills (18 months with scatter) documented his approach to new tasks: scream and throw. He could eventually watch and imitate but would perseverate on games like dumping the pellet in and out of the bottle over and over again.

Gross motor skills (six months with scatter) showed that he could now pull to stand and cruise, walk with hands held and crawl up stairs. He could kick the ball after a demonstration and played catch (18 months skill). Quality of movement was poor: he walked supported on stiff legs with arms flexed and hands fisted.

In the fine motor area, C.M. was only able to complete a two cube tower as he knocked the tower over with the third cube. He demonstrated a neat pincer grasp with a two finger-thumb pinch indicating primitive motor patterns.

Language skills (15 months and scattered) showed non-selective looking at pictures, no identification of picture card items. Consistent vocabulary consisted of four to six words and the child was jargoning and trying other words.

Personal Social skills (15 to 18 months with scatter) showed that he could drink from a cup (21 months) and feed himself with his fingers or a spoon (24 months). C.M. was able to use 'thank you' to give or receive, and was beginning to vocalize his wants and dislikes. He offered toys to

others and interacted well with family and other familiar people. C.M. did better when activities were made into games.

The child was making slow, steady progress although he was still upset by changes in routine or changing activities too quickly. It was felt that he needed time to adjust to new situations and needed much praise and encouragement.

The orthopaedic surgeon (July 23, 1979) commented that this two year old boy was still cruising without independent ambulation and that he was more cooperative. Minimal adducter spasm persisted in the lower extremities and x-ray showed excellent development of femoral heads in the acetabular.

No heel cups were prescribed based on this positive finding and he was scheduled for review in six months.

The IDP worker (July 26, 1979) indicated that C.M. would now attend the play group two mornings per week with ongoing physiotherapy. Home visiting was discontinued at this time.

The paediatric neurologist saw C.M. again for review on August 7, 1979. C.M. was then two years old.

Problem #1 Developmental Retardation

Functioning at 15 to 18 months in most skills with the greatest deficits in the gross motor area. He was now walking independently and using more language. The impression was that he was functioning six months behind his chronological age.

The report from the tympanogram was normal and impedance testing suggested normal hearing in both ears.

There was a 'modestly abnormal EEG' and mum reported screaming attacks at night which brought up the questions of noctural epilepsy and/or nightmares.

Plan Repeat EEG

Problem #2 Still evidence of mild spastic diplegia.

Plan Physiotherapy once a month.

Problem #3 Left exotropia

On examination, the visual axes were normal.

Plan Consultation with opthamology.

Problem #4 Delayed Growth

The boy had followed along the lowest percentiles since birth. These ongoing findings indicated that the child's ultimate growth would be small and slight. The findings of delayed bone age indicated that the pubertal growth spurt would be delayed when compared with his peers.

The following EEG report (November 23, 1979) showed suggestions of 'paroxysmal activity on arousal from deep sleep, but no clear cut epileptiform discharges were seen'. Otherwise, the recording was within normal limits.

March 24, 1980: The neurologist's medical problem list notes:

Problem #5 Epilepsy

Findings of two suspicious EEGs during the last 12 months, screaming spells at night and wakening during the past six months, glassy-eyed, frightened and shaking, unsteady and irritable for up to 3/4 of an hour with some clonic movement of arms and legs seemed to indicate a diagnosis of nocturnal or post-nocturnal epilepsy.

Plan A therapeutic trial of anti-convulsant was recommended of Dilantin 3 to 5 mgs/kg/day in divided doses. Dilantin was recommended as the drug of first choice with the possibility of a switch to Depakane in one year.

June 4, 1980, C.M. was admitted to hospital with clinical signs of Dilantin toxicity (one day history of vomitting and unsteadiness). His Dilantin had been increased one week previously. The Dilantin dose was

withheld and the symptoms stopped. C.M. was discharged after a 48-hour admission with adjusted Dilantin levels and no further signs of toxicity.

He was seen again for review of his cardiac status (paediatric cardiology report, July 17, 1980). The ECG showed "serious rhythm with a right axis and moderate right ventricular hypertrophy". The cardiologist felt that the murmur represented a mild valvar pulmonic stenosis which was a benign lesion and a low risk for infective endocarditis. No special precautions or restrictions were advised at that time.

On the next visit to opthamology (September 12, 1980) C.M. was prescribed glasses for myopia and control of intermittent divergent strabismus. The physician noted that the child had become easier to examine.

C.M. started pre-school at a local Day Care in September 1980 in the special needs class.

He was referred for a speech and language assessment to the Vancouver Health Department. He was 3.2 years of age at the time.

C.M. was seen for speech and language assessment at Day Care. He had difficulty attending to tasks, decreased eye contact and was uncooperative.

Speech assessment showed fair intelligibility of single words and unintelligible attempts at two word phrases. His speech contained vulvar stops. Imitation skills were good and some drooling was noted.

On the Pre-School Language Scale, C.M. scored at 2 years, 15 months for auditory comprehension. Verbal ability was not scored as the child was too uncooperative.

He used mostly one word communication. His two word phrases used in the assessment period were 'no go', 'no more', 'let's go'.

He was found to have expressive and receptive delay, and poor attending behavior based on an overall delay, and speech therapy was recommended once per week at Day Care.

Orthopaedic examination (September 24, 1980) found C.M.'s hip exam and x-rays to be normal with remaining slight tightness of adductors. Hips and lower extemities had realigned satisfactorily, and C.M. was walking well.

On December 18, 1980, the neurology report found the EEG to be abnormal in sleeping and waking.

C.M. was seen by the team from Children's Hospital Diagnostic Centre when he was three years, nine months old (April 28, 1981). The physician reported that he was attending the special needs group at Day Care and had been given permanent life placement with the M. family. His adductors were tight, there was valgus of the feet bilaterally, tendon reflexes were brisk in the lower extremities with bilateral downgoing Babinski reflexes, but no ankle clorus.

The speech evaluation included a hearing assessment (20 db on the right and 20 to 40 db on the left indicating a mild decrease). There was a flat tympanogram which was felt to be indicative of middle ear pathology. Poor articulation was also noted and his spontaneous language consisted of short sentences appropriate to a three year old.

On the Sequenced Inventory of Communication Development (S.I.C.D.), he scored at two years, eight months in expressive and receptive language with occasional successes at the three year level.

Occupational Therapy evaluation made note of fluctuating attention, habitual sitting in reverse "W", immature gait with decreased muscle tone

and a knock-kneed stance, and poor depth perception related to ongoing opthamological status.

Fine and gross motor skills were from 2.0 to 2.5 years with scatter to the three year level. Perceptual awareness was felt to be from 2.0 to 2.5 years.

Otology reported a normal ear, nose and throat exam (ENT) with bilateral and retracted dull ear drums and a history of mouth breathing. This was felt to be transient, but if it persisted it was felt that bilateral myringotomies would be required.

In the summary, the physician described a 3.8 year old boy with small stature along the 3%ile in an appropriate placement at special needs pre-school. There were noctural seizures, hyper reflexia and attention deficits.

He was referred to the Seizure Clinic, for a hearing assessment in July, for follow-up in one year and referred to occupational therapy for a multi-sensory approach to learning.

He was seen at the Seizure Clinic (May 19, 1981) by a neurology fellow who recommended that the Dilantin be discontinued as the seizure disorder had never been confirmed and the child had had no seizures for two years. The medication was stopped gradually over a six week period with a repeat EEG two weeks after total withdrawal of the medication. A recommendation was made for follow-up in three months' time.

Vancouver Health Department Speech Pathology Services discharged C.M. July 31, 1981 when he turned four years of age.

Therapy had focused on noun-verb combinations, on present progressive verb form 'ing' and on early semantic relations (existence, non-existence,

recurrence, action), and listening and attending skills. He had made slow steady progress.

The Goldman Fristoe Test of Articulation indicated the following omissions in speech: /m/, /n/, /d/ and /r/medial; /z/final. He substituted t for k in the medial word position, s for sh, ts/ch, g/l initial, w or y/r, s/th (voiceless), b/v, t/th (voiced). Most consonant sounds were not present and many sounds were omitted in connected speech. His intelligibility was fair.

The Test for Auditory Comprehension of Language (TACL) indicated an age equivalent of 3.1 years at a chronological age of 3.10 years. He used two and three word sentences consistently ("Wan ride bike", "/eat cook us", "where put this?").

The Seizure Clinic appointment for EEG follow-up (September 9, 1981) found 'diffuse slowing and right portal sharp waves with no epileptiform changes during arousal'. The physician felt that further observation was necessary in order to diagnose epilepsy and plans were made to repeat the EEG in one year. There was no diagnosis of epilepsy made as no significant epileptiform activity was seen on EEG.

C.M. was seen for speech assessment and review of hearing at the Diagnostic Centre, September 30, 1981.

He had made good progress with articulation, was having difficulty with auditory attention and listening. Speech was more intelligible with some use of idiosyncratic words. He was now attending a different Day Care and follow-up by the speech pathologist at Day Care was recommended.

Staff at Day Care noted a seizure during his nap and he was seen again at Seizure Clinic (September 22, 1981). He was started on Tegretol as it

was noted that Dilantin causes cognitive slowing and the doctor stated that he now felt more comfortable with the diagnosis of epilepsy since he had now actually had a seizure and his roommates in the foster home confirmed that he clenched his fists and made jerking movements during the night.

The glasses prescribed by the opthamologist were found to be correcting myopic astigmatism and controlling strabismus (November 6, 1981). Surgery was suggested as a possibility prior to grade school.

Physiotherapy assessment by (January 29, 1982, chronological age 4.6 years) found C.M. to be socially aware and lacking in gross and fine motor skills. The Day Care was requesting that C.M. spend his kindergarten year there and not in a regular kindergarten. He was referred to Occupational Therapy for assessment.

This was carried out over January 29, February 12 and 18, 1982.

The family now was running an eight bed emergency foster home. C.M. was attending Day Care full time with a one-to-one worker.

C.M. was referred to O.T. for evaluation of his fine motor and perceptual motor development. He was noted to be distractible in school, to be generally hypotonic and to have problems with prehension, poorly established hand dominance, and poor size, number and shape concepts.

The assessment took place over three sessions and each session was limited to 20 to 30 minutes because of C.M.'s distractibility and lack of cooperation. In one session he absolutely refused to do anything. He was distracted by sound and movement around him and required frequent reminders to watch and attend to what his hands were doing.

In the gross motor area, he showed generally poor body strength. On a scooter board, he had difficulty extending arms and legs against gravity when in prone lying. He ran with some scissoring, caught and threw a large ball, and kicked a ball with good force, preferring the left leg.

Concept formation was clinically adequate for size and shapes. He was able to assemble graduated barrels and match shapes correctly. He was able to name a circle and a square but was not able to count sequentially - naming several numbers in random order.

He knew his own body parts, but found it difficult to transfer that information onto a body image drawing. He did not initiate a draw a person picture even after the head was drawn.

Hand dominance did not appear to be established as he used the right hand for pencil work and the left for other things (feeding, hammering). The right eye was preferred.

No fine index-thumb pincer grasp had developed. C.M. used a gross grasp with two to three fingers and the thumb. Associated reactions were seen in the left hand when using the right hand in fine motor activity.

He had poor pencil control, grasping high on the pencil with a four point right hand finger grasp. He required a hands-on intervention for dot-to-dot.

Upper extremity and hand strength was poor. He fatigued quickly. Eye-hand coordination was variable and may have been a 'factor of behavior' as he was frequently distracted, looking away rather than at his hand during a task.

Visual motor skills were significantly poor (VMI 2.10 years, Motor Accuracy-R, Right and Left scoring at 2.1 standard deviations below the

mean). He was able to copy horizontal and circular strokes with vertical scribbles, and seemed to have a difficult time understanding the task.

He had difficulty with dressing and would put his clothes on backwards unless aligned correctly. He could do pants, socks and boots when he was set up.

In summary, C.M. was found to have many problems in fine motor and perceptual areas as well as behavior problems. Weekly OT appointments for O.T. at Children's Hospital were made with the following recommendations:

> "(a) fine motor skills - hand dominance, dexterity and grasp, eye-hand coordination, strengthening.
> (b) perceptual skills - body image, number, size, shape.
> (c) perceptual motor skills - aim to improve drawing and cutting skills.
> (d) increase attention, concentration and problem-solving ability. Decrease impulsivity and distractibility."

The Assessment Summary of the B.C. Children's Hospital Evaluation Team (May 17, 1982, chronological age 4.10 years) established this Diagnostic Profile.

> "1. Psychological testing showed cognitive development in the slow learner range.
> 2. Attentional deficits.
> 3. Soft neurological signs with perceptual difficulties and motor clumsiness, functioning at the level of a 4.0 to 4.5 year old.
> 4. Seizure disorder controlled on Tegretol.
> 5. Congenital strabismus and estimated normal visual acuity with corrective lenses."

The recommendations were to continue on in the present day care setting for the kindergarten year with the 1.1 special needs worker, continue with O.T. at Children's Hospital, Central Screening for school placement within the Vancouver School Board and a reassessment by orthopaedics.

The Comprehensive Medical Report from the BCCH Child Development Program (May 21, 1982) found global developmental delay with neurological signs and cerebral dysfunction at the borderline average range in mental development.

In the parent conference, it was made clear that C.M.'s attention deficits and problems with visual motor coordination could lead to more learning problems.

On July 2, 1982, C.M. was discharged from O.T. at BCCH. He had been seen on a weekly basis for five months since February 1982 and would continue on at Day Care next year. His Day Care worker had attended some OT sessions at BCCH to facilitate follow through within the program.

He had become more cooperative, was still distractible to sounds, ignored instructions and made up his own games. It was still difficult to direct C.M. to a specific task.

He was still slow and cautious in descending stairs and was fearful of spinning or swinging too high. Weakness in prone and supine antigravity positions persisted.

He was expressing himself in spontaneous speech, but found it difficult to answer specific questions.

There was still no definite hand dominance, he persisted in using the left hand for larger movement and the right hard for fine movement, and still switched.

In dressing, shoe laces and buttons were still a problem.

Recommendation was made for referral for ongoing OT intervention with a community-based therapy team.

Seizure Clinic note (October, 1982) adjusted medication with a goal to discontinue anti-convulsant medication as seizures had not recurred.

The M. family were seen May 5, 1983 by the community agency's Social Service Department. C.M. had been placed in kindergarten at his local school for the last three months of school according to his parents' wishes and against the recommendations of the Day Care staff. His mother described him as a fearful child, reluctant to try new activities. "He is afraid of animals and heights, and has difficulty moving his body in coordination."

OT assessment (May 24, 1983) found him to be active and anxious. He was quite distractible and had difficulty completing tasks. The right hand was preferred but there were frequent shifts to the left. Crayons were held with a gross palmar grasp, although C.M. could adapt to a more mature grasp with reminders. Human Figure Drawing was primitive and disassociated, there was a tendency to scribble and difficulty staying between lines on coloring tasks.

Problems were identified as: 1) Visual Motor Dysfunction, and 2) Attention Deficit. He was seen once weekly in the home until September 1985.

Speech Pathology assessment (May 31, 1983) found that C.M. failed the kindergarten screening which indicated some further work was required in language areas.

C.M. was unable to give his name or age, count animals, relate a simple story through pictures. He was able to name four colors, point to chin, knee, elbow (not ankle) and follow three part commands.

The language sample was hard to elicit and the child used simple, incomplete sentences:

"Try again"

"No good"

"Can't jump on it"

"Washing your teeth"

Sentences and greater fluency included:

"They spilled it"

"Cos it might be sticky"

"I want to do my hearing"

"I wanna go home"

"I don't want to see it"

"Look at the umbrella with the water in it"

"I don't, I have a cat"

"He's pumping the gas"

He used past tense, negatives and pronouns. Two questions were asked, "What's this?", "That's you?"

Mean length of utterance was difficult to evaluate because of the shortness of the sample.

Performance on the PPVT was felt to reflect learning style rather than auditory language abilities. He was unable to scan the pictures and select an answer, pointing to all four.

Age Equivalent: 2.6 years.

Articulation was generally good, with the existence of immature forms.

C.M. demonstrated an ongoing delay in all areas of language functioning. Weekly speech therapy sessions at the community therapy

agency were recommended. If the family was unable to bring the child in for therapy, it was recommended he be referred to the speech language pathologist at his local school to more fully assess language abilities, liase with teachers and give programming advice as necessary.

The Physiotherapy Report (May 19, 1983) found tight heel cords, limitation of abduction in both hips, fluctuating tone with a slight increase in lower extremities and minimally reduced tone in the trunk. He was found clinically to have poor concentration, poor perception and poor fine motor skills. OT was felt to be more beneficial than PT and C.M. could be seen again in six months at the request of the OT.

The Kindergarten Report from the last trimester school placement (June 29, 1983) noted that C.M. had made a fair adjustment to kindergarten. He was beginning to communicate with his classmates, liked the sandbox and the playhouse. Fine motor skills were poor in cutting and he was attempting to color. The teacher felt that fine motor practise over the summer would enhance this performance.

C.M. attended full-time kindergarten the following year and was seen at school weekly for OT sessions. Speech therapy sessions at VNC were never realized as the family were unable to make a weekly commitment for therapy sessions since the nature of the emergency foster home dictated that they could not leave it.

His performance on Psychological Testing (September 1983) placed him in the borderline range, however, his behavior and functioning pattern resembled that of a severely learning disordered youngster. His educational needs required a highly individualized program in a setting designed for students with multiple learning handicaps. Priorities for

planning were on controlling behavior, increasing attention span, improving concentation, development of perceptual and cognitive abilities and acquiring basic, academic skills. The recommendation was that the multi-sensory approach be used extensively.

The School Board Speech Assessment (September 1983) found good progress in acquiring language given the delay in initiation of speech development. Grammatical forms were age appropriate with vocabulary and content deficiencies. His attention span affected listening ability.

A recommendation for all day kindergarten was made for language stimulation, motor skills and social development.

The Psychological Report (April 26, 1984) summarized that this was C.M.'s second year in kindergarten and he had developed no readiness for Grade 1. He had attended LAC since September 1983.

Test Results

1. Ravens Colored Progressive Matrices - 10%ile.

2. Good enough Draw-a-Man
   Age Equivalent 4.2 years

3. Boehm Test of Basic Concepts - Forms
   28/50

4. PPVT-R (Form L)
   Age Equivalent 4.0 years 1%ile

5. Expressive One Word Vocabulary Test
   Age Equivalent 4.5 years - 7th%ile

6. Motor Free Visual Perception Test (MVPT)
   Age Equivalent 4.6 years

7. VMI
   Age Equivalent 4.9 years - 2%ile

A developmental delay was found in all areas assessed. There were visual perceptual and visual scanning deficits, directionality confusions, motor limitations and delays in the cognitive domain, however, the impression was that C.M. was more capable than his test results indicated.

The learning assistance centre progress report (June 1984) reported that C.M. now had basic language concepts of before, after, some, around, over, several, none, almost and different.

