Young Deaf Children and the Computer:
A Study of Learning Styles

by

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Bachelor of Science, Brown University 1982

Submitted in partial fulfillment of the requirements for the degree of

Master of Science

at the

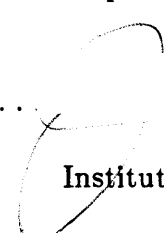## Massachusetts Institute of Technology

September, 1986

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Young Deaf Children and the Computer:
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Sandra S. Bellone Bleecker

Submitted to the Department of Architecture
on August 15, 1986 in partial fulfillment of the requirements
for the Degree of Master of Science, Unspecified

Abstract

This research is directed at exploring ways that computers might enter into the learning processes of deaf children. I am specifically interested in how deaf children acquire written language (English). I begin with an analysis of the problem: namely, that deaf children do not learn to read and write in the same way that hearing children do; nor is the issue one of education "correcting" a medical "deficiency" by making some simple substitution of one modality for another. Instead, one must consider the complex position of a deaf child within a hearing culture, where the values and expectations a child is exposed to may be at odds with the means/conditions best suited for his/her learning and understanding of written language. An effective role of a computer in a deaf child's life will reflect these considerations; if the child is given the opportunity to explore the computer (through interactions with others), and to appropriate its use, s/he will do so in a manner reflective of his/her interest in and involvement with written language. The experimental work reported, which I find supports my theoretical position, explores this view on a practical level. I carry out four case studies of deaf children, particularly noting the relationship between their work with me at the computer and their involvement with writing. What the children did at the computer depended on what they understood about written language and their preoccupations with using it. The children's use of the computer also mediated change in views of language, written and signed.

Acknowledgements

After all has been written, read, and re-read, there are many people for whom I am deeply grateful:

I owe many thanks to,

Seymour Papert, whose thinkings and philosophies since I joined the Media Lab have greatly influenced this work. Discussions with him about the children and some earlier writings led to many new insights, which re-energized my work when I lost sight of the forest because of all the trees.

Jerome Wiesner, who believed in the importance of this work, and kept me on the track of my own goals when I might have changed my research goals to fit in with other projects. My thanks also for his suggestions, and his time spent reading papers and thinking about the problem.

Marie Philip, for her comments and perspective on numerous writings when I was trying to clarify issues of how deaf children learn, and for the discussions that always furthered my understanding of what it means to be Deaf. She had a profound influence on the goals I set for this project in the first place.

Bob Bickford, for use of his Animated Coloring Book (which impressed me even more as the children began to use it), and for his interest in and enthusiasm for my work with the children.

Bob Lawler, for use of his many microworlds for young children, and for his sensitivity to the interests of children and the importance of family involvement.

People involved in the Learning and Epistemology group, who taught me a great deaf about different views from which to think about learning, and for their friendship and support.

Rena Upitis, for reading and ruthlessly commenting on early drafts, when I was trying to get my thoughts together; Ricki Goldman, Judy Sachter, and Edith Ackerman, who read parts of my thesis, just when I needed someone else to take a look; Sherry Turkle, who read earlier draft portions, and whose energy and sense of interesting research renewed the focus of my writing direction; Bill Higginson and Sylvia Weir for early support, advice, and sources of information.

Marlene Kliman, who actively read portions of the thesis, offered valuable

To Timothy,

with love

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Foreword: The Emergence of a Study

1 The Deaf: A Cultural Minority

There comes a time when a long-term interest is recognized as a priority that must be primarily considered. My interest in the Deaf evolved from an interest in sign language as a child, through the recurring study of and involvement with the Deaf. I read through the debate over using sign language for deaf children as opposed to oral methods of education, and emerged a "manualist," convinced that deaf children should be given access to a natural form of expression: sign language. Thus, my initial method of learning signs was to find something I wanted to sign (such as a song) and look up the signs for the Enlish words in a sign language dictionary. I had not yet learned that American Sign Language (ASL) was a language different from an English word ordering of signs. This awareness gave me a new respect for ASL, but one which was still limited without an understanding of Deaf people themselves. I knew that Deaf people got together in their own clubs and activities; friends with common interests and understandings do the same. For Deaf people, though, this is part of their culture. To be Deaf in a hearing world means more than having a handicapping barrier separating one from the majority of the population: there is a source of identification with those in the same situation because of a shared history, culture, and language (ASL), a shared set of experiences, and a shared struggle against a hearing majority who do not understand, but rather act on what they think they know. A convention used to refer to this idea of being

culturally deaf in contrast to the physical impairment of deafness, and which is used in this paper, is to capitalize the "d" in Deaf.

With a new understanding of the Deaf, I became sensitive to my own actions as a hearing person. This has greatly affected my thoughts about research, leading me to believe that hearing people are not the ones to decide what is best for deaf people; rather, Deaf people should be allowed to speak for themselves and have the final say in matters concerning deafness, such as in deaf education. Otherwise, deaf people will be maintained at a lower status as human beings in the eyes and actions of "normal" hearing people, and will be detrimentally stigmatized as such in their own eyes as well. This begins with the influential role of hearing people in a deaf child's world both at school and at home, since 90 percent of deaf children are born to hearing parents.

My own view now rests firmly on the idea that not only should children be given sign language as a first language, but that it should be as close to ASL as possible. The reasons for this are explained in the Background chapter, which also includes a discussion of what "Total Communication" is.

The impact of the above on my research has been to stress the importance of what a deaf child brings to the learning situation -- that is, to take the time first to look more closely at how the children are making sense of their world, before deciding ways that would "help" each of them in their endeavors.

2 Computers for Thinking

One by-product of writing is that it allows one to see what s/he has been thinking about. Another is that it provides a means for reflecting on the structure of written language and how it is used. My view of computers has expanded from one of machines that do the bidding of the user, to tools for reflecting on what one knows and how one thinks. Using a computer differs from writing, however, because there is another side to the computer that already exists -- namely, the hardware and software that one is using, which responds (predictably and unpredictably) to the users' actions. With writing, in contrast, the tools are simple: paper and pen(cil). A computer varies as it is seen, understood, and used by a person. Perceptions of it may range from an electronic pad and pen, to a communicating entity that in some sense has a will of its own.

The above panorama of the computer embodies a change concurrent with a change in my ideas about writing and mathematics. The beginning of the change was marked by my decision to apply to MIT to find a meaningful way to use computers for people: more specifically, for deaf people. Computers seemed to impose a grid of reaction, because the applications for computers were already determined. The manner in which I enountered the world of computers was through problem-solving: how to actually make a computer work to meet specified ends or within an existing framework. I enjoy solving such problems; I enjoy working through math problems as well. There is always a satisfaction in finding a result that

works. Any time I used math for myself, away from school, I thought of it as an application of what I had learned, not realizing that I was open to discovering such applications because I enjoyed mathematical logic as a means for describing and thinking about what I saw.

Writing seemed different. Simply put, there was no way of deciding what the right answer was. School writing was usually intended to report on something that had been done -- either by someone else or oneself. There is an accuracy inherent in this type of writing, but what is rarely pointed out is how one's own view colors the report given. My impression was that I should be an unbiased writer, writing from observable facts. Although this might sound like a straightforward task, whether the result was right or not remained vague until it had passed through the teacher's hands.

I compare the three areas of computers, mathematics, and writing in a different light now, feeling that their application all should reflect the person using them. Educational methods tend to give a narrow perspective on each of these things, emphasizing the unbiased right and wrong of a subject, ignoring the importance of its personal involvement.

3 The Learning and Epistemology Group

Recently, the importance of the child's involvement in learning activities has inspired research and thinking in a number of areas. In particular are the research and writings by Seymour Papert and members of the Learning and Epistemology Group at MIT's Media Lab. Currently, we have been exploring ways that computers can be used as a tool in education, so as to become part of a culture-oriented open-education learning experience. Discussions have looked at the various styles that children exhibit for learning about and using the computer alone or in combination with other activities e.g., Lego, music. Seminars have discussed the role of intuitive knowledge (intuitive physics) and how that affects the approach a person with a "naive" perspective takes. A result of such studies is an appreciation for different ways of encountering the same experience. Not only does a child need the opportunity to develop a special relationship within particular learning experiences, but it is also important to begin to realize what these different relationships are -- to compare them across children, and to understand the implications for education and processes of mind. Such understanding is an attempt, as Seymour Papert expresses at the beginning of Mindstorms, to see "how intellectual structures grow out of one another and about how, in the process, they acquire both logical and emotional form....an applied genetic epistemology expanded beyond Piaget's cognitive emphasis to include a concern with the affective" (vii).

4 Establishing the Connection

My initial research questions centered around how computers and related technologies could be used for deaf children. The area of reading and writing was an intriguing topic from a couple of perspectives. From issues of creativity, research has been carried out with young children learning how to write about things that matter to them, in a manner that will draw the audience into their perspective. The approach was to "make it messy to make it clear." Thus, young children were learning to express themselves about something they cared about, and at the same time were engaged in a process of making that clear to a reader. Involvement in written English causes one to reflect on the workings of English, from spelling and grammar to the content necessary to give enough information to the reader. Young children engage in scribbling and "pretend" reading to test out their current theories about language. Written language is an everyday part of our culture, children are sensitive to this, and begin putting together pieces of what is important about it long before any formal instruction begins.

Deaf children have a difficult time with written English, which persists into adulthood, partly because it is a new language for them, but also (in my opinion) because of other language issues: the extent to which language is available to them for communcation at home, and a related issue, the attitudes and expectations the child develops about language and about him- or herself as a language user. Nevertheless, they, too, are surrounded by written English and begin at an early age

to develop theories of how it is used and is important to them. Unfortunately, as they grow older, they may view written English as a chore and somewhat inaccessible.

This study is a first step in developing and using technology for deaf children with respect to written English. In observing and working with several deaf children, the intent was to be sensitive to what the children themselves knew and wanted to know about written language and its uses. My intention was also to be open-minded about how the children learned, realizing that they are every bit as adaptive and curious as hearing children, and perhaps have ways of their own for making sense of written English, that might be overlooked, given the general attitude that "spoken English is the key to written English."

The purpose of the study, then, is not to determine how a computer should be used to help deaf children learn to read and write; any suggestions that arise would need another look. It is, instead, to raise issues regarding the deaf children's use of interactive and written language, and how these uses change or become evident as they work at the computer.

The computer serves as a two-way learning tool, for the children to explore written language and the computer itself, and for me to learn about them. It was the primary window on the children's learning, but other observations were made of them as well to develop a more complete understanding of the children's interests and learning.

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Chapter One

Introduction

This study is not about what computers can "do" for deaf children, it is about young deaf children and what they bring to the computer -- a look at how they read the world around them, and ways that they get involved with learning about it, sometimes against overwhelming odds. In particular it explores their view of written language, and how that affects what they do at the computer. The present study looks at four young deaf children who have very different family backgrounds and experiences with language.

1.1 The Tapestry of Themes

There are five themes that thread their way through this study, namely issues of deafness and culture, learning to read and write, the importance of styles, the use of a computer, and finally the observations I made working with four young deaf children over the course of five months. Their interrelationship is as follows.

1.1.1 Developing a Perspective -- Deafness and Culture

Several aspects of culture arise in this study: Deaf culture; the immediate interpretation or instance of culture that a child apprehends in his or her environment; and, finally, the culture at large that sets a pervading tone about the importance of reading and writing, as well as how and when one should learn these

"skills."

The first of these cultural aspects has influenced the perspective taken here about language (ASL), and helps explain why the method and goals of the study are important -- they acknowledge Deafness as a way of life, and desire not to impose uninformed hearing views on how deaf children ought to be learning, but instead seek to understand a more complete picture of young deaf children and the experiences and attitudes with which they approach new learning situations (particularly written English).

The second aspect of culture, the child's environment and background, provides information useful to understanding the child's uses of interactive language (which may be signed or spoken) and ways that environment and background may have influenced the child's view of written English. This view assumes that a majority of "natural" language learning and use takes place at home, but is also influenced at school (perhaps more so for some of the children). It is important to recognize the large role that hearing people play in the lives of deaf children, especially remembering that the majority of deaf children are born to hearing parents.

The culture at large maintains a perspective that the basis for written English is spoken English. This paper argues for a different view of reading and writing, that is supported by the literature, but which is still rarely considered without reference to spoken language: that learning to read and write encompasses many other

experiences and skills, many of which are not explictly taught, but are developed

through interaction with other people, and especially through the child's own

curiosity and involvement. This paper seeks to explore these "other" means of access

to written language, and particularly how they are evident in the deaf children

studied.

1.1.2 Making Sense of What the Children Do: A Focus on Written Language

Because an important theme of this paper is to look at children's early efforts

at reading and writing, background is provided on other work that has been done.