C.M. had made steady progress, although readiness was not achieved. He had a positive attitude, good group participation and was enthusiastic about new skills. There had been a gain in printed forms and copying tasks but with much left to do.

He needed to increase his personal data (did not know his birthday or address), extend rote counting, numerical and verbal memory skills, expand stored language and required an experiential approach to basic concepts.

A small group setting was recommended as C.M.'s achievement was significantly below expectations. He was very demanding of teacher attention and tended to model other children's behavior.

OT Report (April 30, 1984, chronological age 6.9 years) found C.M. to be 'agitated with a relentless stream of chatter and questions, and nervous giggling'. Test behavior was erratic and impulsive which may have invalidated results, particularly on the Motor Free Perceptual Test (MVPT, Age Equivalent 5.0).

Attention deficits were found to interfere with performance. Visual memory was not an area of strength, and C.M. had difficulty with auditory sequences.

A small class size was recommended with an experienced teacher sensitive to C.M.'s strengths and weaknesses. A multi-sensory approach was recommended to facilitate attention in task approach and learning as well as programming for language deficits.

C.M. was placed in the Junior Learning Assistance Class at his local school for the school year 1984-85.

The OT report dated April 11, 1985 (chronological age 7.9 years) indicated that progress had been made in writing skills although severe deficits persisted. Organization of space, reversals, difficulty with left-right progression continued to characterize C.M.'s work. Switching hands on fine motor tasks had diminished, but was still observed on rare occasions.

Clinically, balance had made progress as had bilateral coordination and motor planning.

C.M. was enrolled in a sensory integration program for the summer at the community therapy agency and was encouraged to participate in a therapeutic riding program. The family were able to follow through on both suggestions and he was enamoured with both these programs, asking relentless questions as to when he would go to the Centre or to see the riding instructor again.

The School Report (1984-85) recorded progress throughout the year in Language Arts, Math and General Studies.

At the third report, C.M. had taken more interesing comprehension of stories, was more focussed in speaking skills, knew his letter names and a dozen sight words. The sound-symbol relationships were progressing. C.M. was pleased with his progress and always did his best.

A recommendation was made for a fine motor activity program over the summer.

C.M. had enjoyed all the units the class had participated in: helicopters and planes, dragons, seeds and trees. He was integrated into PE with the Grade 1 class and had had a good year.

The school-based team report (May 2, 1985) recommended retention in the LAC class as he was learning to read slowly and was very scattered, requiring small group placement. The school-based team report (January 1986) formulated an Individualized Education Program (IEP, chronological age 8.6).

C.M.'s strengths included integration with peers in Grade 1 gym and demonstration for readiness in some other Grade 1 activities. His general knowledge had improved and he had a good self concept and good interpersonal skills.

His needs were for improved fine motor skills, organizational skills when working, constant repetition, much positive reinforcement and a multi-modal or game approach.

The goals set out were:

1. to complete the Grade 1 math program by June 1986,
2. to complete the level 2 Ladybird reading from the On Our Way, Ginn Series,
3. to recall all CBC words and most common combination sentences independently by June 1986,
4. know his personal information,
5. to cut accurately by June 1986.

The OT report dated April 9, 1986 generated the following problem list:

Problem #1 Fine Motor Dysfunction

Rhythm, postural adjustment, bilateral integration and motor sequencing were still real areas of difficulty with progress seen. Score on Motor Accuracy (MAC-R) on the right and left hands showed performance -1.7 standard deviations below the mean (an improvement since previous MAC-R scores of -2.1 in February 1982).

Problem #2 Visual Motor Dysfunction

Motor planning had improved and C.M. was better able to organize tasks, approaching them in a step-by-step manner. Printing had improved to a functional level, but had not generalized to copy of unfamiliar forms.

Reversals persist and sequencing, organization of letters into word groupings and between space guidelines were areas of difficulty.

Problem #3 Attentional Deficits

These continued to interfere with learning and output, but C.M. was less impulsive and better able to self-monitor.

The plan was to continue weekly intervention at school with use of programs and games designed to develop visual motor integration and to enroll C.M. in the sensory integration program again during the summer.

APPENDIX B

SUBJECT #1: DATA: BLOCK SEQUENCING TASK

APPENDIX B

Subject #1: Data: Block Sequencing Test

Day #	Baseline (A_1)	Intervention (B_1)	Baseline (A_2)	Intervention (B_2)
1	21	23	23	26
2	23	23	26	80
3	22	28	23	32
4	23	26	23	28
5	23	28	22	35
6	23	29	22	30
7	23	26	24	31
8	23	34	22	30

APPENDIX C

SUBJECT #1: TEST RESULTS

APPENDIX C

Subject #1: Test Results

Tests Administered

1. Bruininsks Oseretsky Test of Motor Proficiency.
2. Developmental Test of Visual Motor Integration (Beery).
3. Durrell Reading Analysis.

Test Results

1. Bruininsks-Oseretsky Test of Motor Proficiency.

A battery of subtests to assess motor functioning. The mean of the standard scores is 15 with a standard deviation of 5. The composite standard score mean is 50 with a standard deviation of 10.

Gross Motor Subtests	Standard Score	%ile rank*
1. Running Speed and Agility	1	
2. Balance	1	
3. Bilateral Coordination	4	
4. Strength	6	
Gross Motor Composite	-20	1%ile
5. Upper Limb Coordination	6	
Fine Motor Subtest		
6. Response Speed	6	
7. Visual Motor Control	1	
8. Upper Limb Speed and Dexterity	1	
Fine Motor Composite	-20	1%ile
Battery Composite	-20	1%ile

2. Developmental Test of Visual Motor Integration

A sequence of geometric forms to be copied with pencil on paper.

Standard scores have a mean of 10 with a standard deviation of 3.

Standard Score:	3
%ile Rank*:	3%ile

3. Durrell Reading Analysis
An assessment of ten areas of reading ability.

	Grade Level
Oral Reading	Low Grade 1
Silent Reading	Low Grade 1
Listening Comprehension	Mid Grade 1
Listening Vocabulary	Low Grade 1
Word Recognition	Low Grade 1
Word Analyses	Low Grade 1
Spelling	Low Grade 1
Sounds in Isolation	Mid Grade 1
Visual Memory of Words	Low Grade 1
Sounds in Words	Low Grade 1
Pre reading Phonics Abilities Inventories:	B

*A percentile range (%ile) indicates the percentage of the age peers scoring at or below the subject's test score.

APPENDIX D

SUBJECT #1: CLINICAL OBSERVATIONS

APPENDIX D

Subject #1: Clinical Observations

Day: B1#1

CM: 'Are you going to play with me now?
Am I first?
This is going to be fun!'

LMS: 'Show me how to write on this computer.'

CM: 'Dunno, ask JM.' (Starts to get out of his seat.)

LMS: 'Let's work it out. We need a plan. Look at the screen. This looks like a desk. We can write (W), type (T), or file (F). What do you want to do?'

CM: 'We want to write.'

LMS: 'Yes, we want the menu for writing, so you need to press . . .?'

CM: 'We press 'W'.' (Write menu appears.) 'Oh no, that's wrong, where is the thing?'

LMS: 'This is the menu for writing. Now you have to choose again. What do you want to do?'

CM: 'Write? So I press 'W' again?' (Writing format appears.) 'Phew, there it is, I thought it was broken, no I didn't, I always knew it. Did you know it, did you?'

LMS: 'I figured it out.' (Indicate 'Write to Read' card, first word: RED.) 'Say this word.'

CM: 'Uh. . . rrr . . ., nope, don't know it.'

LMS: 'This letter says rrr, you're right. These letters say?' (No response.) 'They say 'ed'.'

CM: 'R-ed, red, I knew that.'

LMS: 'What does red mean?'

CM: 'You mean like the color red?'

LMS: 'Yes, put it into a sentence, please.'

CM: 'My new bike is red.'

LMS: 'Yes, and you can make a whole line of the word red.' (CM makes a complete, correct line of r-e-d, use of space bar correct, use of (L) index for all letters, appropriately.)

LMS: 'Say the next word.' (FED)

CM: 'Dunno.'

LMS: 'Starts with . . .'

CM: 'F.'

LMS: 'And 'f' says . . .'

CM: 'Fuh, I dunno.'

LMS: 'The first letter says fuh, these letters say . . .?'

CM: 'ed', fuh-ed, fuh-ed, fuh-ed. This is hard, fuh-ed.'

LMS: 'It says 'fed'.'

CM: 'Ok, ok, now where's 'f'?'

LMS: 'Home Keys. Fuh.'

CM: (Completes line of FED, no errors, using L index finger.)

LMS: 'What does fed mean?'

CM: 'Like when you are fed up?'

LMS: 'Make a sentence with 'fed' in it.'

CM: 'We fed the ducks.'

LMS: 'Look at the next word.' (LED)

CM: 'It', that's an 'i', that's why it says it.'

LMS: 'That's an 'l', what sound does 'l' make?'

CM: 'luh'. (Pauses) 'I don't know.'

LMS: 'Luh-ed'. It says 'led'.'

CM: (Completes line of led, no errors, 'l' on (L), 'ed' on R index.)

LMS: 'Say the next word.' (WED)

CM: 'Wuh-llll.'

LMS: 'What sound does it start with?'

CM: 'Wuh.'

LMS: 'And these letters say. . . ?'

CM: 'ed. . . wuh-ed, wuh-ed, dunno.'

LMS: 'It says 'wed'. What does 'wed' mean?'

CM: 'I said I don't know!!!'

LMS: 'When you get married, you wed someone, like at a wedding.'

CM: 'My parents are married. Where's 'w'?'

LMS: "Mr. Qwert's house.'

CM: (Types wed with L index, no errors.)

LMS: 'You are working hard. Say the next word.' (BED)

CM: 'Duh--, buh--, duh--, okay tell me, is that 'b' or 'd' . . . ?'

LMS: 'The first letter says buh, and these letters say . . .'

CM: 'I said I forgot.'

LMS: 'They say '-ed'. Try it.'

CM: 'Duh-ed. Can we play a game?'

LMS: 'This word says 'bed', you say it.'

CM: ''Bed', like you sleep in. I sleep in a bed, you know.' (Confiding tone. Completes line of 'bed', L index used correctly.)

LMS: 'What does this sentence say?' (Ted had a red bed.)

CM: 'The . . .'

LMS: 'The first letter says . . .'

CM: 'Tuh.'

LMS: 'And these letters say . . .'

CM: '-ed, tuh-ed, tuh-ed, the.'

LMS: 'It says 'Ted'.'

CM: 'I knew that. Ted had a red ded. What is that?'

LMS: 'Buh.'

CM: ''Bed', yeah, yeah. Ted had a red bed.'

LMS: 'Good work, the sentence says Ted had (indicate 'had') a red bed. Now you can copy the sentence.'

CM: 'T-e-d space h-a-d space a space r-e-d b-e-d.' (Verbal mediation, saying letter names.)

LMS: 'Now you can copy it again.'

CM: ''Ted', I remember that, it's in my book.' (Continues to copy, gets to bed and types deb, recognizes error and corrects by deleting and re-entering.) 'What do you want bed to start with?'

LMS: 'Buh.'

CM: 'But that's a 'd'!' (Bashes on the keyboard.) 'Oh! that word... Ok, I fixed it. Ok, what do we do, what do you want, what do I do?'

LMS: 'Now you can print. Do you know how?'

CM: 'We have to ask JM.'

LMS: 'I think we can work it out. Press 'escape' to get back to the menu. There's the desk, what do you want to do?'

CM: 'Type?'

LMS: 'What sound do you hear in 'type'?'

CM: ''Tuh' - 't'.' (Presses 't' and the type menu appears.) 'I remember, #4.' (Types #4 and next frame appears.) 'Now what?'

LMS: (Indicates 'return'.) 'It says 'press return'.'

CM: 'I know, I know.' (Presses 'return' and copy is printed.)

LMS: 'Look at this good work!'

CM: 'Yep!'

Discussion

CM's agitated manner is evident in this sample. He recognizes the initial consonant and then guesses with another word beginning with the same consonant. Confusion between 'b' and 'd' and 'l' and 'i' persists.

He is able to problem-solve his way through the word processor command sequences, although unfamiliar situations are met with horror-stricken responses and he requires direction. Familiarity with sequence of word processor commands is evident as he understands that 'type' on the menu means 'print'.

The handwritten sentence contains b/d confusions and reversals, upper and lower case letters and total reversal of BED (DE).

Day: B1#8

CM seats himself at the computer and goes through the sequence to get into the writing format of the word processing program independently. He talks his way through the sequence.

CM: 'W.' (Types 'w'.) 'Wuh.' (Types 'w'.) 'Number four-four-four (repeats as he scans for the key) and return.' (Checks the screen for the correct format.) 'OK, I'm in, now what?'

LMS: 'Say the first word.'

CM: 'Can't.' (Refuses before he looks at the word.)

LMS: 'The first letter says . . .'

CM: 'guh.'

LMS: 'Yes, and these letters say 'um', 'guh-um'. You try it.'

CM: ''Guh-muh'. I said I can't!!'

LMS: ''Guh-um'. Gum.'

CM: ''Gum, gum, gum'. Yep, I knew that.'

LMS: 'What does 'gum' mean?'

CM: 'Means yeh ead it.'

LMS: 'Can you use the word in a sentence?'

CM: 'No! I have the gum and I eat it. That's what I said.'

LMS: 'And you were right. Type a line of 'gum'.' (CM begins to type using the left index for 'G' and the right index for 'um'.) 'Guh-um, guh-um, guh-um.' (CM stops typing when the verbal cueing stops and starts to play with the directional arrow keys, moving the cursor back and forth across the screen.) 'Guh-um.' (CM initiates with cue and types an error: 'GTUM'.)

CM: 'Oh, no! Did you see that!' (Uses the directional arrows to move the cursor to the right of 'T' and deletes it, but has difficulty re-aligning the cursor at the end of the word and leaves a big space. LMS shortens the space with the directional keys and CM continues working quickly, now using the left index for 'G' and the right index for 'um'.)

CM: 'First I go slow and then I go fast.' (Continues with 'u-m' sequence becoming more rapid.) 'Holy smokes! Am I finished? I

didn't know!!' (Starts to use directional arrows to move cursor on to the next line.)

LMS: 'Press 'return' for the next line.'

CM: 'No! I don't wanna (beguiling impish grin). This works just as good.'

LMS: 'The 'return' button tells the printer to start a new line. It will all be on one line when you print it.'

CM: 'No it won't! See, it looks good now.'

LMS: 'We talked about this yesterday. Your printout will all be on one line, unless you press 'return'.'

CM: 'So! Who cares! It looks good!!'

LMS: 'It's your work. We'll check it when we print and you can decide. Say the next word.'

CM: ''Ha-yuh-muh, ha-yah-muh, ha-yuh-muh'. What is it?'

LMS: 'This letter says 'huh'. These letters say 'um'. 'Huh-um'. 'Hum'.'

CM: 'Huh-um. Hum.'

LMS: 'What does 'hum' mean?'

CM: 'Means what you do when you hum. I don't know what it means.'

LMS: 'You're right, a hum is like this.' (Demonstrates hum.)

CM: 'Yuh, like this: hum-hum-hum.' (Hums in a musical sort of way and then initiates 'H-U-M' with the right hand.)

LMS: 'Huh-um, huh-um, huh-um.' (CM continues to end of line and presses 'return'. He types with gross exaggerated staccato movement, typing faster and faster.)

LMS: 'What word are you typing?'

CM: 'Hum.'

LMS: 'Can you make a sentence using 'hum'?'

CM: 'Don't know. I never hum!'

LMS: 'You did it. Say the next word.'

CM: ''Buh-yuh-muh'. I need help. Is that a 'b' or a 'd'?'

LMS: 'This letter says 'buh', these letters say 'um'. 'Buh-um'. 'Bum'.'

CM: 'It says 'bum'? 'Buh-um'.' (Looks at the word.)

LMS: 'What does 'bum' mean?'

CM: 'It's your bum. You go poo. You sit on it.'

LMS: 'Yes, you're right.' (CM initiates typing without cueing using the left index for 'B' and the right index for 'um'. He turns on CAPS LOCK.) 'You don't need CAPS LOCK.'

CM: 'Yes I do. Is that a 'B' or a 'D'?' (Releases CAPS LOCK.)

LMS: 'It says 'buh'.'

CM: ''Buh'. I hate 'buh'!'

LMS: 'Buh-um, buh-um, buh-um.'

CM: (Breaks up laughing.) 'That's pretty funny, eh?' (Continues typing.) 'Buh-um, buh-um.' (Talks himself through the rest of the sentence and presses 'return'.)

LMS: 'Good work! Look at the next word. It says . . .'

CM: 'Buh-y-muh.'

LMS: (Indicates word.) 'This is the next word.'

CM: ''Duh'. I need help.'

LMS: 'These letters say 'dr', these say 'um'. 'Dr-um'. 'Drum'.'

CM: 'That's drum, you mean like a drum you hit?'

LMS: 'Yes, can you make a sentence?'

CM: 'I hit the drum!' (Proceeds to type, preferring to use the left or right index, but not alternating DR (left) and UM (right). No tactile cueing used as he appears agitated and irritable.)

LMS: ''Dr-um, dr-um, dr-um'. Try the left finger for 'DR' and the right finger for 'UM'.'

CM: 'I can't.' (Continues to type, making sequencing and spacing errors, talking to himself as he corrects.) 'Just use the

arrows.' (Completes an error-free line and uses repeated directional arrow key to bring the cursor to the next line.)

LMS: 'Try 'return'.'

CM: 'No!' (At this point the fire bell rings and CM jumps up.) 'We've got to get out or we'll burn!!' (CM is reassured and the fire drill proceeds.)

(Ten minutes later we return to the computer.)

LMS: 'Say the next word.'

CM: ''Puh-yuh-muh'. I need help.'

LMS: 'These letters say 'pl', these say 'um'. 'Pl-um'. 'Plum'.'

CM: 'It says plum?'

LMS: 'Yes, what's a plum?'

CM: 'Plum, you eat a plum.'

LMS: 'Can you make a sentence using plum?'

CM: 'Dunno. When you get one, you get one in your lunch. A plum is in my lunch!'

LMS: 'Good work. 'Pl-um, pl-um, pl-um'.' (CM types using the right index finger and makes reversal error: 'plum', recognizes it and deletes. Difficulty grading delete button and wipes out whole word.) 'Try again, 'pl-um'.' (Re-enters and puts space between 'pl' and 'um'. Deletes and finishes correctly, pressing return.)

LMS: 'Good for you, that was hard work! What does this sentence say?' (Keep the gum on the drum. CM skims through the sentence recognizing 'the' and substituting 'of' for 'on'.)

CM: 'Don't know. Say it so I can read it.'

LMS: 'Keep.'

CM: '. . . the . . . (looks) forgot.'

LMS: 'Gum.'

CM: 'Gum of . . .'