We will examine the points of view that have influenced how hearing children are

taught to read, and, surprisingly, how deaf children are taught to read; then look at

studies that focus on how children (hearing and deaf) are building meaning from

text, from a psycholinguistic perspective and from one of styles; and, finally, discuss

how other activities and skills are seen to contribute to learning about reading and

writing (from the point of view of cognitive processing).

In the analysis of my observations of the children, the discussion of what they

did will be on reading, writing, and supportive activities. A useful heuristic that

arose for thinking about what the children were doing with reading and writing was

to consider how they attended to form versus meaning at various levels of making

sense of written language.

1.1.3 Learning from the Children -- A Look at Styles

Children develop strategies of dealing with their world that arise out of their personalities and experiences: individual styles of interpreting and interacting with their world. Looking at learning from the point of view of styles provides a useful way to think about deaf children's approaches to learning because it stresses the individuality of the child -- and what we can learn from each one -- as opposed to thinking about deaf children as a whole, and thus deciding what technology can do for "Them."

Styles have been used as a way to talk about different approaches to making sense of the world and to explain actions of people. The concept has been discussed, for example, with respect to making sense of reading, programming the computer, patterns of behavior, and studying scientific bodies of knowledge. Furthermore, people tend to have consistent stylistic approaches to what they do, so that observing children in different situations helps to clarify stylistic preferences in another situation. Considering styles then, not only looks at the individuality of a child, but also looks at the child as a whole.

Since observation of styles seems to reflect how a child is making sense of his or her world, it is useful to compare styles among children to understand different approaches leading to the same result, and to hypothesize influential factors.

1.1.4 The Roles of the Computer

If one were to focus only on children's styles of learning, this might very well be done without the use of the computer, because the styles would be apparent in other areas of their learning. The computer's use was twofold: it was a tool for research, as a window for viewing the children's learning processes, and, significantly for deaf children, was an environment in which written (typed) language was the form of interaction.

1.1.4.1 A Window on Learning: The Computer

The computer functions as a window on children's learning because actions and thoughts become explict as the child tries to accomplish different tasks. It also is an object of and opportunity for dialogue between the child and researcher. Because there are discreet steps for interacting with a computer, a certain amount of explicit processing happens from event to event. And, in this study, since there were many possible ways the children could use the computer, the computer mirrored their choices and responded to their actions. The computer is a tool to learn with for both the researcher and the child.

1.1.4.2 Interactive Written Language: Using the Computer

Secondly, the computer uses a written (typed) language for commanding it. This gives the child an opportunity to view written language as an interactive form of communication, soliciting attention to syntax, spelling, and the attached meaning

for making things happen. Using the computer raises issues about the child's relationship to written language, whether the child is comfortable with it, overwhelmed, or perhaps curious.

The programs used made use of different kinds of language involvement. Some had single letters for whole commands, which one would expect to allow the child to concentrate on the results appearing on the screen. Others required full English words to be typed, which were, however, complete commands in themselves; one would expect the child in this case to attend to words and meanings. Programming languages, such as Logo, require the child to take a different point of view -- to learn a specific language (spellings, syntax, etc.) as a set of meaningful tools that can be recombined. The child can attend to a desired product or looking at results that can happen when different pieces are combined. Which programs the child uses, and how s/he uses them are affected by the child's style of learning and present preoccupations with language.

1.1.5 The Children Themselves

Four children participated in the study, representing different ages (4 to 7) and stages of thinking about and using language. By looking at each with respect to the others, a set of issues arose concerning their preoccupations with language and use of the computer. The idea of preoccupations is important because it stresses the active role of the child as a learner, as one who both develops ways of learning about things, and chooses what s/he wants to learn about. Language is not something one has to

force children to think about; it is wiser to be alert to ways they might become discouraged in this pursuit, such as through conflicting educational goals and methods.

1.2 Results of the Study

The results of this study are in the form of an analysis of what the children did both at and away from the computer, and as seen in light of how they were preoccupied with issues of language. From this analysis arose issues regarding how their preoccupations influenced the children's work at the computer (with respect to how they viewed the computer and appropriated its use for their own needs), how aspects of learning to use the computer paralled learning about other bodies of knowledge such as written language and art, and how prior language experience seemed to account for the children's expectations of themselves as language users.

Chapter Two

Background

In order to develop a particular mindset about deaf children learning to read and write, the following sections will discuss the influence that culture plays on literacy, and how deaf people are viewed in a hearing world where spoken language is an assumed key to written language. To develop these ideas we will look at how deaf children learn to read and write, but from different perspectives: some are detrimental to thinking about how deaf children learn to read and write, others are more productive. Then we will look more specifically at some of the issues raised concerning deaf children learning to read and write (including a historical look at the sign language / spoken language debate). In an attempt to put out of mind more traditional views of learing to read and write, we will discuss uses of the computer for that purpose (especially with deaf children), including some general learning philosophies that combine old and new ideas.

2.1 Hearing Children Learning to Read and Write

In this section we will look at how hearing children learn to read and write, from several perspectives. (1) The first of these looks at the debated mechanics of learning to read -- an oral approach to decoding the printed word, versus a meaning-emphasis approach for understanding text. (2) The second looks at other strategies that children use in learning to read, many of which have not been explicitly taught.

Some of these strategies are related to a child's overall style of learning. (3) Another way to look at learning to read and write takes a functional view of the matter -- in learning speech, function is an integral part of the learning process; so it is with learning to read and write. Learning to read and write is a puzzle the child must solve, discvovering the meaningfulness of each of the pieces for him- or herself. The child needs to acquire insights into the meaningfulness of text. (4) Slightly different is the approach that analyses skills underlying reading and, particularly, writing. Examining these pieces provides explicit alternatives for strengthening a child's readiness / ability to read and write, and does not simply focus on the mechanics of learning to read and write. Instead, this approach focuses on other skills that are built up as part of growing up, but which, depending on ther child's background, might also be seriously lacking.

2.1.1 A Traditional Look at Learning to Read

There are two basic views on how children should learn to read. One is based on the fact that written English is essentially a sound-based encoding (despite its many quirks) of spoken language. Provided with the rules for decoding print, children theoretically have immediate access to all the words in their spoken vocabulary. The second view is based on using context to help decide the meaning of unfamiliar words. The child is first taught a sight vocabulary and then given whole texts to read; without explicit rules for decoding words, the child will learn to rely on context for meaning. The emphasis is on the meaning of the whole rather than a

focus on individual words. This method grew out of a couple of ideas: Adult readers do not read individual letters, but rather several words at a glance, suggesting that children might be taught to read whole words right from the beginning (Brown 67). Additionally, children should be given meaningful wholes to read from so that they will understand and take interest in what they read (Brown 68). A further supporting argument is that the children are not left without phonetic clues: they learn them incidentally by recognizing the patterns.

The results from studies, in summary, of using these two methods are that children learning under a code (phonetics or otherwise?) emphasis have an advantage in oral reading, which may not help with reading for meaning at first, but which in second and third grades gives an advantage in reading for meaning due to word recognition ability. Children learning under a reading for meaning emphasis have an advantage with early reading-for-meaning texts, but in second and third grades are adversely affected because of their inability to recognize words. It is not clear what effects there are after the third grade (Chall 137-8).

Both of these methods make use of the child's knowledge of spoken language. They assume that oral and written language are essentially the same because they share the same intrinsic characteristics of vocabulary and grammar. The first explicitly calls for an association of the child's spoken vocabulary to printed words, while implicitly calling on knowledge of spoken grammar for making sense of a string of recognized words. Similarly, the second view implicitly assumes that a child

already knows the grammar of the language and what words would make sense in the gap of a particular text. (It is conceivable to imagine a child having an idea of what might fit in without knowing the specific word.)

2.1.2 Strategies Used by Beginning Readers

The approaches described above provide the basis for teaching methods. Their success or lack thereof has been attributed to numerous factors. In any event, teachers do not seem to use a method based purely on either one. Methods of one are included with the other as the teacher deems appropriate.

Since both methods have produced successes and failures, other studies have tried to examine how children go about reading by analyzing children's oral reading. The question is, how do the children construct meaning from text?

A method of looking at the mistakes, called miscues, that children make while they read has led Goodman and Goodman to posit a theory that readers rely on three cueing systems to construct meaning from text. They are the semantic, syntactic, and graphophonic. The graphophonic system relies on using graphic information (patterns of letters, such as reading "cat" for "cap" in "The little boy lost his cat.") or sound-patterns ("symbol-sound relationships" -- substitution of phonemic patterns; they occur less frequently than graphic substitutions). Syntactic miscues substitute words, but within the allowable grammatical and morphophemic constraints (morphemes are the smallest units of words that have meaning, such as

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prefixes and suffixes). Semantic substitutions make sense syntactically, but change the meaning of the story (Goodman and Goodman 267). Making sense of their own "world knowledge" and the input from the three cueing systems, readers develop hypotheses and confirm, strengthen, discontinue, or modify them.

An important question their work raises is the relative degrees to which children rely on the different systems. Goodman and Goodman predict that the proficiency of the reader is reflected by the reactions to miscues: the less proficient reader, who lacks ability or is less interested in constructing meaning will not necessarily correct an error, whereas a more proficient reader will do so as necessary (Goodman and Goodman 268). Ewoldt, who did a similar study with deaf children, said the relative amounts the systems are used vary with the difficulty of the text and with the proficiency of the reader.

Researchers from the Educational Testing Services (ETS) also looked at beginning readers' reading efforts and miscues. They found that different readers had different styles of constructing meaning from the text. Some constructed meaning from the text on a word by word basis -- that is, figuring out each word as they reached it was important to building up the meaning. Others read based on what they knew was happening in the story, intent first on making sense and using that to make guesses about words. In other words, one group endeavored to uphold the accuracy with which they read; the other group strove to uphold the momentum with which they read. This was not simply a matter of preference, it made a

difference in the child's ability to build meaning. One little girl, Jenny, usually kept up the pace of a story. When she became preoccupied with accuracy she would miss the general meaning of it (Bussis et al 181).

The researchers also looked at the children in other activities and compared their reading styles to ways the children behaved in other situations. They found correlations between the children's styles of reading and their involvement in the classroom. For example, Carrie was a leader in the classroom. She was known for getting children involved in dramatic play efforts -- acting herself as the director and principal character. She often played a role of narrator, making the connections to keep the story line evident. Similarly, in her reading efforts, her primary concern was with making a story happen; although she realized that she did not read exactly what was on the page, her sense of story combined with other clues she had picked up about books (such as the thythm and redundancy of text) allowed her to sustain her momentum of reading. In her influential manner she would find people to read to (children and adults), and thus had an involved audience -- this time to support the practice of her style of reading (Bussis et al 206-40).

This latter study is strikingly important since it presents children as active readers who have developed a style of reading that suits them. Their style of reading may, in fact, reflect a number of factors that have gone into their view of themselves as learners and language users.

2.1.3 Significance of the Written Word

Intertwined with children's early attempts to read, and in some cases preceding these, are early writing endeavors.

Children attach significance to written text becasue of all that they see in the environment around them, e.g., cereal boxes, car license plates, toy packaging, comics. Although they may recognize its importance, they may not yet have realized its uses for them. Along the road to developing this significance, they are acquiring other information about print. Technically, they begin to pay attention to the features of letters and words. They begin to make sense of word patterns, deciding what is readable, and going through stages of recognizing, for example, that words appear horizontally, are of a certain size and pattern, and are read, in our culture, from left to right (Sinclair 8). When they begin their attention to and memory for actual words, among the especially important are names of themselves, family, and friends.

They also develop a sense of the uses of written language for communication, information, and pleasure. Their drawings take on these same roles. Children begin to play with the role of writing as a form of communication through their drawings. They begin to understand that what is commuicated has a meaning for themselves, which they are making known to or sharing with someone else, who then also understands (or should understand) the drawing's intent.

Functionally, children begin to use drawing symbolically, using pictures to convey stories, as letters, or simply as a significant representation of some part of their world -- be it real or imaginary. They may or may not intersperse letters or words as they begin to learn them. These letters and words may serve different roles within the context of different pictures. Anne Haas Dyson suggests,

> Contrary to popular belief, writing may not begin as speech written down. The differentiation of writing from drawing and its precise connection with language is not necessarily a step preceding, but a gradual process occurring during and through first attempts to represent experience through letter graphics. (Dyson "The Emergence of Visible Language" 379)

2.1.4 The Puzzle of Written Language

Children are involved in making sense of their world; as new unknowns surface for them, their questioning seeks resolutions, taking into account what they know and incorporating new information along the way. This idea of puzzlements suggests that it is not enough that one is simply exposed to something new, one needs to become actively involved with it in order to incorporate it into one's model of the world (Dyson "Reading, Writing, and Language" 831). Writing for children is such a puzzle, but it is also a key into the workings of spoken language. Somewhat unintentionally, learning about written language explicates the workings of oral language's formalities. Sinclair describes the depth of this involvement: "...children re-invent or re-construct the symbolic systems of the society they live in..." (Sinclair 15).