LMS: 'On.'

CM: 'On the . . . (looks) forgot.'

LMS: 'Drum.'

CM: 'Drum. Keep the gum on the drum.'

LMS: 'Good work, now you can copy the sentence.'

CM: (Begins, using shift-K for capital K.) 'Shift-K.' (Proceeds through the sentence and recognizes 'gum'.) 'I already did that one!' (Proceeds correctly, places a period at the end of the sentence and presses 'return'.)

LMS: 'That's right. Once more please.'

CM: (Proceeds correctly again, with an error in 'gum': 'gnm' and three extra spaces before 'on'.) 'Now I print, right?' (Proceeds through the print sequence correctly and prints his copy.)

LMS: 'Let's look at your work..

CM: (Recognizes alignment difference.) 'What happened?' (In absolute dismay.)

LMS: 'Let's look at the work on the screen.' (Puts work back on to monitor. It looks aligned correctly.)

CM: 'See! I told you it was OK!'

LMS: 'CM, it looks OK on the screen, but not on the paper. What do you think happened?'

CM: 'Return? Aw-w-w.' (Sheepish grin and laughs.)

LMS: 'See you next time.'

CM: 'Bye, see you . . .'

Discussion

Several word processing functions are performed without errors. These are: access to writing format, printing sequence and use of left and right directional arrows to move the cursor and delete extraneous letters within words. Letter reversals are corrected by deleting both letters and re-entering. The 'shift' function for capitals is used with verbal cueing, however, spontaneous capitalization is done with CAPS LOCK.

CM uses phonetic decoding and verbal mediation to talk himself through the word processing sequences. He recognizes letter errors and visual format errors by visual inspection.

CM attempts to decode by pronouncing all the letters he sees, but did not decode any words independently. He asks for help appropriately on some examples and lashes out in frustration on others. Confusion about 'b' and 'd' is noted; CM prefers to deal with upper case letters for 'B' and 'D'. He is confused by the lower case printout using uppercase lettering on the letter keys.

Use of 'return' is sporadic, sometimes spontaneous, other times he persists with directional arrows. He remembers the nature of his error when the results of not using 'return' are demonstrated.

He is able to use alternating hands on 3-letter words, but has difficulty switching hands in 4-letter words.

He demonstrates an irritable affect, but will laugh and joke as well.

CM was unable to read the sentence in the lesson, recognizing 'the' as a sight word. When he copied the sentence, he recalled the sequence of 'gum'.

The handwritten sample omitted the 'p' in 'keep' as well as 'the'. The 'u' in gum was inverted and this may have been as a result of copying the second typewritten sentence, which contained the same error. CM ran out of space and crowded 'drum' together with the 'um' on top of the 'dr'.

CM was able to decode the initial consonant of each word. When the word was broken down phonetically, he was not able to produce the word from its parts.

Day: B2#1

CM: 'Now the computer?'

LMS: 'Get the computer ready, CM.'

CM: 'Where's 'w', w-w-w.' (Scanning the keys horizontally with his finger. Keeps scanning, seems to be playing.)

LMS: 'Try Mr. Qwert's house.'

CM: 'Wuh, here it is and now I press again, right?' (Writing format appears.)

LMS: 'What does this word say?'

CM: duh. Nope.

LMS: 'This letter says duh - these letters say 'en'. Duh-in. It says den.'

CM: (Initiates typing, preferring one-handed approach.)

LMS: 'Decide which fingers to use, CM.'

CM: (CM starts using both pointers on each key, giggling and making eye contact with LMS, inviting LMS to go along with his 'silly' behavior.)

LMS: (Tactile cueing.) 'Duh-en, duh-en, duh-en.'

CM: (Settles down, using both hands appropriately and locating letters quickly.) Duh-en, duh-en.... (Completes a line and uses arrows to send cursor to the next line.)

LMS: 'What's another way to start the next line, CM?'

CM: 'Press return.' (Giggles, eye contact with LMS.)

LMS: 'How are they different?'

CM: (Proud to display knowledge.) 'Well, return tells the printer when to start over, you know, or else it can't know.'

LMS: 'Do you want to tell the printer now?'

CM: 'Yep.' (Happily hits return, looks around at a disruption in the class.)

LMS: 'What does the next word say?'

CM: 'Denut'.

LMS: 'This letter says duh, these letters say 'en'. Tuh-en. Ten. What's ten?'

CM: 'You know, ten.' Like counting.' Geez, don't you know ten?' (Laughs.) 'Where's 'tuh'?'

LMS: 'Mr. Qwert's house.'

CM: (Use of right hand to reach for T, tactile curing, switches to left hand for T and E, and responds to tactile cueing to switch to N with the right hand.)

LMS: 'Tuh-en, tuh-en, tuh-en.'

CM: (Continues) 'Tuh-en, space, tuh-en, space.' (To end of line, eye contact with LMS as his finger hovers over the directional arrows and he presses return.)

LMS: 'You remembered! What a guy! What does the next word say?'

CM: 'puh-n, puh-n-t. What time is it?'

LMS: 'This letter says?'

CM: 'puh'.

LMS: 'These letters say 'en'. Puh-en. Pen. What's a pen?'

CM: 'You write with it. Where's 'puh'?' (Initiates typing, unresponsive to tactile cueing, use of right index.)

LMS: 'Try this hand (touch) for 'puh' and this one for 'e' (touch) and this one for 'nuh'.'

CM: 'Nope. Too hard. Puh-en-space-puh-en-space-puh-en-space (to end of line). Now return.' (Smiles encouragingly at LMS.)

LMS: 'You remembered. The next word says?'

CM: MINEK

LMS: 'This letter says 'm', these letters say 'en'. M-en. Men. It says 'men'.

CM: 'What's that mean?'

LMS: 'You say one man, you say two men.'

CM: 'Two of them?'

LMS: 'Yes. Can you make a sentence using men?'

CM: 'Them.'

LMS: 'Two men sat down in two chairs.'

CM: (Pensive.) 'Yeah.'

LMS: 'Try this hand (tactile cue) for 'm-m', this hand (tactile cue) for 'e' and this hand for 'n-n' (tactile cue).

CM: (Goes ahead with right index only, no response to cueing.) 'I want to just use one hand. Me. That spells me.'

LMS: 'You're right. Put an 'n-n' at the end and it says 'men'. Mm-en. Mm-en, mm-en.'

CM: (Continues with correct sequence and spacing with one finger. Presses return. Starts drawing his finger along the keys, they make a clicking sound, seem lost, waiting for instructions.)

LMS: 'Good work, CM. This word says?'

CM: 'hai yuh.'

LMS: 'This letter says 'huh', these letters say 'en'. Huh-en. Hen. It says hen. Do you know what a hen is?'

CM: 'Nope. A hen is a chicken.'

LMS: 'That's right. Have you ever seen a chicken?'

CM: 'Yeah, I've seen one. Alive and dead.'

LMS: 'Which hands are you going to use to type the letters?'

CM: 'This one.' (Uses right hand to type, using a high elbow and staccato style, presses return.) 'Huh-en, huh-en.'

LMS: 'Here's the sentence. What does it say?' (Ten men chased the red hen.)

CM: 'The.....'

LMS: (Pointing to each word.) '"T"-en. Ten. Ten-mm-en chased.'

CM: 'the.'

LMS: 'You're right. Ten men chased <u>the</u> red hen.'

CM: 'Now I type? Shift-T. Right?' (Types slowly through, using the left hand for 'ased' and the right hand for all the other keys.) And a period at the end and return. Type again. Shift-T. (Types slowly through again.) 'Now I print. What do I do?'

LMS: 'Escape to the desk.'

CM: (Complies.) 'Now what?'

LMS: 'Do you want to write, type or file?'

CM: 'Type?' (Look at LMS for approval.)

LMS: 'Try it.'

CM: (Presses T.) 'Now #4 and return.' (Printer types work.)

Discussion

After a two-week period of no intervention, CM recalls the word processor sequence to get into the writing format.

He recognizes initial consonants and some individual letter sounds within the word, but gives up on the rest of the word, or adds in extra sounds (puh-n-t). He recognizes sight words (me, the).

CM requires direction to stay on task and some 'silly' behavior is noted throughout the session.

He avoids alternating hands for each letter (MEN), but will use hands together if there is a letter sequence using two letters with the same hand (T/EN).

He has retained the information regarding the function of 'Return', although spontaneously he reverts to directional arrow use. He requires direction for this at the beginning of the session and then incorporates 'Return' into the rest of his work for the remainder of the session.

He has retained the shift-T command for capitalization and abandoned CAPS LOCK. Keyboard Town cues seem to assist with letter-key location.

CM requires guidance through the print sequence, but has retained the last two stages (#4 and return).

The handwritten sample contains erratic lettering with a reversed 'e' in the first 'the'.

The word 'men' is left out altogether, represented by a solitary 'e' which allies itself to 'ten' giving it the appearance of 'tene'.

There is erratic spacing between the words and the sample presents as an undifferentiated string of letters.

Day: B2#8

CM: (Uses word processor commands to get into writing mode without direction, looks at first word.) 'Stop.' (Proceeds to type with his right hand.) 'You stop at a stop light.'

LMS: (Introduces divider.) 'Try two hands, CM.'

CM: (Hesitates, reticent to use two hands, but complies and continues correctly with no spacing, targetting or reversal errors. Presses return.) 'Huh-y, op, huh-y-op. I don't know. You have to tell me.'

LMS: 'This letter says huh, these say 'op'. Huh-op. Huh-op.'

CM: 'Huh-op. So what!'

LMS: 'The word says, 'hop', CM.'

CM: 'Well, why didn't you say so! Like a bunny hops. Now I have to do this. Huh-op, huh-op.' (Uses verbal mediation, correct use of right hand and spacing. Presses return.) 'What does the next one say?'

LMS: 'You look at it.'

CM: 'How am I supposed to know? 'OP'. There, I said it.'

LMS: 'This letter says 't', these say 'op'. Tuh-op.'

CM: 'Tuh-op, tuh-op, what kind of word is that?'

LMS: 'CM, I think you can try harder on these words.'

CM: 'Ok, ok, top!' (Types with two hands correctly.) 'Tuh-op.' (Finishes line without errors and presses return.)

LMS: 'What does 'top' mean, CM?'

CM: 'Well, you have the bottom and you have the middle, and you have the top. The bottom's down here and the top's up here.'

LMS: 'Can you use the word 'top' in a sentence, CM?'

CM: 'Ernie is on top of the computer.' (Points to muppet on top of computer and laughs.) 'That's a sentence!'

LMS: 'It sure is. Good for you.'

CM: 'No one is perfect, right?' (Looks anxiously at LMS.) ''cept for one. You know. Him!'

LMS: 'You mean God?'

CM: 'Yeah. God's perfect.' (Shakes his head sadly.) 'My legs don't work, you know.'

LMS: 'They work ok, CM. Legs get better with practise.'

CM: 'I have! I have! I practise all the time. So I'm going to get a new pair. Cut 'em off right here (indicates mid thigh.) 'and get a doctor to hook 'em up again, and then they'll work better.'

LMS: 'I don't think it words that way, CM. The legs we get are the legs we always have. We keep them and do our best.'

CM: (Sad) 'Yeah, my mom says that, too. She says ther' good enough for her.'

LMS: 'They're good enough, CM.'

CM: 'Yep.' (More matter of fact.) 'Next word. Puh-op. OP? I need help.' (Unable to combine the sounds into a meaningful word.)

LMS: 'Pop. Puh-op. Pop.'

CM: 'Oh, yeah, like pop goes the weasel.'

LMS: 'Can you use 'pop' in a sentence?'

CM: 'A balloon goes pop.' (Snickers) 'It really goes BAM!!' (Hilarious giggles.) 'And boy, they jump right up!' (Gales of laughter.) 'Oh, boy...' (Recovers himself, wipes his eyes.) 'Now what do we do here.... Pop. OK.' (Initiates with right hand correctly and continues with accurate spacing, and no errors, presses return at the end of the line.)

LMS: 'Puh-op, puh-op, puh-op.'

CM: 'Next word. Muh-op. Mm-buh-op. Don't know.'

LMS: 'Mop. Mm-op. Mop.'

CM: 'Oh, year... Heh, I get to do it with one hand.' (Types rapidly making errors and alternating correction strategies between total word deletion and use of directional arrows. He finishes the line correctly and presses return.)

LMS: 'What is a mop, CM?'

CM: 'Oh, you clean with it. Squeeze it out in a bucket.'

LMS: 'Use the word 'mop' in a sentence.'

CM: 'Mop up the mess.'

LMS: 'Well done.'

CM: (Scans the sentence.) 'The only word I know here is 'the'.'

LMS: 'Start at the beginning.'

CM: 'Come....'

LMS: 'Can.'

CM: 'Can .... op.'

LMS: 'Pop.'

CM: 'Can Pop hop oh-vaiv... don't know....'

LMS: 'Over.'

CM: 'Can Pop hop over the mop.' (Scans again.) 'Shift C, Shift P, right?'

LMS: 'Right.'

CM: (Types accurately using 'shift' function, uses directional arrows to correct spacing error. On the second copying, he makes a targetting error, hitting the arrow. Impulsively he hits the return button and the whole display shifts down one line, breaking in the middle of the line. Very calm.) 'I don't think I can fix this, LMS.'

LMS: 'That's a hard problem, CM. Let me help you.' (LMS corrects error and CM proceeds with the rest of the sentence correctly.)

Discussion

C.M. is quite confident with the word processing functions of the computer. He uses both word deletion and directional arrow/space bar strategies to correct his errors. He has abandoned CAPS LOCK for capitalization and presses return consistently at the end of each line.

C.M. had difficulty combining letter sounds on this session and exhibited a discouraged approach to the task. He scanned the sentence for

familiar sight words first and then made a good attempt to read the whole sentence, finding more familiar words than he had seen at first. C.M. used verbal mediation while typing two items (hop and top).

He asked for help appropriately when his targetting error reoriented the entire visual display and did not exhibit his usual irritable manner when he knew the situation was beyond his control.

He prefers to type with one hand, but can be directed into bilateral hand use.

The handwritten sample is almost indecipherable with large scrawling letters, perseverance on 'v', making it into a 'w' and no recognizable word groupings.

APPENDIX E

SUBJECT #1: MOTOR SKILLS: VIDEO DISCUSSION

APPENDIX E

Subject #1: Video Discussion

These motor skills were selected to show balance, bilateral motor coordination, movement patterns, eye/hand coordination and fine motor sequencing. The skills were based on selected subtests of the Bruininsks-Oseretsky Test of Motor Proficiency.

C.M. was fatigued and irritable on the day of the filming, and this may have affected his perseverance at difficult tasks.

C.M.'s balance was poor, with poor trunk stability and foot placement in balancing tasks. His quality of movement was poor, showing internal rotation of the lower extremities and a scissoring gait.

There was left-right confusion on tasks requiring bilateral motor coordination, and difficulty following complex motor directions. C.M. tended to lose his balance forward on these tasks and demonstrated a discouraged task approach.

The jumping and touching heels tasks fed into C.M.'s primitive motor pattern of internal rotation and flexion of the lower extremities. He was unable to differentiate from this pattern by reaching down to his heels.

Performance on the broad jump was adequate, but C.M.'s poor balance interfered with the necessary weight shifting required to make any distance. Spontaneous movement shows sitting in 'reverse W' pattern and movement through 'bunny hopping', reflecting low muscle tone and persistent primitive movement patterns.

Ball skills were performed more enthusiastically. Catching, throwing and bouncing the ball showed some performance success.

C.M. was unable to keep his hips extended during the push-ups and used hip flexion to approximate task expectations. This, again, reflects use of his primitive movement pattern. He collapsed through his shoulders on this task, showing poor shoulder strength and stability.

Sit-ups reflected poor abdominal strength, and C.M. grasped the examiner's yard stick to pull himself up rather than use his weak abdominal muscles.

Running showed good alternating movement with some limitation in stride length, determined by lower extremity internal rotation.

Targetting with a ball was poor and showed limited success.

There was no isolated movement in thumb-finger touching.

APPENDIX F

SUBJECT #2: CASE HISTORY

APPENDIX F

Subject #2: Case History

Name: O.R.
Date of Birth: August 3, 1979
Chronological age: 6.10 years

O.R. is the youngest son of two boys, the oldest son is 12 years old. Mrs. R. was originally from Prince Edward Island and graduated from university in 1972 with a B.Sc. in Biology. When O.R. was initially diagnosed with minimal cerebral palsy and bilateral club feet, his mother raised funds from various service clubs in order to take him for patterning therapy at the Institute for the Achievement of Human Potential in Philadelphia, Pennsylvania.

Mrs. R. is a single parent and has been on assistance, taking training in a Computer Systems Technology program. She is presently employed. She was described as being knowledgeable about cerebral palsy, having realistic expectations, adequate parenting skills and receptive to participating in Oliver's therapy (Social Services Report, July 3, 1985), with no problems to warrant Social Services intervention.

The Day Care Report of May 1985 stated that O.R. had attended the Day Care since September of 1985. He was described as having mild CP with club feet. He wore a special brace and special shoes. There had been surgery for correction of the foot deformity and he had recovered well.

O.M. was reported to interact well with other children, having close relationships with male friends his own age with whom he enjoyed playing

Superman and Batman. He often felt that he could not do a task and exhibited a discouraged approach to difficult tasks.

Cognitively, the clinical impression was that he was slightly behind. He missed letters in the alphabet song, having had a difficult time with alphabetical and numerical sequences. In May of 1985, he recognized all letters by their letter names except 'X' and 'Z' and could count to "about 9 or 10". O.R. did not attend kindergarten within the School Board, attending Day Care for his kindergarten year.

His physical disability manifested as a limp in running and walking. He was not independent in taking his shoes on and off. He had an awkward and imprecise pencil grip.

O.R. was described as a friendly child who tended to attach to new staff, and showed gentleness and concern for other children. He tended to shy away from new situations and to adopt a helpless attitude. He preferred adult assistance but responded to positive enouragement.

Language development was described as adequate, although there was some slurring of his words and drooling as a result of his cerebral palsy.

He learned best in small groups and tended to be intimidated in a larger group with other children who easily grasped the material being presented. He required extra time from the teacher.

Areas for improvement were writing, pencil control, self-confidence and alphabetic and numerical sequences. The Day Care recommendations were that he receive lots of positive encouragement and little assistance for writing, dressing and shoes.

Psychological assessment (School Board report, April 29, 1985) found O.R. to be functioning within the normal range on the Weschler Preschool

and Primary Scale of Intelligence (WPPSI) with scores for verbal performance falling in the average range (subtest mean: 11) and performance ability in the low average range (subtest mean: 8).

There was a scatter of scores in the Performance area with lowest subtest scores of 6 on Mazes and Geometric Design, and the highest subtest score on Block Design. Overall performance was pulled up by Block Design, a more concrete task. Poor performance on the Geometric Design subtest was consistent with poor perceptual motor performance on the McCarthy Scales (16%ile) and the VMI with an age equivalent of 4.4 at a chronological age of 5.8, a delay of one year, four months.