It is one thing to acknowledge and study the process of a child exploring

puzzlements, but a question that might well be asked is, "how does a child decide to start puzzling over something?" In the case of reading, Smith argues that children need two fundamental insights before they can begin learning to read: "(1) that print is meaningful and (2) that written language is different from speech." In the case of writing, we might add another: that print is useful.

Markman looked at conditions under which children realized they did not understand: more specifically, that they did not have enough information with which to accomplish some task (Markman 987-992). In the case of following instructions, if one realized s/he did not know enough, then one could take appropriate action to investigate until one did have enough information. Markman attributes this failure (of children's not realizing they don't understand) to superficial processing, a relative absence of constructive processing. In the study, the task was geared at being a relevant and do-able one. Another reason for a child not realizing his or her un-understanding would be that the child did not expect to understand from the given situation. In a circular way, this would indicate the importance of such fundamental insights about learning to read and write.

At another level, "not realizing" could go beyond not having insights, into a view of the child's self as a learner, language user, understander.

2.1.5 Skills Underlying Reading and Writing

We have looked at how other skills / abilities influence a child's reading. These skills are relevant to learning about writing, but there are others involved as well. Here we will look at knowledge of written language as a complex of contributing skills. From this perspective, writing itself is viewed not as a skill that one acquires, but rather as an integration of other skills (Bracewell 407). Although one might argue that there are certain understandings of written language that are acquired, thinking about underlying skills offers useful insights.

An extreme point of view is that literacy (being able to read and write) encompasses our ability to produce and understand spoken language. This is because it is through our experience with reading that we develop our abilities to understand abstract speech (Smith 421). This, too, is debatable, because there are certainly things we know about speech that do not pertain to written language, such as the expression, gestures, and turn-taking that figure prominently in conversation, but the perspective is useful in considering the idea that deaf children acquire English as a written form.

Many skills contribute to that of writing, but writing stands outside them all because it is the "least contextually constrained" (Bracewell 401). Reading gives an awareness of text and ways that text is used, and how the content is structured in terms of events, descriptions, characters, etc. On the other hand, one does not become conscious of these things without acting on them in some way. One kind of

action for children is acting out a story, or discussing it with someone else. Listening (for a long period of time) develops one's attention span for writing. Conversations act as an initial way of finding out that one has something to say, and are a model for the first few things a child might try to write (perhaps accurately called conversation pieces). Developing the ability to figure things out is important to writing, and is developed as a child constructs meaning from stories -- seeing how characters in stories solve problems. Problem-solving also occurs in other kinds of play that require action based on an explicit logic. One thing that does not happen in these activities is learning how to set a problem as well as to solve it. As children realize that writing has topics and themes, they need to gain confidence and experience setting their own topics, themes, conflicts, and problems, then write through these in a logical manner -- laying out the supportive ideas or story for someone else to understand.

Building an understanding of what is involved in written language is an unfolding process. From early ages on, children are developing skills that will help them acquire proficiency at reading and writing. Interestingly, during their initial explorations with writing, children's freedom of expression is as confident and easy as that of their artwork. Later, with another level of reflection, they basically view writing as speech written down. Still later, as their reading level surpasses their writing ability, they realize the complexity of what they must know and do in order to becom effective writers (grammar, organization of ideas, clear presentation). As with their art, their expressiveness loses its ease (spontaneity) because they bog down

in the technicalities of what must be done. Their reading level has passed their writing level to an overwhelming and disappointing extent (Bracewell 419).

Learning to read and write are mutually supportive endeavors. Reading is a source of knowledge about structures of language, as well as of useful content. Writing is important as it contributes to one's growth in thinking about language and about one's own ideas. Beyond being a tool with which to communicate, it is also a tool with which to think.

2.1.6 Summary -- Implications for Deaf Children

What we have looked at in the previous section were things that children learn about reading and writing that go beyond what is generally considered in a school curriculum. The purpose was a fuller understanding of the child's role as a learner and the kinds of skills and attitudes s/he may bring to, or that are helpful to, these tasks. The dangerous implications for deaf children arise when one considers only the significance of speech to learning to read and write. There are many other skills and kinds of knowledge implicit and explicit in literacy.

Views that recognize the importance of children's skills as language users and active thinkers provide a healthy beginning for understanding deaf children's thinking about written language. After all, these various forms of language are all symbol systems -- one as imprecise as another. What is obvious is that all of these skills develop through interaction with other people and then with the opportunity to

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actively reflect on this interaction oneself.

2.2 Deaf Children Learning to Read and Write

In this section we will take a historical look at influences of the hearing world

on teaching deaf children. An important debate is over the use of sign language and

of various forms of sign language. For many deaf children, hearing parents at home

are an important (but sometimes disappointing) influence on developing their self-

image as a learner and their relationship to print. This lack is significant when

compared to the way a deaf child of deaf parents acquires ASL and English

(Maxwell, Philip). There have been studies looking at ways that deaf children seem

to be learning to read and write as well as the language base they have for expressing

themselves: their basis for processing English and for expressing themselves in sign

language (ASL). Finally, we shall address the question of what is useful about other

ways of looking at beginning reading and writing.

2.2.1 Cultural Perspective

A cultural perspective further supports the need for this type of study. For

centuries deaf people have been subject to decisions made by hearing people --

whether they were allowed to sign, whether they could marry or have children, etc. --

leaving one with the impression that deafness placed one outside the limits of a

normal, liveable life (Lane).

Many illusory beliefs endorsed these actions. Perhaps the most outstanding

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subject of misinformation has been that of language. It will be discussed more fully in the next section, but a few comments now may be in order. The lack of spoken language (English) immediately makes deaf people into an enigma for hearing people. How do they think? How can they possibly communicate and understand abstract / complex ideas by using their hands? Misunderstandings about language have placed undue pressures on the education of deaf children to give them "language" -- that is, to teach them to speak, lipread, read and write English, in order to become functioning members of society. The role of education, at times, was primarily to teach English, as opposed to teaching children general knowledge using a natural language, namely, sign language (ASL). Certainly, it would not be hard to understand deaf people feeling a resentment towards hearing people and "their English."