Recommendations at that time were for occuptional therapy for visual motor skills and pencil practice; puzzles, for experience in pieces to make the whole, looking for clues, things that match; a program for gross motor skills. He was found to have some articulation problems and some auditory sequencing difficulty in remembering things in order. He was referred for learning assistance in non-verbal skills and therapy services at a community-based therapy agency.

The medical referral letter to the community therapy agency (June 14, 1985) stated that O.R. would "benefit from physiotherapy and occupational therapy for his hands and feet".

Therapy assessment went ahead and a Problem-Oriented Medical Record was generated (August 25, 1985).

Problem List

Problem #1 Poor Gait Pattern

Problem #2 Decreased Strength and Endurance

Plan To initiate a physiotherapy program in September, after surgery on the left ankle.

Problem #3 Fine Motor Deficit

Plan Varied exposure to manipulative materials such as construction paper and play dough, with emphasis on bilateral input. A trial of a triangular pencil grip to facilitate pencil control was suggested as well as use of larger scale writing and drawing materials.

Problem #4 Perceptual Motor Dysfunction

Plan Kinesthetic input to facilitate motor learning, especially in the area of pencil skill development. Eye tracking exercises. Work sheets with mazes, dot-to-dot and tracing activities. Activities requiring spatial discrimination and design, visual closure and visual memory."

The speech and language report found some mild articulation problems, but no language deficits, and concluded that no speech therapy was indicated (Speech and Language Report, August 15, 1985).

The School Board Team report of March 13, 1986 indicated that O.R. still required one-to-one assistance for fine motor skills and had no real understanding of numbers greater than ten. His printing was showing some improvement and he had progress to the third level of the Ginn reading program. The team felt that the child was still quite play-oriented and required a longer period in Grade 1, recommending retention.

APPENDIX G

SUBJECT #2: DATA: BLOCK SEQUENCING TASK

APPENDIX G

Subject #2: Data: Block Sequencing Test

Day #	Baseline (A_1)	Intervention (B_1)	Baseline (A_2)	Intervention (B_2)
1	23	32	31	23
2	27	30	17	30
3	26	30	15	20
4	31	30	25	18
5	28	25	26	26
6	31	25	26	24
7	32	36	25	26
8	32	26	16	26

APPENDIX H

SUBJECT #2: TEST RESULTS

APPENDIX H

Subject #2: Test Results

Tests Administered

1. Bruininsks Oseretsky Test of Motor Proficiency.
2. Developmental Test of Visual Motor Integration (VMI).
3. Durrell Reading Analysis.

Test Results

1. Bruininsks-Oseretsky Test of Motor Proficiency.

A battery of subtests to assess motor functioning. The mean of the standard scores is 15 with a standard deviation of 5. The composite standard score mean is 50 with a standard deviation of 10.

Gross Motor Subtests	Standard Score	%ile rank*
1. Running Speed and Agility	2	
2. Balance	1	
3. Bilateral Coordination	7	
4. Strength	8	
Gross Motor Composite	20	1%ile
5. Upper Limb Coordination	4	
Fine Motor Subtest		
6. Response Speed	6	
7. Visual Motor Control	14	
8. Upper Limb Speed and Dexterity	10	
Fine Motor Composite	36	8%ile
Battery Composite	21	-1%ile

2. Developmental Test of Visual Motor Integration

A sequence of geometric forms to be copied with pencil on paper.

Standard scores have a mean of 10 with a standard deviation of 3.

Standard Score:	7
%ile Rank*:	24%ile

3. Durrell Reading Analysis

An assessment of ten areas of reading ability.

	Grade Level
Oral Reading	Low Grade 1
Silent Reading	Low Grade 1
Listening Comprehension	Low Grade 3
Listening Vocabulary	Low Grade 1
Word Recognition	Low Grade 1
Word Analyses	Low Grade 1
Spelling	Low Grade 1
Sounds in Isolation	Mid Grade 2
Visual Memory of Words	Mid Grade 1
Sounds in Words	Low Grade 1
Pre reading Phonics Abilities Inventories:	A/B

*A percentile range (%ile) indicates the percentage of the age peers scoring at or below the subject's test score.

APPENDIX I

SUBJECT #2: CLINICAL OBSERVATIONS

APPENDIX I

Subject #2: Clinical Observations

Day: B1#1

OR: 'I've been on the computer before in the afternoon with Miss A.'

LMS: 'Can you show me how to write on this computer?'

OR: 'No.'

LMS: 'Let's work it out. This looks like a desk. We can write (indicate 'w'), type (indicate 't') or file (indicate 'f'). What do you want to do?'

OR: ''Write', press 'w'.' (Presses and write menu appears.) 'Press 'w' again?' (Presses and writing format appears. He presses the letter 'r' and delights in the series of 'r's' which zoom across the screen). 'I did a lot of 'r's'.'

LMS: 'Let's start. You can push this button to erase those.' (Indicates delete button.)

OR: (Deletes 'r's' and starts to slide down in his chair.)

LMS: 'Can you say this word?'

OR: 'REED.'

LMS: 'This letter says 'ruh', these letters say 'ed', 'ruh-ed'. Try again.'

OR: 'RED.' (Sliding down in his chair.)

LMS: 'What does red mean?'

OR: (Looking up from slumped position.) 'Like the color red?'

LMS: 'And can you make a sentence with the word red?'

OR: 'Red-is-a-color.' (Staccato voice and further slumping with occiput now resting on the chair back.)

LMS: 'Before you type, you need to sit up.' (OR complies and slumps down again. LMS places OR upright in his chair.)

OR: (Scans keyboard quickly and types R-E-DDDD as he slides down in his chair and his hands hit all the keys at once.)

LMS: (Replaces OR in upright position.) 'You need to erase those 'D's'.'

OR: (Uses delete button and erases the entire word, and slides back to his slumped position.)

LMS: (Removes child from chair, turns the back of the chair to the left and reseats the child so he is sitting without a chair back.) 'Try again.'

OR: (Maintains correct posture and types series of 'RED's', initially having trouble grading pressure on keys so that they repeat, but deleting appropriately. He chooses the right hand, but responds to nonverbal tactile cueing and initiates the left. Does not verbally mediate and works silently with the occasional 'Oops' to indicate an error in letter key selection or spacing. Uses the spacebar correctly. Self-corrects without direction.)

LMS: 'Now you press 'return' (indicate 'return' button) to start a new line.' (OR complies and cursor moves to next line.) 'Say the next word.'

OR: 'FEED.'

LMS: 'This letter says 'fuh', these letters say 'ed', 'fuh-ed'.'

OR: ''Fed', like 'I fed the cat.' (Trouble grading pressure on keys, types f-f-f and deletes automatically.)

LMS: 'Fuh-ed', 'fuh-ed', 'fuh-ed.' (as the boy types the corresponding letters.)

OR: 'Oopsie.' (Forgets to space and deletes whole word to replace the space, initiates with right hand, responds to tactile cueing and switches with left, completes line of 'FED'.)

LMS: 'Now press 'return'.' (OR finds key immediately and moves cursor to the next line.) 'What does the next word say?'

OR: 'Luh-ed.' (Adopts decoding strategy, modelled in previous examples.) 'Led.' (Initiates 'L' with right hand; tries to cross red line with right hand.)

LMS: 'This hand types on the left of the line, this hand types on the right side.' (Tactile cueing to left and right dorsum. OR completes 'ED' with the left hand.) 'Luh-ed', 'luh-ed', 'luh-ed.' (OR continues without errors and presses 'return' spontaneously.) 'This word says . . .'

OR: ''Wuh-ed', 'wuh-ed', 'wed'.' (Types immediately using left hand appropriately.)

LMS: ''wuh-ed', 'wuh-ed', 'wuh-ed'.' (OR finishes row.) 'Press 'return'.' (OR complies.) 'This word says . . .'

OR: 'BEED.' (Reverts to previous word attack.)

LMS: 'This letter says 'buh', these letters say 'ed', 'buh-ed'. Try again.'

OR: 'Bed.' (Then types in 'Wed', seems to be confused by 'wed' line above, self-corrects, starts searching for 'B', tactile cue on right dorsum, immediately scans on left side of line to find 'B', using left hand appropriately for all letters and space bar.)

LMS: ''Buh-ed', 'buh-ed', 'buh-ed'.'

OR: (Scanning for 'D' and says 'duh' aloud as he scans, completing the line of 'BED', presses 'return'.)

LMS: 'These words say . . .'

OR: 'Ted hed a red bed.'

LMS: (Pointing to each word.) 'Ted had a red bed.' (Emphasizes the 'a' in had.)

OR: (Typing with left hand only, cueing to right dorsum for 'H', makes an error on 'hed'. Self-corrects by deleting 'ed' and substituting 'ad'. Recognizes own error.) 'Is it recess yet?'

LMS: 'Press 'return'.' (OR complies.) 'Now type the sentence again.' (OR complies and repeats the 'hed' error.) 'Now you can print your work. Press 'escape' to get back to the menu.' (Indicates ESC and OR presses, desk menu reappears.) 'There's the desk, you want to press 'T' for type.' (OR complies and 'Type' menu appears.) 'Press #4.' (OR complies.) 'And press 'return'.' (OR complies and the work is typed.)

OR: 'I did that?' (Observes work with pride.)

LMS: 'You do good work, OR. Did you like working on the computer?'

OR: 'Yes, I like it better 'cos I don't have to draw.'

Discussion

This child had had some experience on the keyboard doing computer games, but none using the word processor. He picked up quickly on the

appropriate letter commands (W = write) after one demonstration and was able to repeat the 'W' command again, indicating some previous experience with menu selection.

His initial preference was to explore the way the letters repeated themselves with continued pressure on the keys, but also had difficulty grading his own pressure on the board. He had this under control by the third example.

OR's tendency for poor postural control was most evident during this session and this also initially affected his ability to grade his pressure on the keys. The rearrangement of the chair was a satisfactory solution and was adopted for the remainder of the time.

OR started to verbalize the tutor's decoding strategy on the third example and used it again on the fourth example. He reverted to his initial interpretation of a long 'E' (ē) on the fifth example. After LMS repeated the decoding procedure, he pronounced the word correctly and used a verbal phoneme cue (duh) himself while scanning for the correct letter key.

The sentence example included a generalization of the word family into 'had'. This was not pointed out as an error, but the sentence was repeated with spoken emphasis on the 'a' in had. OR self-corrected on the first trial, but repeated the error on the second trial as well as in the handwritten sample. He also omitted the word 'a' in the handwritten sample.

He displayed obvious pride in his work.

Day: B1#8

OR: (Seats himself and looks at 'Write to Read' card.) 'Gum, hum, bum.'

LMS: 'What a reader!' Don't forget to set yourself up on the word processor.'

OR: 'What do I do?'

LMS: 'Do you want to type, write or file?'

OR: 'W, W again' (presses appropriate keys and the writing format appears).

LMS: 'Now you can type a line of the first word. What does it say?'

OR: 'Gum.'

LMS: 'Yes and what is gum?'

OR: 'Gums, here, all this red stuff and gum you chew.'

LMS: 'Make a sentence using the word gum.'

OR: 'Gum is bubble gum.'

LMS: 'You did it. I think you can use the left hand for 'g' and the right for 'um'.'

OR: (Complies using correct fingering, stopping frequently to look around the room.)

LMS: 'G-um, g-um, g-um.'

OR: (Responds to verbal pacing, but allows hands to lean on the keyboard causing multiple letters to appear. He corrects these without direction, using the delete button. Reaches the end of the line and sits passively. Then starts to fiddle with the lighted 'on' button.)

LMS: 'How do you move the cursor to start the next line?'

OR: 're-turn, re-turn, re-turn.' (Presses once and looks at 'Write to Read' card.) 'Hum, what does that mean?'

LMS: 'It's a sound, hum-mm-m. Can you use it in a sentence?'

OR: 'You have a tune and you hum. Means you go m-m-m like a bee.'

LMS: 'Look and see which hands you should use.'

OR: (Proceeds to type using the right hand appropriately, having difficulty grading pressure and creating multiple 'Hs' which he deletes.) 'And press return.' (Presses return.)

LMS: 'And the next word says....?'

OR: 'Bum.'

LMS: 'Yes. What does that word mean?'

OR: 'Like a person who doesn't have any places so they sleep under old newspapers and pick out of garbage cans and pick bones and eat old ice creams.'

LMS: 'Can you use it in a sentence?'

OR: 'There's a bum who digs out of garbage cans and eats food that people don't eat and they're no good 'cos they drop on the floor.'

LMS: 'Think about which hands to use.'

OR: (Uses the left hand for 'b' and the right for 'um', forgets spacing and stops.)

LMS: 'Try to use the arrows to fix that.'

OR: 'It says 'bumbum.'

LMS: 'Use the arrows and the space bar.'

OR: (Backs up the cursor using the left directional arrow, aligns it to the right of 'm' and presses the space bar.) 'Now what do I do?'

LMS: 'Move your cursor out of the word.'

OR: (Complies and carries on to complete line and presses return, looks at 'Write to Read' card.) 'Drum.'

LMS: 'Look at the first letter.'

OR: 'Drum.'

LMS: 'What is that?'

OR: 'You have a drumstick and you whack a drum.'

LMS: 'Yes. What sentence can you use drum in?'

OR: 'Drum is a big circle, you take a drumstick and you whack it. It-is-a-drum.'

LMS: 'Decide which hands to use.'

OR: (Types "DR" with the left and "um" with the right.) 'Drum-space-drum-space.'

LMS: 'DR-um, DR-um, DR-um.'

OR: (Reverses DR (RD) and forgets space. Uses delete to correct, finishes line and presses return.)

LMS: 'Next word is.....'

OR: 'Don't know. Last part says 'um'.' Plum!! Purple fings you eat, but they're little bit messy.' (Decides without direction to use the right hand for all four letters. Has difficulties grading pressure and so creates multiple letters which he deletes. Then types pl-pl, recognizes error, corrects with delete button and goes on to finish line and press return.)

LMS: 'You're working well, O.R.'

OR: (Reads sentence without prompting.) 'Keep the gum on the bum. Drum. Shift-K.' (K(R) EE(L) P(R) T(L) H(R) E(L) G(L) UM(R), forgets space on (R) T(L) H(R) E(L) DR(L) UM(R). Recognizes spacing error, uses directional arrows to correct, has difficulty grading when to stop the cursor to align it properly. Requires assistance. Moves cursor out without difficulty and presses return.) 'Is it recess yet?'

LMS: 'Not yet. What do you do now?'

OR: 'Type again.' (Does so without crossing the red line saying 'space' out load.) 'Press return? How do I print?'

LMS: 'Escape to the desk.'

OR: 'I want to type 'T', and #4 and return. (Printer types his work).

'Can I have another copy to show my mum?' (LMS complies.) 'I want to tear off the dots. (OR tears off the perforated sides of the computer paper, he is drooling slightly). 'Do I come back tomorrow?'

LMS: 'Yes, I'll see you tomorrow. You worked hard today.'

Discussion

OR has difficulty with grading his pressure on the keys, but self corrects without cueing, preferring the delete key. Grading interferes with his ability to use the directional arrows correctly, and he chooses to delete an entire letter sequence rather than use the arrows.

He requires cueing to initiate word processor sequences and needs reminding about the return function. He is distractible and can be passive and 'dreamy' during the lesson.

He uses self-cueing for spacing and return which he forgets.

The handwritten sample is poorly spaced and includes an upper case "T" in 'the'. His letters are sitting on the line.

Day: B2#1

OR: 'Greg's back! He has a cast on his elbow! He fell out of a window, you know. He looks like a chicken'. (Reads through 'Write to Read' word list.) 'Den, ten, pen, men, hen.'

LMS: 'You read all those words. Do you remember how to write on the computer?'

OR: 'No. #4? What number do I push?'

LMS: 'Do you want to write, type or file?'

OR: 'Write. W.' (Presses) 'W again.' (Presses) 'That was easy!' (Checks list.) 'Den. "D".' (Proceeds)

LMS: (Tactile cues to reinforce DE on left and N on right.) 'Duh-en, duh-en, duh-en.'

OR: (Completes line of typing with correct hand use, and spacing and return.)

LMS: 'What is a den, OR?'

OR: 'A den is a big barn with draw in it. Or maybe a wild animal lives in it, like cow.'

LMS: 'The next word says....'

OR: 'Ten, like ten fingers.' (Holds up wide spread hands in demonstration.) 'Or like a metal?'

LMS: 'The number ten is the word.' (Types) 'The metal is tine, like this.' (Types) 'Are they the same?'

OR: 'No, no, this has an 'e' in there, an' this is the other one, 'i''

LMS: 'Which word are we typing now?'

OR: 'Ten.' (Begins with use of two hands, space bar, completes correct line and presses return.)

LMS: 'Good work. Try the next word.'

OR: 'Pen. That's like a sharp thing what can hurt you in the finger.'

LMS: 'You mean a pin. That's this word.' (Types) 'The word we're doing now is pen.' (Types) 'Are they the same?'

OR: 'Oh, no. It's the "i" in here and the "e" there.'

LMS: 'Do you know what a pen is?'

OR: 'It's a big fing you write with.'

LMS: 'That's right. Now you can type a line.'

OR: (Types with both hands, P(R), E(L), N(R), uses delete to correct spacing errors, completes line, presses return.)

'The next word is MEN. Like all men, not just one man. It is not with one man, it's with three, four, five or six men.'

LMS: 'Good for you. Go ahead.'

OR: (Types M with right, EN with left.)

LMS: 'This hand stays on that side of the line. Try the "n" with this hand.' (Tactile cue.) 'Try again.'

OR: (Completes the first trial and reverse to the second. Tactile cueing given again and OR completes the rest of the line. Some difficulty with spacing arises, he corrects with the delete bar and presses return.)

LMS: 'You're working hard. Here's the last word.'

OR: 'Hen.' (Distracted by disturbance in the classroom.)

LMS: 'What's a hen, OR?'

OR: 'I don't know.'

LMS: 'A hen is a chicken, a female chicken.'

OR: 'What lays eggs?'

LMS: 'That's the one.'

OR: (Types H(R) and EN(L), responds to tactile cueing for two trials, continues for two more trials and reverts to "EN" on the left for next trial, tactile cueing on next trial, continues for last trial, presses return.)

LMS: 'Here's the sentence.'

OR: 'Ten men can, ken,....'

LMS: 'Chased.'

OR: 'Chased the hen into the pen.'

LMS: 'What a good reader.'

OR: 'Now I type? Shift T?'

LMS: 'Go ahead. You know how to do it.'

OR: (Types sentence using both hands correctly throughout the sentence, using space bar correctly and presses return and retypes again without a reminder.)

'Now we print..... Oopsie, I forget.'

LMS: 'Escape to the menu.'

OR: (Presses ESC x two.) 'Now "T" and then #4. Oh. What now?'

LMS: 'Tell the printer....'

OR: 'Return!!' (Presses and material is printed.)

Discussion

OR is unfamiliar with the word processing commands after two weeks without intervention. He retains some segments of the sequences, but requires cueing.

He is very eager and competent when reading through the word list, and read all the words at a single try with the exception of 'chased' in the sentence.

He recognizes his typing errors visually without prompting and used the delete button to correct. He does not attempt to use the directional arrows at all.

OR is happy to use two hands for typing, but tends to use one hand for the initial consonant and the other for the rest of the word. This was consistent with the phonetic approach taken in previous lessons. OR responds to tactile cueing, is able to sustain the sequencing pattern for

two trials and then reverts to his original strategy. Recueing results in a correct response for the next two trials.

OR types the entire sentence with correct left and right hand use. Without phonetic structure, he follows the visual keyboard format for hand selection. In this sample, he decodes 'chased' with the word families rule, slotting in the initial consonant phoneme on to the word root being used in the lesson.

OR is able to anticipate the lesson sequence and remembers to type the sentence twice.

He has retained some of the print sequence, requiring some cueing and remembers the verbal explanation of the function of the return key. (It tells the computer/printer you're ready.)

Some difficulty with auditory discrimination between the 'i' and the 'e' sound was noted. OR is able to recognize the difference visually and make appropriate choices.

The handwritten sample contains erratic lettering with reworking on the initial capital 'T' and the dotted 'i'. There is poor spacing between words and the sentence resembles an undifferentiated sequence of letters. Letters are crowded in toward the end of the line and OR does not use the next line to write on in order to avoid crowding.

Day: B2#8

OR: (Sits down, stands up and rearranges his chair so the seat back is to the left, sits down again. Uses word processor commands to get into writing mode without direction. Looks at the Write to Read card.) 'STOP. You stop when you run and some one says 'stop', you stop.'

LMS: 'That's right, OR. Can you use 'stop' in a sentence?'

OR: 'Stop means finished.' (Uses two hands to type appropriate letter keys without requiring cues, he recognizes his spacing errors by visual inspection and uses the directional arrows and space bar to correct, presses return.) 'Hop.' (Jumps up and down into the seat to demonstrate.) 'A bunny hops or a frog. Ribbit, ribbit.' (Types accurately with appropriate use of right hand, spacing and return button.)

LMS: 'Good work, OR. Put hop into a sentence.'

OR: 'A bunny can hop.' (Looks at next word.) 'Top. You know, you've got the sugar bowl and you take something off and that's the top. It means a roof.'

LMS: 'Can you use 'top' in a sentence?'

OR: 'A roof is on top of a house.' (Types with bilateral hand use, correct spacing and return. Looks at next word.) 'Pop. Popcorn pops. It flies all over the place and makes a noice. And it means you can drink pop.'

LMS: 'Yes. Use 'pop' in a sentence, OR.'

OR: 'Pop is a noise.' (Types with correct use of right hand and space bar, rapid and automatic movement, presses return.) 'Mop. What scrubs dirty stuff off the floor.'

LMS: 'Good. Use mop in a sentence.'

OR: 'You can mop the floor with a mop.' (Types rapidly and accurately, with correct right hand use and spacing without errors. Presses return.)

LMS: 'What does the sentence say?'

OR: 'Can Pop hop over the mop.' (Reads correctly.) 'Shift C and Shift P?' (Recognizes need for capitals.)

LMS: 'Yes, you go ahead.'

OR: (Types right through the sentence using correct hand use without error in letter keys or spacing. Uses Shift C and P to capitalize.) 'Now type again?'

LMS: 'Go ahead.'

OR: (Presses return and typs the sentence again perfectly.) 'Now what do I do? Oh, escape. Escape again. Now, Write?'

LMS: (No response.)

OR: 'Type. 'T'. Return?'

LMS: 'Look at the screen.'

OR: '#4. Now what?'

LMS: 'Look at the screen.'

OR: 'Return. Now can I make two copies?' (Goes back through the menu selection independently and makes a second copy for himself.)

LMS: 'You worked hard today, OR.'

Discussion

O.R. types with correct bilateral hand use and does not require tactile cueing. He uses the more complex strategy of directional arrow use, delete and space bar to make corrections rather than deleting the whole line up to the error and starting again. He tend to rely on LMS for directions re word processor commands, but manages when he has to do it by himself. He is able to problem-solve how to print a second copy of his work independently.

OR read all of the words on sight and read the sentence without assistance. He knew the meanings of all the words and offered a second meaning for 'pop'. He was able to use all of the words correctly in sentences. The written sample contains no errors and adequate spacing.

APPENDIX J

SUBJECT #2: MOTOR SKILLS: VIDEO DISCUSSION

APPENDIX J

Subject #2: Video Discussion

These motor skills were selected to show balance, bilateral motor coordination, movement patterns, eye/hand coordination and fine motor sequencing. The skills were based on selected subtests of the Bruininsks-Oseretsky Test of Motor Proficiency.

O.R.'s running showed limites stride length determined by a hip flexion pattern in his movement.

His balance in standing was poor. He continued to demonstrate hip flexion in standing, and was unable to sustain his weight on one foot.

Balance on the balance beam was poor, showing hip flexion and trunk instability. There was internal rotation of the lower extremities. O.R. had difficulty keeping his balance on the narrow base of the balance beam.

O.R. had difficulty following the complex instructions required for bilateral motor coordination. His performance consisted largely of undifferentiated movement.

The jump and clap, and jump and touch heels tasks was poorly performed and O.R. tended to lose his balance in jumping.

Sit-ups were poorly executed and demonstrated O.R.'s poor abdominal strength and muscle tone.

Push-ups showed poor shoulder strength and stability, and inability to maintain his hips in extention. O.R. used his hip flexion to approximate task performance.

Ball skills of catching, throwing and targetting were immature and unsuccessful.

Sequenced finger opposition was hesitatnt initially, but became more integrated after the initial unsuccessful attempts.

APPENDIX K

SUBJECT #3: CASE HISTORY

APPENDIX K

Subject #3: Case History

Name: I.R.
Date of Birth: October 18, 1977
Chronological age: 8.7 years

This boy's first language is Yugoslavian, and he has had extensive medical investigations for severe psoriasis and severe otitis media.

He is the youngest son of four children and has three older sisters. The family is under financial strain and the father is presently working in Australia as he was unable to find employment in Vancouver. The oldest daughter has been apprehended by the Ministry of Human Resources (MHR) for alleged abuse and has been placed in a foster home. Mother is described as anxious and well intentioned.

I.R. did not attend pre-school and had a limited exposure to kindergarten because of significant absenteeism (44 days) for his various somatic complaints. He was assigned to Grade 1, even though his readiness was very low.

He has been followed carefully by the Hearing Disorders Clinic at B.C. Children's Hospital, as well as by the psychological and speech and language services at the Vancouver School Board (VSB). Hearing testing at the Western Institute for the Deaf (WID) on November 25, 1982 revealed a mild conductive hearing loss. He was referred for an Ear, Nose and Throat (ENT) consultation, and he diagnosed an otitis media. The family did not follow up on the recommendation for a hearing re-evaluation at WID.

His Grade 1 year (September 1983) was a difficult one as his academics were affected by poor auditory and visual memory, receptive and expressive language delay, his English as a second language (ESL) background, immature fine and gross motor delay and a fluctuating hearing loss.

The initial psychological assessment at a chronological age of 5.10 years (VSB, September 8, 9, 1983) described a child who had difficulty following instructions, participating in class discussion, had poor coordination in craft activities, was socially immature and depended on his parents to do his dressing for him.

No problems with behavior were reported and he apparently got along well with his peers.

Testing on the Weschler Preschool and Primary Scale of Intelligence (WPPSI) indicated borderline verbal skills and performance skills at the top of the low average range. It was noted that the child's ESL background would affect the verbal and full scale results on the WPPSI and should not be considered to be indicative of the child's potential. Performance scores may also have been lowered by the boy's difficulty in understanding complex directions in English.

The lowest subtest score was on Animal House (5%^{ile}) reflecting diminished visual motor coordination and the highest subtest score was seen on Picture Completion (84%^{ile}), which requires minimal motor coordination and measures "detail noting of information recognized from a visual format".

Performance on the Developmental Test of Visual Motor Integration (VMI) placed I.R. at the 3rd%^{ile} with an age equivalent of 4.1 years, while the Test of Motor Free Performance (MVPT) placed him at the 70%^{ile} with an

age equivalent of 6.2 years. These results indicated adequate visual perception with fine motor pencil control problems and difficulties with visual motor integration. The Coloured Progressive Matrices placed I.R. at the 90th%ile (although this was converted to the 70 to 70%ile for B.C. norms), which indicated good visual processing.

Peabody Picture Vocabulary Test (PPVT-R) placed I.R. at the 3%ile with an age equivalent of 3.11 years and the vocabulary subtest of the WPPSI was at the 9th%ile.

The Brigance Kindergarten Grade 1 Screening indicated weakness in reading readiness.

The boy was referred for speech and hearing assessment (September 21, 22, 1983, Vancouver School Board) to determine the origin of his language difficulties and to rule out any hearing problems.

At that time, the mother reported a normal birth history and motor milestones. He began speaking single words at nine months and combining two words at 18 months. Sentences were spoken by three years of age. Yugoslavian is spoken in the home and the child had limited exposure to English prior to his public school experience.

The oral peripheral exam (VSB assessment, September 1983) found adequate tongue and lip movement for speech sound production, although the boy found it difficult to raise his tongue tip. The examiner noted "mouth breathing and a frontal tongue position with tongue thrust and large tonsils being evident".

Testing of articulation (Goldman Fristoe Test of Articulation) showed inability to imitate /t/, /ch/, /dz/, /j/, although the articulation errors were inconsistent when I.R. was asked to repeat.

The examiners also noted that he chose associated responses for words he could not recall (kitchen for stove, smoke for pipe).

Language testing was done with the following assessments, and the results are noted below.

Peabody Picture Vocabulary Test (PPVT-R) Placed I.R. at the 3rd%ile for the English population.

The Illinois Test of Psycholinguistic Abilities (ITPA) subtest of Auditory Association scored below the mean (standard score of 17 with average range of 36±6) showing difficulty relating oral concepts (i.e., Grass is green, sugar is _____).

The Test for Auditory Comprehension of Language (TACL) found the child's English vocabulary and grammar to be 1.8 years below his chronological age and he was found to have difficulty with adjectives, verbs and prepositions.

The Boehm Test of Basic Concepts placed I.R. at the 3rd%ile for beginning Grade 1 English students and he showed difficulty with concepts of quantity and number.

The List of Language Development (TOLD) showed a below average performance. The mean range for subtest scores is 10±3. Picture Vocabulary (a measure of receptive vocabulary) scored at 6, oral definition of English words scored at 6, Grammatic Understanding scored at 1, Sentence Imitation scored at 8 and Grammatic Closure (completing a sentence with correct grammatical form) scored at 10.

I.R. required a long response time, gave limited responses and little information.

The examiner reported that informal assessment of expressive language showed use of simple sentences with few complex structures. There were grammatical errors in sentences and inappropriate responses to questions. It was difficult at that time to determine if the ESL background, hearing or lack of understanding was the basis for the extra time required to process and produce responses.

The boy did not provide basic information regarding his age, birthday and address.

He was unable to sequence simple picture stories and word recall difficulties were evident in spontaneous speech.

The Carrow Auditory Visual Abilities Test (C.A.V.A.T.) showed weak auditory memory span and auditory sequential memory, although these findings may have been confounded by hearing difficulties.

I.R. scored a scaled score of 43 (mean 36±6) on the ITPA Auditory Sequential Memory subtest where he was able to repeat digit series in order of presentation. He was able to follow four-step directions (touch the wall, clap hands, etc.) but not always in order.

The examiner did not conclude whether there was a language delay above and beyond the boy's ESL background, but recommended that his progress be monitored further.

Recommendations at that time were:

"1. Language activities such as story telling in the home.

2. Classroom activities for vocabulary, spatial relationships, verbal expression and sequencing, concept knowledge (e.g. opposites), categorization skills (things that go together), auditory, sequential memory (following directions) and temporal concepts (before and after)."

Materials suggested were the Boehm Concept Kit, Language Remediation and Expansion (C. Bush), Of Course I Can, H.E.L.P. Vol. 1 and 2, and M.E.E.R.

No ongoing therapy intervention was recommended and it was suggested that the boy's progress be monitored by the School Based Team. Difficulties following directions in class secondary to vocabulary and memory problems were predicted and the suggestion was made to limit the number of directions and to use visual cueing with oral instructions. The school-based team were cautioned that I.R. required a "longer time to process information and to produce a response".

Further hearing assessment and monitoring at WID was also recommended as he had failed the audiometric screening.

I.R. was seen by a Vancouver School Board (VSB) Speech Pathologist who was fluent in Yugoslavian (October 3, 1983) and who found that the child understood Yugoslavian well, but preferred to respond in English within the interview situation.

A nurse's memo (November 16, 1983) to the Grade 1 classroom teacher stated that the child had a "mild bilateral hearing loss significant enough to affect school performance". It was recommended that he be seated at the front of the class and that he would require additional attention.

The boy was sent to Central Screening at the end of the Grade 1 year. A letter from the principal at his local school (April 10, 1984) recommended a small group situation as the boy is described as "easily distractible" and "a poor listener". School absenteeism had continued and I.R. was apparently very embarassed about his skin condition. Financial stress was affecting the emotional stability of the home environment.

The Grade 1 teacher's report (April 25, 1984) describes a child who could "not generalize or apply learning", had "erratic learning behaviors and lack of motivation to succeed in school".

He was cooperative, volunteering for classroom tasks and responded to praise and positive rewards, working well with cueing and constant attention.

The boy was below class level in reading (no letter names, letter sounds, inability to hear differences and similarities of letter sounds in rhyming words and math (counting and making numbers, learning arithmetic vocabulary: large, small, more, less, equal to) in the Math Their Way program.

The letters to Central Screening from the Area Counsellor (May 10, 1984) recommended a "better situation for next year where he could be nurtured academically, socially and emotionally to establish more readiness skills for successful school experience in the future".

It was felt that I.R.'s "strengths were masked by stress" and a "calm, small group setting with individualized teaching and ongoing assessment of acquired learning" with opportunity "for emotional support and development of self-esteem" would be optimal. Programming objectives were to include "language development usage and expression, gross and fine motor skills development, visual-motor coordination activities and continuation in a general readiness program".

I.R. was referred to an Observation Class.

On April 13, 1984, I.R. was reviewed by a team of the Hearing Disorders Program at B.C. Children's Hospital (BCCH). He was 6.5 years old.

A review of the medical history indicated that I.R. had been hospitalized for one month in Grade 1 (January 10, 1984 to February 10, 1984) for treatment of severe psoriasis under the care of a dermatologist. He had been on medication since November 1983 (otic drops of Cholemycin three times per day) for external otitis.

At that time, he had been seen for a hearing assessment and a borderline conductive hearing loss was noted in the right ear with normal hearing on the left.

Reassessment by the speech and language pathologist at BCCH found a mild bilateral hearing loss with a "significant air bone gap". Speech reception thresholds were 25 db on the right and 30 db on the left. Speech discrimination was 92% on the right and 80% on the left. Impedance measurement showed "reduced eardrum mobility and absent reflexes, suggestive of conductive involvement".

Because of previous assessments, a brief speech and language evaluation was carried out. I.R. was found to follow simple directions, having difficulty with complex and abstract material.

PPVT-R score showed an age equivalent of 4.6 years, which was "moderately low for his age" and placed him in the 8%^{ile}, an improvement from previous testing.

The Test of Early Language Development showed "strengths in repeating sentences, understanding of simple paragraphs" and "weakness in sentence completion or relating concepts meaningfully". Results showed an age equivalent of 5.2 years with scatter.

Visual subtest of the ITPA were administered with the following results:

	Age Equivalent	Standard Scores
Visual Reception	5-10	31
Visual Association	6-10	41
Visual Memory	5-10	34

The average range for standard scores is 36±6 and all of these subtests fell in that range.

In spontaneous speech, I.R. was able to use long sentences with grammatical errors "characteristic of ESL" speakers. For example, "You open the light. A fireman has a hose. He got fire in the house. He get fire out."

Tongue movements were found to be poor, continued difficulty with tongue tip control and poor fine oral motor control was noted.

The psychologist carried out on an abbreviated assessment since he had had a complete assessment done by the school board psychologist in September 1983. The referral was for "assessment of skills in a child with mild bilateral hearing loss, conductive in origin".

The psychologist agreed with the previous VSB assessment and noted that the child "lacked familiarity with numerous age appropriate toys" and wondered if this formed the basis for his delay.

I.R. continued to demonstrate "poor academic readiness for his age", "matched letters by form, not by name", showed "little correspondence counting to 12 with random sequencing beyond that", had difficulty with the concept of 'more' and trouble with addition and subtraction. He was able

to recognize numbers from one to ten. He had "specific difficulty in many fine motor areas."

The examiner noted that the child had the flu and was "feverish and tearful, his intelligibility interfered with by missing front teeth".

The Draw-a-Person task was scored at the three year old level and "head and legs attached directly and minimal facial detail". The drawing was constricted and the examiner noted that this finding could be associated with anxiety.

I.R. was unable to print his first name and traced it with poor control. He used his right hand for printing and demonstrated correct pencil grip.

Results from the Leiter International Performance Scale which measures non-verbal conceptual development gave a score in the average range with a mental age of 6.0 years. This was felt to be a "minimal estimate of non-verbal potential secondary to illness, poor effort and concentration and cultural bias". I.R. passed all test items at the five and six year old level and none at the seven year old level.

The team conference was attended by the community health nurse (CHN), the speech language pathologist and psychologist from the VSB and the MHR worker, as well as the Hearing Disorders Program Team.

The VSB team reported that although I.R. attended the Learning Assistance Centre (LAC) daily, he was falling behind his classmates and required individual help. He had difficulty grasping information in a group setting and the amount of LAC help was felt to be insufficient. Preferential seating in a small group setting was advised.

The medical impression described an anxious boy with severe psoriasis, the management of which the family found difficult.

He was functioning in the average range non-verbally "with specific weaknesses in language and fine motor areas, and limited exposure to readiness activities basic facts".

The psoriasis had been complicated with external otitis leading to accumulation of material in the ear canal, with resultant fluctuating hearing loss. There was delayed speech and language which was showing slow improvement.

A letter to the Head of Student Service, VSB, from the classroom teacher of the observation class (March 21, 1985) suggested school placement for the following year in an "age appropriate LAC class with a supportive teacher and ongoing monitoring of academic, medical and emotional development".

The teacher noted that the mother was excessively concerned with neatness and had, on several occasions, sent the boy to school wearing a three-piece suit.

He was "still at a beginning Grade 1 level", and despite "daily multi-sensory activity" and was still not clear on the alphabet.