As adults, deaf people lack social acceptance in the hearing world, and are often treated degradingly as if they were "deaf and dumb." Further evidence of this stigmatization shows up at work: not uncommonly deaf people are given a trial period for measuring up on the job (Higgins 135-6). Concerning education of deaf children in the past, because deaf teachers could not speak, they could not develop the children's speech skills, and therefore could not pass the tests for teaching deaf children.

Identification in the Deaf community is a very important part of being Deaf, for the majority of deaf people. The community may not exist in one location, but

that is not what is so important. Their community exists together when they get together, and otherwise endures because its members are so closely knit by their experiences, from childhood on up. These are the people who understand what it means and how it feels to be Deaf. They are bonded with and for each other. Children, except possibly those of deaf parents, are not part of the community, until they grow to become a part of it as adults.

The child's view of culture is largely a hearing culture, perceived through the surrounding environment and people's actions and reactions. Most deaf children, then, do not have the support and understanding of having other deaf people around, except perhaps at school. But school cannot replace the relationships of the family. Deaf children of hearing parents grow up in a variety of environments, where acceptance and understanding of their deafness is the exception rather than the rule. Limited communication with a deaf child can lead to bitterness as s/he grows up. A full and natural development of language may be at stake -- so may be the child's self-image.

Nevertheless, people are adaptive and no less so as children. For one thing, as children they are not completely aware of ways they differ from other people, nor of the ways they are making adjustments in order to compensate. They are making sense of the world from their perceptions and their interactions with people in it. In the process of doing so, they develop their expectations about how to make sense of what is happening around them and how they should act in different situations.

These are certainly not "bad" developments, but it is important to realize how they might influence the child's involvement with other things, such as, in this study, written language. For example, as we shall see later, one child in the study, whose parents did not sign to, her often relied on cues from others as to what she should do in a situation; she would imitate what others were doing.

2.2.2 Using Sign Language

This continuous debate is largely instigated by the hearing community and at the expense of the Deaf community. The debate has two forms. The first is the debate over sign language versus spoken language. The second is over the form of sign language.

The debate over spoken language (English) as opposed to sign language centers around the argument that deaf people need to be able to communicate with the hearing world around them in order to survive. Akin to this are such ideas as these: spoken language is necessary for thought, sign language is not a legitimate or adequate language, or if sign language is used, written language (English) will not be accessible. Cases of deaf people who have been taught to speak and read lips are used as supporting arguments. First, the degree of deafness and the age of onset must be considered; then, to what extent the person can communicate with the world at large, as opposed to teacher and family; and finally, how comfortable the person is doing this -- whether or not this would really be a chosen form of communication. Unfortunately, hearing people have often not trusted the opinions of deaf people,

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deciding that they must not know what is in their best self-interest.

Simply using the phrase "sign language" in the above paragraph was not adequate, as we shall now see. Deaf people in this country have a language, American Sign Language (ASL), which is an important factor of identification in the Deaf community. Recently there has been a great deal of research focused on ASL, establishing it as a "legitimate" language -- having its own structure and capable of expressing whatever. Its importance as a language is not a new idea. Even in the 1700's, some hearing people (such as the abbe Sicard and the abbe de l'Epee) realized that the natural language of deaf people was the best way to go about communicating with and teaching deaf children (Lane).

Still the insistent voice cries, "What about English?" Just suppose a sign language could be devised for English. Then, the children could be taught in Signed English, the best of both worlds, learning the structure of English, which could be carried over to reading and writing, and all with the use of signs. There are any number of problems with this approach, which, as a matter of course, has been tried. Even in France centuries ago, a manual form of French was devised so that deaf students could learn French (Lane). One problem with this "language" is that it is not a language, but a transliteration of English. It is not a language used by any community of signers, but only artificially invented for educational purposes. And as such, it does justice to neither English nor ASL. Word-for-word, one can speak faster than one can sign. As with any language, ASL economizes, such that it uses

approximately half the number of signs as spoken words to communicate the same thing (Wilbur 256). This is important both expressively and receptively for maintaining the flow of conversation and for acquiring meaning within human processing limits. ASL incorporates a great deal more facial expression and body movement than does English, and slight alterations in the execution of a basic sign can change its meaning. These things are lost in Signed English and replaced by cumbersome word markings, indicating information like plurals, verb tenses, pronouns, prepositions and articles. Studies about efforts to use Signed English report that it is not used accurately and with consistency anyway (Wilbur 257) -- another indication of its cumbersomeness as a language -- so it cannot be expected to live up to the goals of its intended purpose.

Most common for hearing educators and parents to use is a sign system that approaches English so that speech can be used simultaneously. This has been part of a movement called "total communication" which, in most cases, has mistakenly been assumed to be an educational method (Denton 2), a simultaneous method of communication (Reagan 275). Total communication actually refers to "'a philosophy of communication which implies acceptance, understanding, and use of all methods of communication to assist the deaf child in acquiring language and the deaf adult in understanding'" (quoted in Reagan 275).

> It is a way of thinking and feeling about deafness and deaf people based
> upon an unconditional faith in the abilities of deaf people....a recognition
> that the language of Signs is the cultural language of most deaf people....[a]
> premise that language grows out of human encounter....the understanding
> that the linguistic process is common to all people, deaf or hearing, and that

any child can and will develop a functional language capability if provided two things... an opportunity to interact with others and a stable symbol system that he [sic] can learn to manipulate for himself [sic]. (Denton 3)

Unfortunately, not many hearing people know ASL. Depending on the knowledge of the user, hearing people incorporate varying amounts of ASL and English. This form of sign language that mediates between ASL and English is called Pidgin Sign English (PSE), and, as a pidgin, is commonly used between deaf and hearing people as well as in educational settings (Reagan 269).

An important benefit of using ASL for communication is that it gives a child access to concepts and language in a natural mode of interaction. With respect to learning written language (English), which incorporates so many skills, using ASL does not make English a more remote possibility, but instead prepares the child with a complete knowledge of language and all that that includes, such as confidence (as a language user), an acceptance of his or her deafness, and a means for learning about written English (as a second language).