His printing had improved and he had a total of 18 sight words in reading. He was able to do "addition and subtration combinations up to ten".

The School Based Team (SBT) Report (June 12, 1985) found I.R. to be working at the early Grade One level. He was "unsure of alphabet names and sounds", and was working at level 2 of the Ginn 360 program. Math was "adequate" at the first grade level, printing was clearer, although he had

difficulty with spacing between words. He was described as distractible and quick to "check out the action in the hall".

Mother was trying to be positive but troubled by diffuse anxiety, being "concerned about the boy drowning during class swimming period".

The SBT report included Individualized Educational Plan (IEP) planning.

APPENDIX L

SUBJECT #3: DATA: BLOCK SEQUENCING TASK

APPENDIX L

Subject #3: Data: Block Sequencing Test

Day #	Baseline (A_1)	Intervention (B_1)	Baseline (A_2)	Intervention (B_2)
1	2	20	29	17
2	3	32	26	35
3	3	24	22	30
4	3	24	27	28
5	2	29	27	22
6	1	35	27	28
7	20	24	28	30
8	20	26	29	32

APPENDIX M

SUBJECT #3: TEST RESULTS

APPENDIX M

Subject #3: Test Results

Tests Administered

1. Bruininsks Oseretsky Test of Motor Proficiency.
2. Developmental Test of Visual Motor Integration (VMI).
3. Durrell Reading Analysis.

Test Results

1. Bruininsks-Oseretsky Test of Motor Proficiency.

A battery of subtests to assess motor functioning. The mean of the standard scores is 15 with a standard deviation of 5. The composite standard score mean is 50 with a standard deviation of 10.

Gross Motor Subtests	Standard Score	%ile rank*
1. Running Speed and Agility	5	
2. Balance	1	
3. Bilateral Coordination	6	
4. Strength	16	
Gross Motor Composite	27	1%ile
5. Upper Limb Coordination	11	
Fine Motor Subtest		
6. Response Speed	2	
7. Visual Motor Control	15	
8. Upper Limb Speed and Dexterity	12	
Fine Motor Composite	35	7%ile
Battery Composite	32	4%ile

2. Developmental Test of Visual Motor Integration

A sequence of geometric forms to be copied with pencil on paper.

Standard scores have a mean of 10 with a standard deviation of 3.

Standard Score:	4
%ile Rank*:	3%ile

3. Durrell Reading Analysis

An assessment of ten areas of reading ability.

	Grade Level
Oral Reading	Low Grade 1
Silent Reading	Low Grade 1
Listening Comprehension	Low Grade 2
Listening Vocabulary	Low Grade 2
Word Recognition	Mid Grade 1
Word Analyses	Mid Grade 1
Spelling	Low Grade 1
Sounds in Isolation	Low Grade 1
Visual Memory of Words	Mid Grade 1
Sounds in Words	Low Grade 1
Pre reading Phonics Abilities Inventories:	A

*A percentile range (%ile) indicates the percentage of the age peers scoring at or below the subject's test score.

APPENDIX N

SUBJECT #3: CLINICAL OBSERVATIONS

APPENDIX N

Subject #3: Clinical Observations

Day: B1#1

(IR stares sternly at the screen.)

LMS: 'Have you worked on the computer before?'

IR: 'Yep.'

LMS: 'Can you show me how to write on this computer?'

IR: 'Yep.' (Presses 'W' and the write menu appears. He presses 'W' again and presses #4 and the writing format appears on the screen. Still sitting with a very straight back, staring sternly at the screen.)

LMS: 'Thank you! What does this word say?'

IR: 'Red.'

LMS: 'You're right. Make a whole line of 'RED's, please.'

IR: (Complies, showing knowledge of letter key location. He initiates with the right hand, responds immediately to tactile cueing and switches to the left hand. Shows correct use of spacebar and 'return'.)

LMS: 'What does 'red' mean?'

IR: 'Red is a color.'

LMS: 'Would you put it into a sentence, please?'

IR: 'I am red.'

LMS: 'Say the next word.'

IR: 'FED.' (Says 'fe-duh', emphasizing the last letter sound, and types a complete line without further verbal instructions and presses 'return'. Uses left hand after one cue.)

LMS: 'The next word says . . .'

IR: 'LED.' ('Le-duh', and types complete line, using both hands after one tactile cue to do so, and presses 'return'.)

LMS: 'The next word says . . .'

IR: 'WED.' (Stops emphasizing the final letter, making errors in letter by selection between 'B' and 'D', laughing as his errors show up on the screen, and using the directional arrows to correct his mistakes. He completes a correct line with the left hand and presses 'return'.) 'BED.' (Going on to the next word by himself.)

LMS: 'What does 'bed' mean?'

IR: 'Bed we sleep in?'

LMS: 'Can you put 'bed' into a sentence, please?'

IR: 'I am a bed.' (Laughs) 'I sleep in a bed.' (Types complete line with left index finger without cueing and presses 'return'.) 'What are these dots?'

LMS: 'The right hand types on this side of the line and the left hand types on that side of the line.'

IR: (Laughs and reads ahead.) 'Ted had a red bed.' (Goes ahead to type and makes an error - 'Ted had a red Ted', which he corrects. Tactile cueing for 'H' brings right-handing response and initiates with left hand for all other letter keys. Presses 'return'.)

LMS: 'You're a fast worker. Type the sentence again, please.' (IR complies.) 'Now you can print your work.' (IR moves swiftly through the print sequence, becoming stern again, stands up and leaves abruptly.) 'Thanks for your good work. See you tomorrow.'

Discussion

IR was quite familiar with the word processing package and was quite a successful 'hunt and peck' typist using his right hand. He responded automatically to tactile cues for left hand use.

Phonetic emphasis on the final letter of each word may have reflected his classroom work in reading.

IR tended to rush through the lesson, keeping ahead of the tutor. He seemed anxious to please, trying on various affects (e.g., sternness and

then laughing at his own mistakes). This may have reflected underlying anxiety.

His approach to sentence completion tended to be stereotypical ("I am a ....."") but he was able to recognize and correct errors in language ("I am a bed. I sleep in a bed.).

The handwritten sample was neat and well spaced. IR used uppercase letters for 'had' and 'red', but did not initiate 'bed' with an uppercase letter.

Day: B1#8

IR: (Seats himself at the computer, sets up writing format on word processor independently.) 'Gum.'

LMS: 'What's that?'

IR: 'You chew it.'

LMS: 'Use 'gum' in a sentence.'

IR: 'I chew gum.'

LMS: 'Which hands are you going to use?'

IR: (scrutinizes the keyboard) "G" with this one (indicates left index). "And then this one" (indicates right index). Types rapidly using two hands with swift transfer between 'u' and 'm' in the 'um' sequence. Presses return. 'Hum'.

LMS: 'What's that?'

IR: 'Humming: m-m-m.'

LMS: 'Yes! Use it in a sentence.'

IR: 'I hum.' (Types all letters with right hand without direction and presses return.)

IR: 'Bum.'

LMS: 'Yes. What does it mean.'

IR: 'You mean like a street bum?'

LMS: 'That's a meaning for bum. Use it in a sentence.'

IR: 'I am a street bum.' (Grins) (Types with appropriate fingering and rapid shift on the 'um' sequence, presses return.) 'Dum.'

LMS: 'Look again.'

IR: 'D-r-um. Drum. A drum what you go in a parade.'

LMS: 'And a sentence?'

IR: 'I am a drum' (smiles).

LMS: 'Decide what hands to use.'

IR: (Types correctly with rapid sequence on both hands, presses return.) 'Plum, a plum what you eat. I eat a plum.' (Types rapidly and correct hand use, and presses return, surveys his work.)

'That 'g' looks like a nine.'

LMS: 'They look a bit the same, don't they?'

IR: 'Keep the gum on the dr-um.' (Types the entire sequence diligently with proper hand use, presses return and types it again. Carries on with word processor commands and prints his copy. The recess bell rings and he is gone.)

Discussion

IR is able to locate letter keys quickly and chooses correct fingering, carrying this on throughout the line of the word. He is familiar with the word processor control keys, command sequences and spacing. He is able to use both hands at the keyboard once he decides which hands to use. He types four letter and three letter sequences with equal facility.

He seems unfamiliar with blends and remembers on the next trial within the context of the lesson. Sentence structuring with concrete style persists (I am a drum).

The handwritten sample shows well spaced words with some crowding on letters within words. A capital 'K' is superimposed over a lower case 'c' at the beginning of the word 'keep'. Lettering is slightly erratic.

Day: B2#1

IR: (Reads right through the 'Write to Read' card.) 'DEN, TEN, PEN, MEN, HEN.' (Smiles with satisfaction. Continues into word processing commands and sets up writing format, looks at first word.) 'Den.'

LMS: 'You're going quickly today, IR. You really know your work.'

IR: (Smiles in response, eyes rivetted to the screen.) 'A den is like a cabin and you live in it.'

LMS: 'Can you use den in a sentence?'

IR: 'We live in a den.' (Starts to type using appropriate hands and spacing intervals, continues without error to the end of the line and presses return.)

'Ten. I am ten feet.' (Smiles)

LMS: 'I am ten feet?'

IR: 'I have ten feet.' (Big smile. Types correctly using appropriate hands, spacing intervals, continues without error and presses return.)

'Pen.'

LMS: 'What's that?'

IR: 'You can write of it?'

LMS: 'You can write with it. How about "pen" in a sentence?'

IR: 'I write with a pen.' (Types without error, with correct spacing and presses return.) 'Men, like two men.'

LMS: 'Sentence?'

IR: 'Two men were wrestling?' (Grin. Proceeds to type at a rapid automatic rate, use of directional arrows and space bar to correct spacing error, correct finger use and return.)

'Hen. A hen is a pet, like a farm hen, an orange hen.'

LMS: 'Good! Use it in a sentence.'

IR: 'The hen is on the farm.' (Types without error and presses return.)

LMS: 'Here's the sentence.'

IR: 'Ten men..... k.... k.' (Stops in confusion.) 'What's this word?'

LMS: 'Chased.'

IR: 'Chased the hen into the pen.' (Types initiating with shift T and continues with correct hand use. Uses directional arrows and space bar for spacing errors, types the sentence a second time and goes through sequence to print without error.)

LMS: 'You remembered everything, IR!'

IR: (Smiles)

Discussion

IR had retained all of the information related to word processor sequences, hand use, capitalization and punctuation.

He typed rapidly and quickly, corrected the spacing errors he made as a result using the more complex system of directional arrows and space bar.

He was able to read the entire word list, but was unable to decode 'chased', but did not generalize it into the word family format.

He still used some concrete sentence structures 'I am.....' when asked to use a word in a sentence, but was able to correct incorrect syntax when it was repeated back to him and may have recognized his error before the repetition, smiling as a result of his error. He was able to move away from 'I am a....' sentence structure. (Two men were wrestling.)

The handwritten sample is neat, legible and well spaced.

Day: B2#8

IR: (Reads right through 'Write to 'Read' list.) 'STOP, HOP, TOP, POP, MOP. Can Pop hop .... Oliver the mop? Does that say Oliver?'

LMS: 'It says 'over', o-ver.' (Points to word.)

IR: 'Over the mop. Oliver. Ha-ha!' (Grins to himself and initiates first word.) 'STOP.' (Begins to type using one-handed approach with the right hand.)

LMS: (Places physical barrier onto board.) 'Use two hands, IR. You can do it.'

IR: (Complies, grinning widely and types the rest of the line rapidly and accurately, with correct spacing and presses return.)

LMS: 'What does 'stop' mean?'

IR 'Red light.'

LMS: 'Can you use the word 'stop' in a sentence?'

IR: 'We stop at the red light.'

LMS: 'Great sentence, IR. What about the next word?'

IR: 'Hop. Like you jump. A rabbit can hop.' (IR is going rapidly now and making spacing errors. He chooses initially to delete the entire word instead of using the directional arrows and the space bar.)

LMS: 'Take your time, IR. Look at your work and use the arrows, please.'

IR: (Continues at frenetic pace, using right index appropriately and making no further errors.) 'Top. A top like you spin?'

LMS: 'You can spin a top, and you put it on top of a table.'

IR: (Makes eye contact with LMS and smiles.) 'A top can go on top. That's my sentence.' (Types accurately, and left and right index fingers, and using directional arrows and space bar to correct spacing errors. He does not make any targetting errors or reversals. Presses return.)

LMS: 'Good work. How about the next word.' (Removes physical barrier.)

IR: 'Pop, like a balloon or your dad.'

LMS: 'What kind of sentence can you make using the word 'pop', IR?'

IR: 'A balloon can go pop.'

LMS: 'Good one! Keep going.'

IR: 'Mop. What you clean the floor.'

LMS: 'You clean the floor with a mop.'

IR: (Types letters accurately with right hand appropriately used. Some spacing errors occur. IR impulsively hits the space bar before he removes the cursor out of the word.) 'Delete. Arrows.' (Use of verbal mediation to problem solve, continues to the end of the line and presses return.)

LMS: 'What does the sentence say?'

IR: 'Can Pop hop Oliver the mop. Ha-ha. Can Pop hop over the mop.' (Grinning from ear to ear, most amused by his Oliver joke.)

LMS: 'You're very funny today, IR.'

IR: (Breaks into giggles, regains control and begins to type. Spontaneously prefers one-handed approach with right index.)

LMS: 'Keep trying with two hands, IR.' (Indicates visual barrier of red dots.)

IR: (Self corrects without difficulty and does not cross line gain. Uses SHIFT-C function for 'can', but is unsure about Shift-P for Pop.) 'Shift-P?'

LMS: 'Pop is the man's name. You need a capital.'

IR: (Completes sentence, presses return.) 'Now you time me. Go!'

LMS: 'Try not to rush. Do your best.'

IR: (Rushes through the sentence a second time, forgetting a capital 'P' for 'Pop'. Recognizes his own error and, uses directional arrows and space bar to correct it. Presses 'return' and proceeds through word processor sequence without error.) 'I went fast today.'

LMS: 'You're a hard worker, IR.'

Discussion

IR still prefers to use a one-handed approach although he is very capable of using two hands. He can use the word processing functions very well, although he has begun to make spacing errors in his quest for speed. He does not make targetting errors and can correct his spacing errors readily.

IR has attached great importance to speed of output, although this was not emphasized by LMS.

He does not attempt to decode words, but makes approximations based on a quick appraisal of the beginning and end of the word (Over = Oliver).

IR has begun to show more spontaneous affect and has diversified into a variety of sentence formations, moving away from 'I am a....' to 'A balloon can go pop,' 'You clean the floor with a mop.' He still tends to stay with one form, however. "A rabbit can...., a balloon can...., a top can....) He seemed to enjoy the two applications of the word 'top' and came up with two meanings for the word 'pop' by himself.

He understands the concept of capitalization at the beginning of a sentence, but faltered with the capitalization of a word in the middle of the sentence, not being sure of the rule and perhaps being rigid about the sentence format from previous examples, which generally do not have capitalized words in mid-sentence.

He is proud of his ability for speed and independence in sequencing word processor commands. He uses verbal mediation to problem solve spacing errors.

The handwritten sample shows slightly erratic lettering with adequate spacing between words. He omitted the capital 'P' in 'pop' and did not recognize his error when asked to visually inspect his handwritten sample.

APPENDIX O

SUBJECT #3: MOTOR SKILLS: VIDEO DISCUSSION

APPENDIX O

Subject #3: Video Discussion

These motor skills were selected to show balance, bilateral motor coordination, movement patterns, eye/hand coordination and fine motor sequencing. The skills were based on selected subtests of the Bruininsks-Oseretsky Test of Motor Proficiency.

I.R. showed adequate standing balance on one foot when standing on the floor, with good hip stability. He had more difficulty when standing on the narrow base of the balance beam, using trunk rotation and compensatory arm movements to try to keep his balance.

Heel-toe walking on the floor and on the balance beam showed some task success.

I.R. was able to coordinate the arm and leg of the same side of his body in bilateral motor coordination tasks, but was unable to coordinate opposite sides of his body.

Jumping tasks were attempted, but quality of performance was poor.

I.R. was unable to lift his hips off the ground during push-ups, and shoulder strength was weak.

Sit-ups were performed adequately, showing good abdominal flexion.

Ball skills were adequate for bounching and catching with two hands. Catching the ball with one hand was not performed successfully, and I.R. tended not to attempt to catch balls which did not come directly to him, indicating a lack of ability to shift his weight laterally.

Targetting was poor, showing poor eye/hand coordination.

Running performance was adequate with alternating arm swing showing body coordination.

Thumb-finger touching was accurate and precise bilaterally.

APPENDIX P

SUBJECT #1: OUTPUT SAMPLES

C.M.
8, #1.

RED RED RED RED RED RED RED RED RED RED

FED FED FED FED FED FED FED FED FED FED

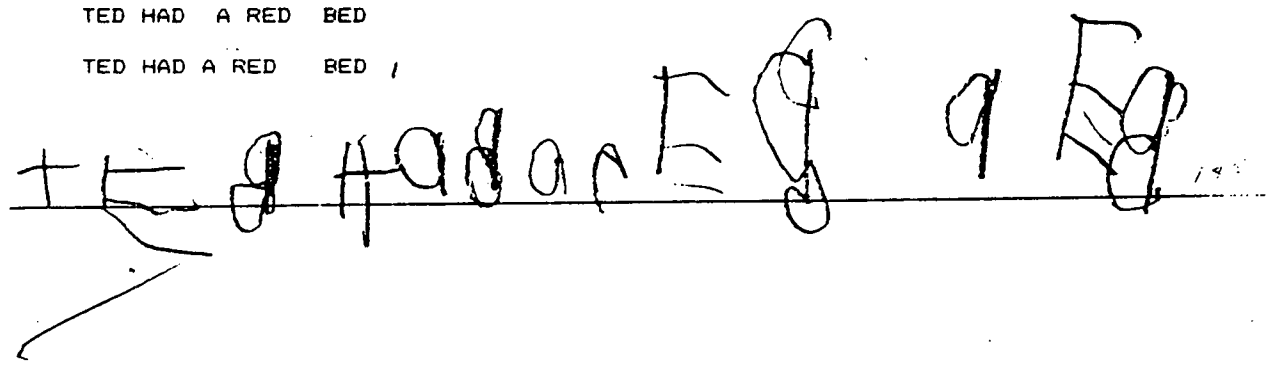
LED LED LED LED LED LED LED LED LED

WED WED WED WED WED WED WED WED WED WED

BED BED BED BED BED BED BED BED BED BED

TED HAD A RED BED

TED HAD A RED BED



C. M.
B, #2

did did did did did did did did did did

kid kid kid kid kid kid kid kid kid

lid lid lid lid lid lid lid lid

rid rid rid rid rid rid rid rid rid

hid hid hid hid hid hid hid hid hid bid bid bid bid bid bid bid bid bid

Sid hid the lid .

Sid hidthe lid. 1:1D
1 mor.