2.2.3 Reading and Writing

The suggestion that deaf children make use of sign language in learning to read is supported by studies of deaf children's reading and language acquisition. Studies have shown that deaf children remember words with corresponding signs better than those without (Odom, Blanton, and McIntyre cited in Ewoldt 61). A study of the various forms of language acquired by a deaf child of deaf parents demonstrated the

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successful acquisition of English through sign language (Maxwell), and the use of sign language as a base for deaf children's reading strategies was documented in a study by Ewoldt.

Maxwell's study traced the language acquisition (except that of ASL) of a deaf girl, Alice. ASL was her first language, acquired from her Deaf parents. Maxwell presented her case as a model of how one deaf child acquired ASL, Fingerspelling, Speech, English print, Sign English and Sign print. Sign English is English-like signing with invented forms for certain words and morphemes such as "the" and word endings (-ed, -ly, -ing). Sign Print refers to illustrated signs corresponding to English print. These signs include invented forms of Sign English.

Alice first encountered written English in the form of the alphabet and her name when she was 26 to 30 months old, with the use of flash cards that had English block letters on one side, and fingerspelled letters on the other. She was interested in the forms despite the lack of meaning they had for her. Alice's first exposure to English came through Sign print in storybooks at home. She first made the connection between signs and Sign print, but initially disregarded the English print that appeared below. Maxwell observed her signing behavior in both a familiar and an unfamiliar story. In the latter case, she paid a great deal of attention to the unfamiliar forms of signs. In the former case, because she was familiar with the story itself, she signed only the basic forms of the signs, and relied on her knowledge of the story's meaning to help her read the signs.

Alice varied her attention to form and meaning as she learned about the relationships between the different forms of language. Sometimes she would focus on the forms; other times she went through a kind of scribble-fingerspelling or scribble-writing to put forth different meanings. By the time she was four, she had begun attending to the English print below the Sign print, concentrating on the forms. For text without Sign print, Alice signed words she knew and fingerspelled others, changing many letters without reflection. The new forms she learned found their way into her signing, and it was not until she was six that she had begun to separate the different varieties, and learn from one and transfer to another.

Ewoldt did a study based on Goodman and Goodman's work. She had the children "read aloud" by signing the stories as they read them (Ewoldt 62). She was unable to directly compare scored results to the work done with hearing children, both native and non-native speakers, but was able to compare strategies used between hearing and deaf readers. Her results indicated that the children were working from a different language base, namely sign language. Amy (age 6:11), the youngest of the readers studied, resembled a hearing beginning reader in that her cueing systems, semantic, syntactic, and graphic (note: not graphophonic) were not yet integrated. In her easiest story she used all three kinds of information, but overly relied on the graphic information, signing CAT for CART and FROG for FRONT. In the hardest story, she initially minimized her use of graphic information, but instead predicted syntactically and semantically.

Text: The boy did not want to go into the woods.

Amy: The boy cry, look for where is home.

By the end of this story she switched back to focusing on graphic information
(apparent because of omissions and fingerspellings), probably because she had
completely lost the story meaning (Ewoldt 69). As do hearing children, Amy varied
her reliance on the three cueing systems. Each of the deaf children studied paid
increasingly closer attention to graphic information as the story difficulty increased
(Ewoldt 69). This is one strategy used by both inefficient hearing readers and
capable ones when they encounter difficult material. And, as had the children in the
ETS study, Amy was able to rely on her knowledge of story structure to help her
make sense of text.

Both Alice and other deaf children reported on in another study (Manson
"Explorations in Language Arts for Preschoolers") used writing as a means for
making sense of written English. As with hearing children (reported in Dyson
"Reading, Writing, and Language"), writing gives deaf children a place to test out
their theories about the workings of English and allows them to get feedback from
people to whom they show their writing.

2.3 Using the Computer for Deaf Children

This section will describe the ideas behind this study: how a computer is useful
as a window onto children's learning processes and styles; how it can facilitate active
methods and exploratory / child-controlled environments for learning to take place;
how, specifically for deaf children, it can offer a place for written language to become

meaningful as an interactive language, for engaging in problem-setting and problem-solving activities, and for taking control -- using the computer for the children's own purposes and taking action to make actions (cause effects).

2.3.1 Philosophy Concerning Computers and Education

Children make sense of their world through experience with it. This is particularly demonstrated by the way that children learn language: really, the majority of language is not learned through formal instruction at school, but through everyday interaction with it. Similarly, some of the first things a child picks up about written language come through experience and not because someone suddenly decided to introduce the child to the world of print.

Unfortunately, at school children are often in "react" mode, and thus can develop a passive attitude about learning, working toward goals that the teacher has set -- because that is what one is supposed to do at school. Deaf children are particularly susceptible to this type of "banking" education, as Freire calls it. Teachers cannot account for the differing ways that the children communicate at home. They must act on what they observe in the children, and respond only to the extent that their own communication skills allow them to. In order not to let situations get out of hand, they strive to control the children as a group, working to mold them into obedient students -- before the children have ever had much chance to express themselves. Considering the large number of hearing people influencing deaf education, this holds them highly suspect to establishing a controlling

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relationship with the children, and thereby setting a submissive / inferior role for them as adults towards hearing people.

Children in school also receive few opportunities to set their own problems and goals. When they are older, this too can produce a negative effect: low self-esteem, and a tendency to turn the responsibility for their problems and goals over to others. Even in solving problems, there is often more than one way to work through something. The way subjects are usually taught, however, allows only one right and many wrong ways to do things. Certainly this does not leave much room for children to develop their own ways of thinking through situations.

Depending on how they are used, computers can offer a place to set and solve problems, as well as an individual means of doing so, at the same time giving a child concrete access to manipulating symbols. Papert points out that until recently, symbol manipulation could only be done in one's head, or abstractly on paper. Computers allow one to manipulate symbols in a very real way ("Microworlds: Transforming Education" 44). The issues concerned in such involvement go beyond cognitive processing to include the affective relationship the child assumes and the role that culture plays in the significance of the event (Papert, "New theories for New Learnings" 8). The kinds of programs that encourage this real involvement are not ones that drill or test a child, but ones in which a child can explore, investigate and comfortably take control. (Programs that allow this kind of interaction and model some domain of knowledge, or small piece of reality, are referred to as "microworlds"

(Papert, "Microworlds" 29).)

2.3.2 Computers for Learning to Read and Write

Previous sections looked at reading and writing in terms of many factors. Computers can offer "microworlds" that relate to such issues, but it is the children who find what is meaningful for them. The programs specific to this study will be explained in the next chapter.