Sid hid the lid 100

C.M.
B, #3

dud dud dud dud dud dud dud dud dud

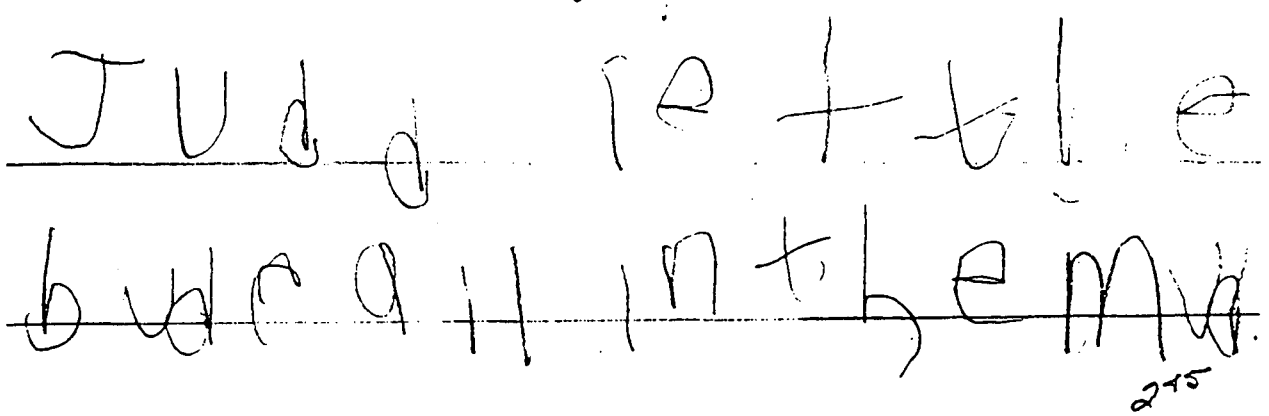
cud cud cud cud cud cud cud cud cud

bud bud bud bud bud bud bud bud bud

mud mud mud mud mud mud mud mud mud

Judd let the bud fall in the mud.

Judd let the bud fall in the mud. 205



CM
8, #4

rod rod rod rod cod cod rod cod cod

rod rod rod rod rod rod rod rod rod sod sod sod sod sod sod

sod sod sod sod

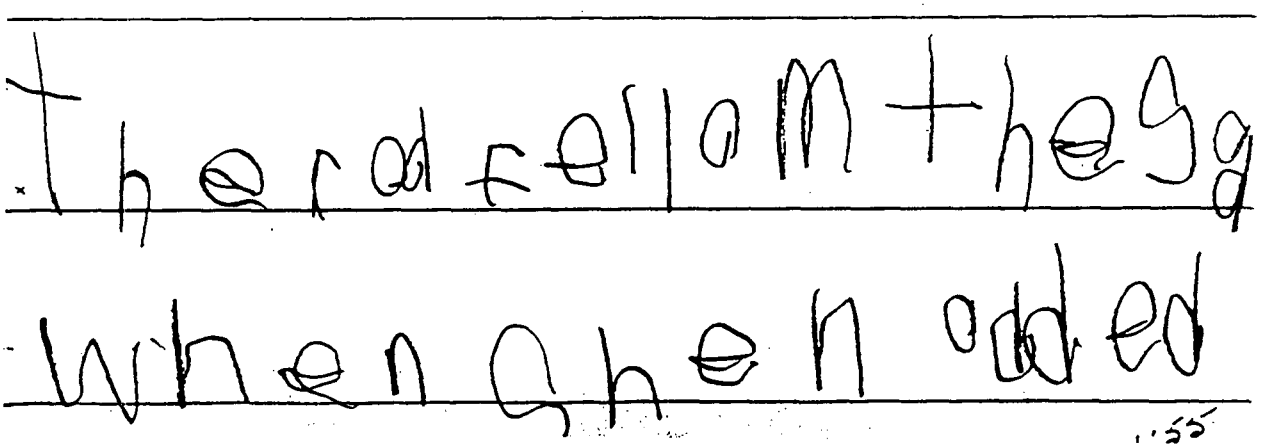
nod nod nod nod nod nod nod nod nod

nod nod nod nod nod nod nod nod

nod

The rod fell on the sod when she nodded

The rod fell on the sod when she nodded 2nd



CM
B, #5

DAD DAD DAD DAD DAD dad dad dad dad

fad fad fad fad fad fad fad fad fad fad

had had had had had had had had had had

mad mad mad mad mad mad mad mad mad

sad sad sad sad sad sad sad sad sad

bad bad bad bad bad bad badbad bad

A bad lad had a mad dad .

A bad lad had a mad dad . 3/15

A bad lad had a mad dad . 1/16

Pam saw the ram upset the jam.

1st

CM.
B, #6

jam jam jam jam jam jam jam jam jam

ham ham ham ham ham ham ham ham ham

ram ram ram ram ram ram ram ram ram tam tam tam tam tam tam

tam tam tam

yam yam yam yam yam yam yam yam yam

pam saw the ram upset the jam.

pam sawthe ram upset the jam. 2nd

CM
B, #7

dim dim dim dim dim dim dim dim dim rim rim rim rim rim rim

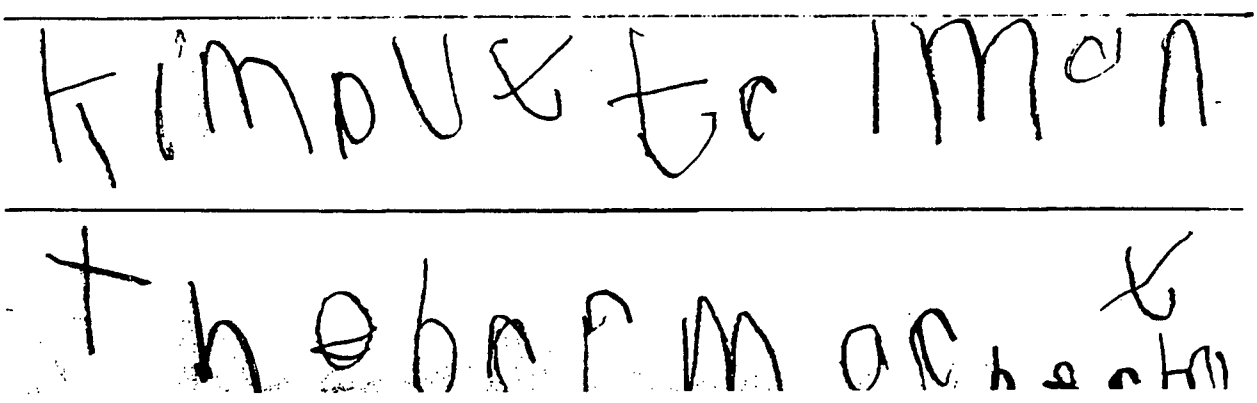
rim rim rim him him him him him him him him brim brim

brim brim brim brim brim trim trim trim trim trim trim trim

Kim put trim on the brim of her hat.

Kim put trim on the brim of her hat. 150

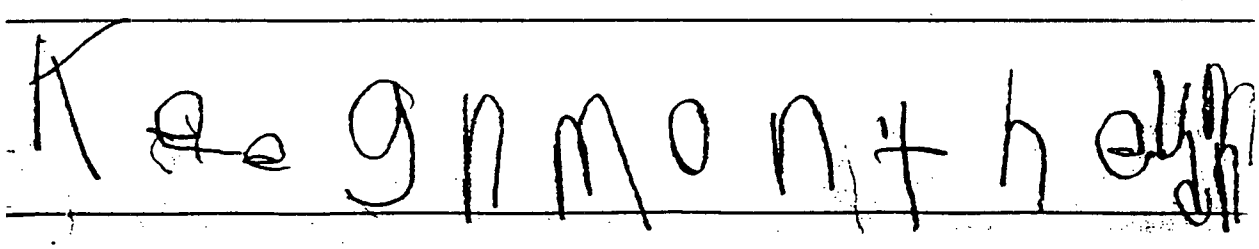
155



CM
B, #8

gum gum gum gum gum gum gum gum hum hum hum hum hum hum
hum hum hum
bum bum bum bum bum bum bum bum
drum drum drum drum drum drum drum plum plum plum plum plum
plum plum
Keep the gum on the drum.
Keep the gnm on the drum. 15

30



CM

B2 #1

den den den den den den den den den

ten ten ten ten ten ten ten ten ten

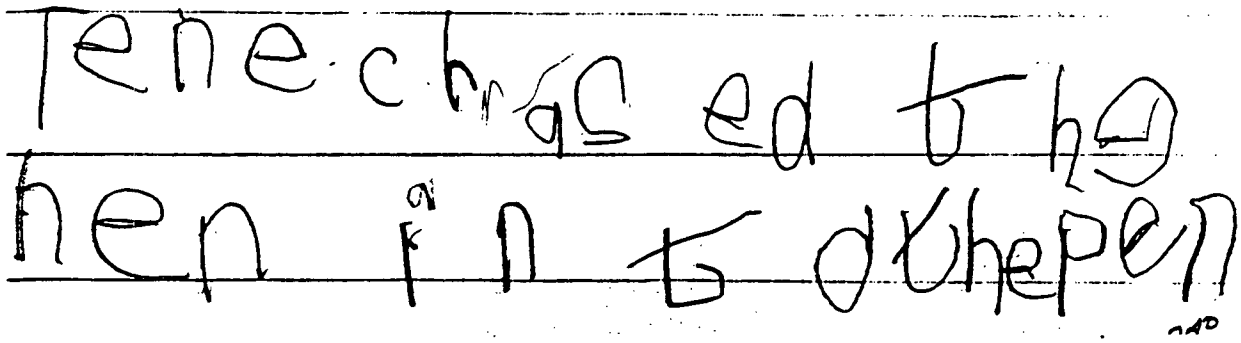
pen pen pen pen pen pen pen pen pen

men men men men men men men men men

hen hen hen hen hen hen hen hen hen

Ten men chased the hen into the pen.

Ten men chased the hen into the pen . 6 1/5



CM

B2#2

fin fin fin fin fin fin fin fin fin

pin pin pin pin pin pin pin pin pin

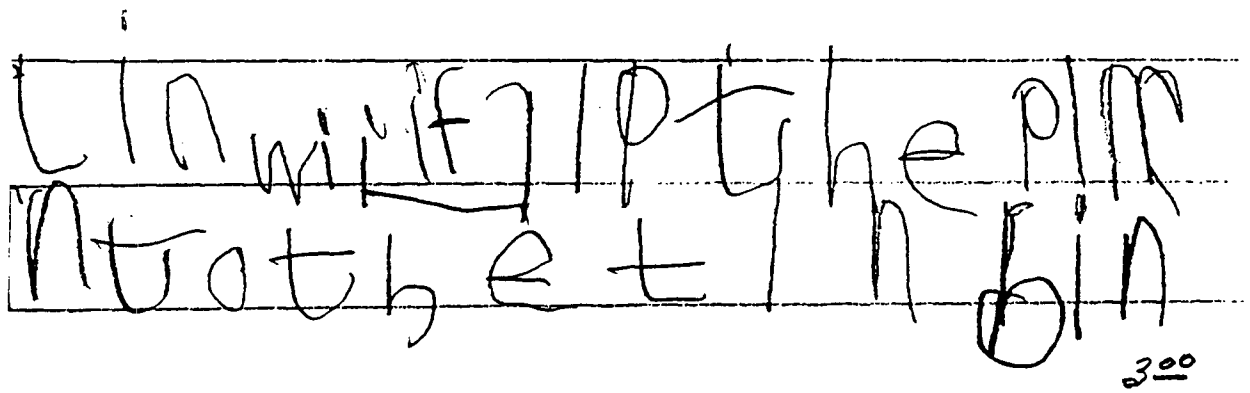
tin tin tin tin tin tin tin tin tin

win win win win win win win win win

bin bin bin bin bin bin bin bin bin

Lin will flip the pin into the tin bin.

Lin will flip the pin into the tin bin. 2:35



cm B, #3

fan fan fan fan fan fan fan fan fan

man man man man man man man man man

ran ran ran ran ran ran ran ran ran

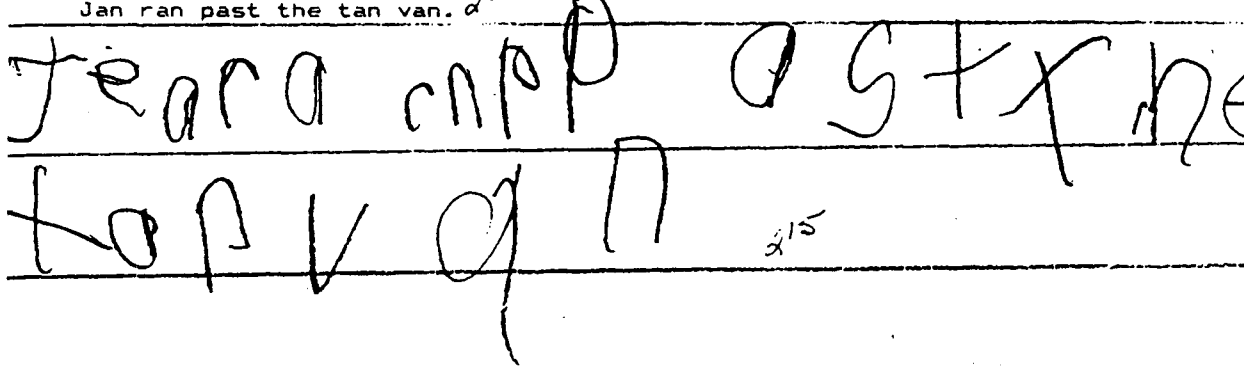
can can can can can can can can can

van van van van van van van van van

pan pan pan pan pan pan pan pan pan

Jan ran past the tan van.

Jan ran past the tan van. 2nd



B_2 #4 CM.

fun fun fun fun fun fun fun fun fun gun gun gun gun gun gun

gun gun gun

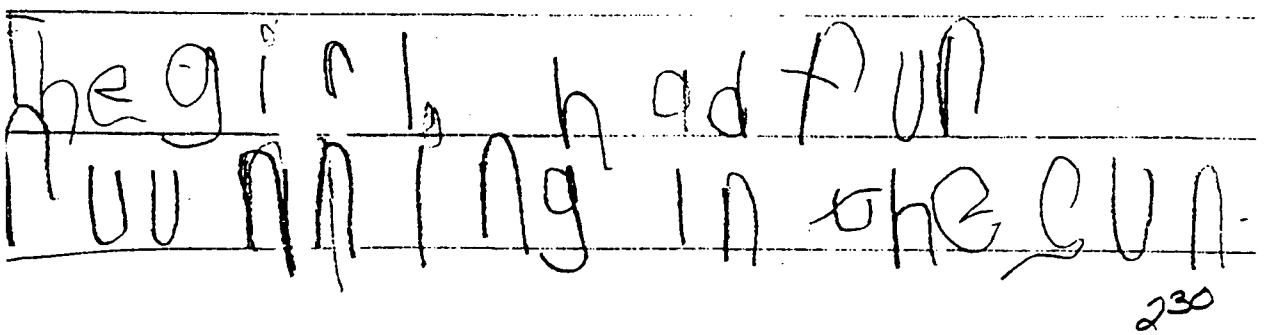
run run run run run run run run run

bun bun bun bun bun bun bun bun bun

sun sun sun sun sun sun sun sun sun

The girl had fun running in the sun .

The girl had fun running in the sun. 3 30



~~B~~ B♭5
CM

hat hat hat hat hat hat hat hat hat

pat pat pat pat pat pat pat pat pat

bat bat bat bat bat bat bat bat bat

vat vat vat vat vat vat vat vat vat

cat cat cat cat cat cat cat cat cat

Put the hat on the cat, Pat.

Put the hat on the cat, Pat. 140

Putthenatontheeat

DOT. 215

cm 6, #6

fat fat fat fat fat fat fat fat fat rat rat rat rat rat rat

rat rat rat

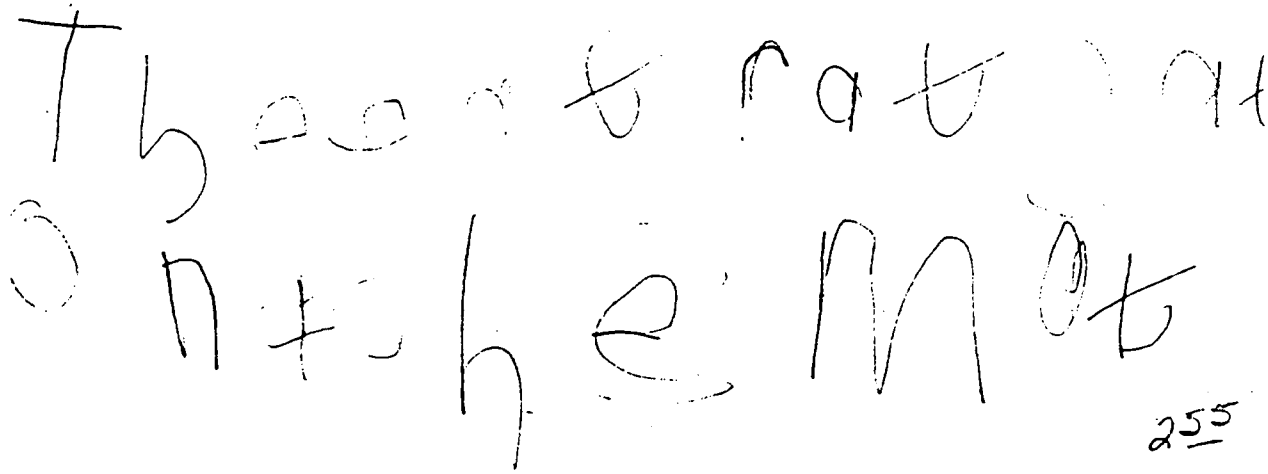
sat sat sat sat sat sat sat sat sat

mat mat mat mat mat mat mat mat mat

that that that that that that that

The fat rat sat on the mat.

The fat rat sat on the mat. 140



255

CVC Bg #7

dip dip dip dip dip dip dip dip dip

rip rip rip rip rip rip rip rip rip

tip tip tip tip tip tip tip tip tip

lip lip lip lip lip lip lip lip lip

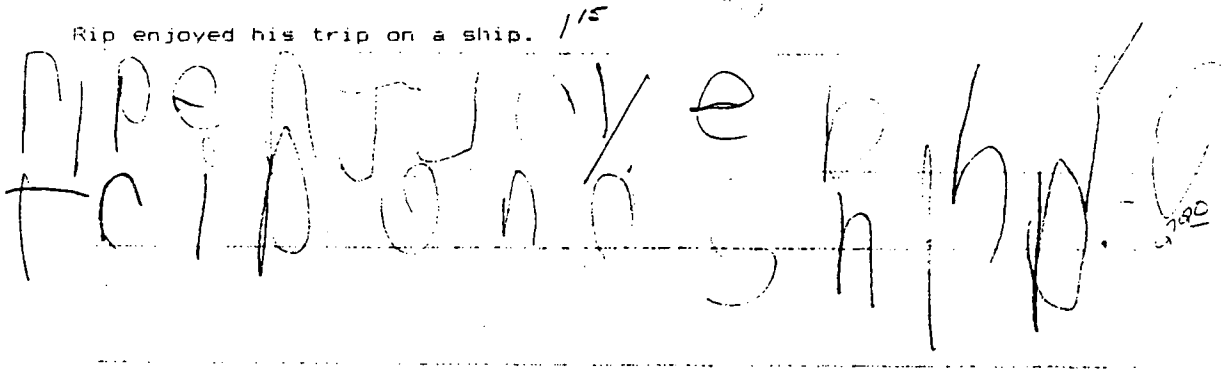
hip hip hip hip hip hip hip hip hip

ship ship ship ship ship ship ship

trip trip trip trip trip trip trip

Rip enjoyed his trip on a ship.

Rip enjoyed his trip on a ship.



stop stop stop stop stop stop stop

hop hop hop hop hop hop hop hop hop

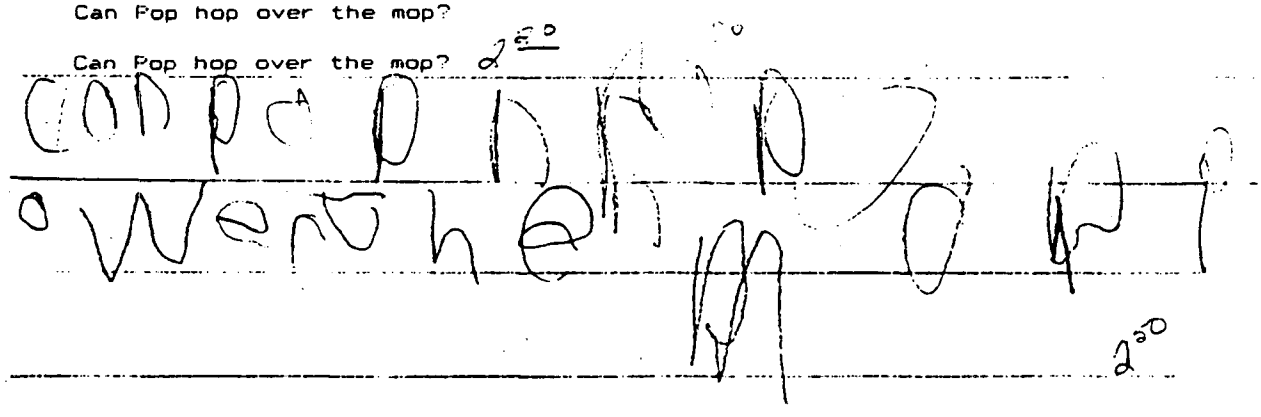
top top top top top top top top top

pop pop pop pop pop pop pop pop pop

mop mop mop mop mop mop mop mop mop

Can Pop hop over the mop?

Can Pop hop over the mop?



APPENDIX Q

SUBJECT #2: OUTPUT SAMPLES

OR
B, #1

RED RED RED RED RED RED RED RED RED

FED FED FED FED FED FED FED FED FED

LED LE D LED LED LED LED

WED WED WED WED WED WEDD

BED BED BED BED BED BED BED

TED HAD A RED BED

TED HED A RED BED. 2:05

TED HE DRED BED. 1:10

OR
B, #2.

did did did did did did did did did

kid kid kid kid kid kid kid kid kid

lid lid lid lid lid lid lid lid lid

rid rid rid rid rid rid rid rid rid

hid hid hid hid hid hid hid hid hid

bid bid bid bid bid bid bid bid bid

sid hid the lid.

sid hid the lid 1:20 1 error.

sid hid the lid 1:05

OR
B, #3

dud dud dud dud dud dud dud dud dud

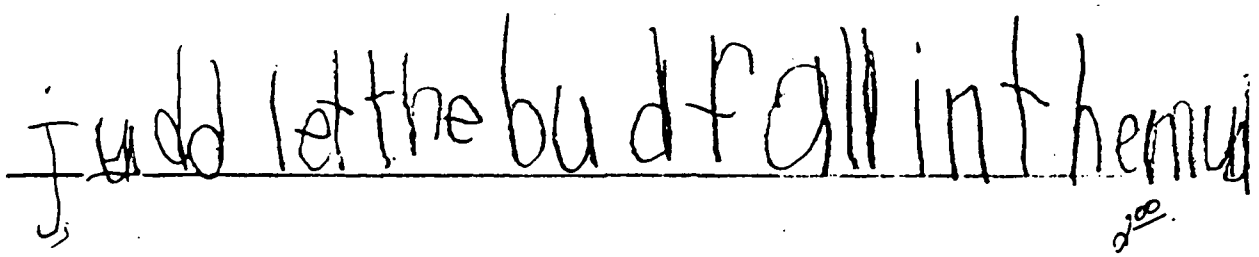
cud cud cud cud cud cud cud cud cud

bud bud bud bud bud bud bud bud bud

mud mud mud mud mud mud mud mud mud

Judd let the bud fall in the mud.

Judd let the bud fall in the mud. 1st



OR
B, #1

con con cod cod cod cod cod cod cod

rod rod rod rod rod rod rod rod rod

sod sod sod sod sod sod sod sod sod

bod bod bod bod bod bod bod bod bod

nod nod nod nod nod nod nod nod nod

The rod fell on the sod when she nodded.

The rod fell on the sod when she nodded. 3:05

the rod fell on the Sod When

She nodded. 2:25.0

OR
B, #5

dad dad dad dad dad dad dad dad dad

fad fad fad fad fad fad fad fad fad

had had had had had had had had had

mad mad mad mad mad mad mad mad mad

sad sad sad sad sad sad sad sad sad

bad bad bad bad bad bad bad bad badb

A bad lad had a mad dad.

A badlad had a mad dad . 3 1/2

A bad lad had a mad dad. 2 1/2

OR
B, #6

jam jam jam jam jam jam jam jam jam

ham ham ham ham ham ham ham ham ham

ramb ram ram ram ram ram ram ram ram

tam tam tam tam tam tam tam tam tam

yam yam yam yam yam yam yam yam yam

Pam saw the ram upset the jam.

Pamsaw the ram upset the jam. 1-15

Pamsaw the ram upset the jam

3-D.

OR
B, #7.

dim dim dim dim dim dim dim dim dim

rim rim rim rim rim rim rim rim rim

him him him him him him him him him

brim brim brim brim brim brim brim

trim trim trim trim trim trim trim

Kim put trim on the brim of her hat.

Kim put trim on the brim of her hat. 1:45.0

Kim put Trim on the

brim of her hat. 2:15.0

OR
B, #B.

gum gum gum gum gum gum gum gum gum

hum hum hum hum hum hum hum hum hum

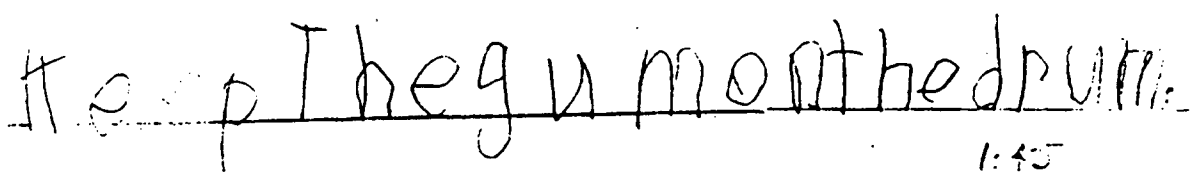
bum bum bum bum bum bum bum bum bum

drum drum drum drum drum drum drum

plum plum plum plum plum plum plum

Keep the gum on the drum.

Keep the gum onthe drum. 2:30



OK.
b_2 #1

den den den den den den den den den

ten ten ten ten ten ten ten ten ten

pen pen pen pen pen pen pen pen pen

men men men men men men men men men

hen hen hen hen hen hen hen hen hen

Ten men chased the hen into the pen .

✓ ✓ ✗ ✓ ✓ ✓
Ten men chased the hen into the pen. 2:25

Ten men chased the hen into the pen.

2 1/2

CIK
B2 #2

fin fin fin fin fin fin fin fin fin

pin pin pin pin pin pin pin pin pin

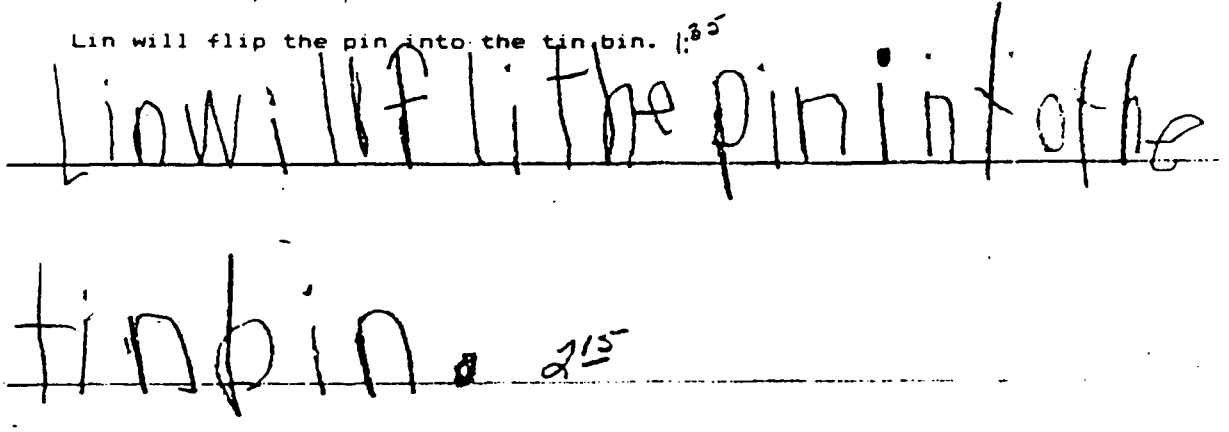
tin tin tin tin tin tin tin tin tin

win win win win win win win win win

bin bin bin bin bin bin bin bin bin

Lin will flip the pin into the tin bin.

Lin will flip the pin into the tin bin. 1:35



OR
b_2 #3

fan fan fan fan fan fan fan fan fan

man man man man man man man man man

ran ran ran ran ran ran ran ran ran

can can can can can can can can can

van van van van van van van van van

pan pan pan pan pan pan pan pan pan

Jan ran past the tan van .

Jan ran past the tan van.

Jan ran past the tan van.

OR
B #1.

fun fun fun fun fun fun fun fun fun fun

gun gun gun gun gun gun gun gun gun

run run run run run run run run run

bun bun bun bun bun bun bun bun bun

sun sun sun sun sun sun sun sun sun

The girl had fun running in the sun.

the girl had fun running in the sun . 300

The girl had fun running in the sun. 255

Ez #5.
OF

hat hat hat hat hat hat hat hat hat

pat pat pat pat pat pat pat pat pat

bat bat bat bat bat bat bat bat bat

vat vat vat vat vat vat vat vat vat

cat cat cat cat cat cat cat cat cat

Put the hat on the cat, Pat .

Put the hat on the cat, Pat. 10.

Put The hat on the cat, Pat. 165

OR Bg #6

fat fat fat fat fat fat fat fat fat

rat rat rat rat rat rat rat rat rat

sat sat sat sat sat sat sat sat sat

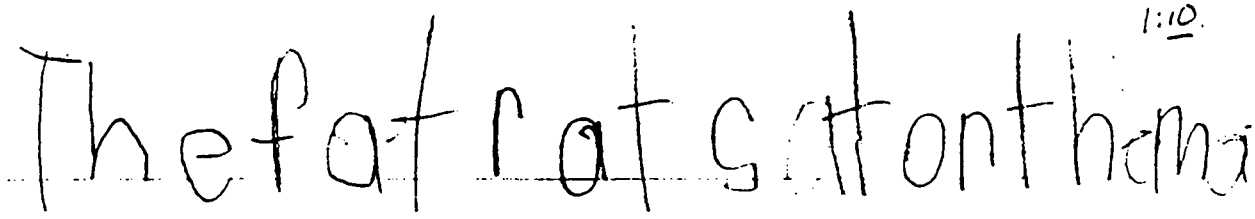
mat mat mat mat mat mat mat mat mat

that that that that that that that

The fat rat sat on the mat.

The fat rat sat on the mat. 1:5

1:10.



OR $B_2 = 1$.

dip dip dip dip dip dip dip dip dip

rip rip rip rip rip rip rip rip rip

tip tip tip tip tip tip tip tip tip

lip lip lip lip lip lip lip lip lip

hip hip hip hip hip hip hip hip hip

ship ship ship ship ship ship ship

trip trip trip trip trip trip trip

Rip enjoyed his trip on a ship.

Rip enjoyed his trip on a ship. 130

Ripenjoxed his trip on a ship 145

OR B_2 #8.

stop stop stop stop stop stop stop

hop hop hop hop hop hop hop hop hop

top top top top top top top top top

pop pop pop pop pop pop pop pop pop

mop mop mop mop mop mop mop mop mop

Can Pop hop over the mop.

Can Pop hop over the mop. 140

CanPop hop over the mop. 055

APPENDIX R

SUBJECT #3: OUTPUT SAMPLES

IR
B_1 #1

RED RED RED RED RED RED RED RED RED

FED FED FED FED FED FED FED FED FED

LED LED LED LED LED LED LED LED LED

WED WED WED WED WED WED WED WED WED

BED BED BED BED BED BED BED BED BED

TED HAD A RED BED .

TED HAD A RED BED. 5

TEd Had a Red bed 0:15

IR
B, #2

did did did did did did did did did

kid kid kid kid kid kid kid kid kid

lid lid Lid lid lid lid lid lid lid

rid rid rid rid rid rid rid rid rid

hid hid hid hid hid hid hid hid hid

bid bid bid bid bid bid bid bid bid

Sid hid the lid.

Sid hid the lid. 15 sec. 0 errors.

Sid hid the lid .30 sec

IK
B, #3

dud dud dud dud dud dud dud dud dud

cud cud cud cud cud cud cud cud cud

bud bud bud bud bud bud bud bud bud

mud mud mud mud mud mud mud mud mud

Judd let the bud fall in the mud.

Judd let the bud fall in the mud. /35

Judd let the bud fall in thems

/35

IR
B, #4

cod cod cod cod cod cod cod cod cod

rod rod rod rod rod rod rod rod rod

sod sod sod sod sod sod sod sod sod

nod nod nod nod nod nod nod nod nod

pod pod nod nod nod nod nod nod nod

The rod fell on the sod when she nodded. 2:30

The rod fell on the sod when she nodded.

1:15

The rod fell on the sod She nodded

1R
B, #5

dad dad dad dad dad dad dad dad dad

fad fad fad fad fad fad fad fad fad

had had had had had had had had had

mad mad mad mad mad mad mad mad mad

sad sad sad sad sad sad sad sad sad

bad bad bad bad bad bad bad bad bad

A bad lad had a mad dad.

A bad lad had a mad dad. 2nd

A bad lad a mad dad 3rd

IR
6, #6.

jam jam jam jam jam jam jam jam jam

ham ham ham ham ham ham ham ham ham

ram ram ram ram ram ram ram ram ram

tam tam tam tam tam tam tam tam tam

yam yam yam yam yam yam yam yam yam

Pam saw the ram upset the jam.

Pam sam the ram upset the jam. 2 15

Pam sam ram the jam

Pan sam the ram upset the jam 1:45 o.

1R
B, #7.

dim dim dim dim dim dim dim dim dim

rim rim rim rim rim rim rim rim rim

him him him him him him him him him

brim brim brim brim brim brim brim

trim trim trim trim trim trim trim

Kim put trim on the brim of her hat.

Kim put trim on the brim of her hat. 2 01

2 15

Kim put trim on the brim her hat

IR
B1 #8

gum gum gum gum gum

hum hum hum hum hum

bum bum bum bum bum

drum drum drum drum

plum plum plum plum

Keep the gum on the drum.

Keep the gum on the drum. 0.55

Keep the gum the drum 0:40

IR
B_2 #1

den den den den den den den den den

ten ten ten ten ten ten ten ten ten

pen pen pen pen pen pen pen pen pen

men men men men men men men men men

hen hen hen hen hen hen hen hen hen 0:55

Ten men chased the hen into the pen.

Ten men chased the hen into the pen. 1:10

Ten men chased the hen into the pen 1:05

1K
D_2 #2

fin fin fin fin fin fin fin fin fin

pin pin pin pin pin pin pin pin pin

tin tin tin tin tin tin tin tin tin

win win win win win win win win win

bin bin bin bin bin bin bin bin bin 0:25

Lin will flip the pin into the tin bin.

Lin will flip the pin into the tin bin. 1:45

Lin will flip the pin into the tin bin.
0:45

1R B2 #5

fan fan fan fan fan fan fan fan fan

man man man man man man man man man ran ran ran ran ran ran

ran ran ran

can can can can can can can can can

van van van van van van van van van

pan pan pan pan pan pan pan pan pan

Jan ran past the tan van.

Jan ran past the tan van. D. 55

Jan ran past that can van. 1.5

IR B3 #4.

fun fun fun fun fun fun fun fun fun
gun gun gun gun gun gun gun gun gun
run run run run run run run run run
bun bun bun bun bun bun bun bun bun
sun sun sun sun sun sun sun sun sun
The girl had fun running in the sun.
The girl had fun running in the sun. 140

The girl had fun running in the sun. 145

B_2 #5
1R

hat hat hat hat hat hat hat hat hat

pat pat pat pat pat pat pat pat pat

bat bat bat bat bat bat bat bat bat

vat vat vat vat vat vat vat vat vat

cat cat cat cat cat cat cat cat cat

Put the hat on the cat, Pat.

Put the hat on the cat, Pat. 113.

Put the hat on the cat, Pat. 115.

K

fat fat fat fat fat fat fat fat fat

rat rat rat rat rat rat rat rat rat

sat sat sat sat sat sat sat sat sat

mat mat mat mat mat mat mat mat mat

that that that that that that that

The fat rat sat on the mat.

The fat rat sat on the mat. 0:50

The fat rat sat on the mat. 0:45

dip dip dip dip dip dip dip dip dip

rip rip rip rip rip rip rip rip rip

tip tip tip tip tip tip tip tip tip

lip lip lip lip lip lip lip lip lip

hip hip hip hip hip hip hip hip hip

ship ship ship ship ship ship ship

trip trip trip trip trip trip trip

Rip enjoyed his trip on a ship.

Rip enjoyed his trip on a ship. 0:50

Rip enjoyed his tripa ship. 0:40 ?

IR Eg #8

stop stop stop stop stop stop stop

hop hop hop hop hop hop hop hop hop

top top top top top top top top top

pop pop pop pop pop pop pop pop pop

mop mop mop mop mop mop mop mop mop

Can Pop hop over the mop?

Can Pop hop over the mop? 0:10

Can pop hop over the mop.? 0:40

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