One possibility the computer offers children is a place to interactively use written language. Otherwise, this happens only when two people write messages back and forth, which situation assumes a working knowledge of written language. The child interacts with the computer by using text, and has a meaningful reason for paying attention to the mechanics of text in order to get the computer to do what s/he wants.

Another important aspect of the computer is that it allows the child the possibility of creatively interacting with it -- choosing the content, focus and means for achieving ideas. As mentioned before, writing encompasses these types of activities. In Chapter 5 we will consider how a child knows what s/he can do on the computer, and what influences the things that the child attempts to do.

The computer is also a place where logical thinking can be used in an explicit / reflective way.

2.4 The Importance of Styles

In light of previous discussion, the question of styles for deaf children is particularly important (especially considering their backgrounds). Each child has come to view language in a different way, and because of the pressures of his or her environment has had to compensate for, adjust, and resolve his or her view of him- or herself as a communicator / language user. The styles of learning and doing that a child develops are important to understand: an emphasis on styles acknowledges the fact that goals and understandings can be reached in more than one way. Researchers, such as Bussis et al, Turkle, Keller, and Levi-Strauss, have discussed styles from different perspectives. Here are a few of the ideas that have emerged:

- Styles of thinking have been shown to vary at the level of a civilization, not in ways that show different stages of thought development, but rather different levels of access to a body of knowledge.

- Culture influences one's style of thinking in that the purposes and importances of objects and skills are culturally transmitted.

- Culture may dictate the validity of one style of thinking over another, and thus its acceptance.

- An individual's style mediates his or her approach to and involvement with an experience in a way that makes it most meaningful for him or her.

- Evidences of styles have been described for many activities, including children's work at the computer and strategies for making sense of text.

The sections that follow will further disscuss these ideas and their implications for this study.

2.4.1 Discussion of Styles

The anthropologist Claude Levi-Strauss looked at different styles of developing

science and its nomenclature from the perspectives of different civilizations. He

contrasts two approaches by characterizing the styles of the bricoleur and the

engineer. A bricoleur collects a set of objects which all have propensities towards a

certain usage, but for which the bricoleur conceives new uses. Thus, in building

something new with these pieces, the bricoleur reinterprets them (but always in light

of their existing nature and past purposes), each decision affecting the remaining

possibilities and structure of the final product. The engineer, on the other hand,

always seeks to find the significant "other" thing, that is not already in existence,

and need not have any relationship to culture at all (Levi-Strauss 16-21).

Levi-Strauss uses these two characterizations to express the contrast between

mythical thought and scientific thought, which

> are certainly not a function of different stages of development of the
> human mind but rather of two strategic levels at which nature is accessible
> to scientific enquiry: one roughly adapted to that of perception and the
> imagination: the other at a remove from it. It is as if the necessary
> connections which are the object of all science, neolithic or modern, could
> be arrived at by two different routes, one very close to, and the other more
> remote from, sensible intuition. (Levi-Strauss 15)

These styles he proposes characterize a cultural way of thinking, but can be

observed in individuals as well. It is important to note that both ways of thinking

provide valid entry-points for thinking about some phenomenon or task.

This type of distinction is also made by Keller on both the cultural and

individual level. Her biography of the geneticist Barbara McClintock tells of her very

different approach to the scientific study of maize, which was out of synch with

current methods and issues. As a result, her work was disregarded until many years

later, when others arrived at the point of understanding through different avenues.

> The word 'understanding,' and the particular meaning she attributed to
> it, is the cornerstone of Barbara McClintock's entire approach to science.
> For her, the smallest details provided the keys to the larger whole. It was
> her conviction that the closer her focus, the greater her attention to
> individual detail, to the unique characteristics of a single plant, of a single
> kernel, of a single chromosome, the more she could learn about the general
> principles by which the maize plant as a whole was organized, the better her
> 'feeling for the organism.' (Keller 101)

In addition to making a distinction between styles, the above observation

supports this study in its attempt to learn from working with and observing the

children themselves, being sensitive to their differences -- interests, goals, strategies,

etc.

Sherry Turkle, in **The Second Self**, looks at people's styles of interacting with

the computer, in the ways that people view the machine itself and the ways they

decide to use it. She discusses children programmers and the distinction between

them as hard masters and soft masters. A hard master plans out a solution and

"thinks in terms of global abstraction." The soft master tinkers with a problem,

arranging and rearranging known pieces, similar to Levi-Strauss' "bricoleur" (104-5).

Turkle further describes these distinctions in terms of Shapiro's personality

descriptions of neurotic styles: she compares hard mastery to the obsessive-

compulsive style and soft mastery to the hysterical style, then relates them to a

common view of gender differences, where males are typically seen as hard masters, and females as soft masters.

Her discussions are useful in highlighting these differences, and for examining the relationships of children to computers. The fact that these styles can be related to something like gender differences suggests a cultural attitude about these styles as well; being able to "plan" a solution would be considered a "better" way than "tinkering." This is dangerous; what Turkle shows is that each way of thinking allows different children to learn and work through a problem. One must be careful, however, in categorizing a child as strictly one or the other; people are variable, and may exhibit some combination of styles, or rely on different ones depending on the situation.

The last of the studies to which I shall refer here is relevant because of its look at children's reading styles. This is the ETS study described in Section 2.1.2. The children's styles were evident in their reading strategies and in other activities. In their reading, some constructed meaning by using their expectations about "story," relying on the overall meaning to carry them through difficult passages. Others built up meaning on a word-by-word basis, working from the base of technical accuracy. This distinction is similar to an intuitive versus technical approach to problem-solving. The study also described children changing their strategy at times (which was less effective), but then returning to their usual style. A similar change in focus between meaning and form was evident in Maxwell's study of a deaf girl learning

about language forms. Both of these studies suggest the importance of recognizing a child's preferred style as well as the strategies and situations for using others.

2.4.2 Observation and Implications

A child develops a style of working with the computer that is heavily influenced by his/her personality, self-image as a learner, and interests. By observing children's use of the computer, one can observe their styles of confronting new information, the kinds of things that interest them, and expectations they have about their abilities to set goals and follow through on them. Observations of the ideas and projects children initiate can make explicit some of the paths of thinking along which they travel.

Chapter Three

Setup of the Study

3.1 Location: The Learning Center for Deaf Children (TLC)

The location of the project was particularly important because it had to allow for work on the computer as well as opportunity to observe and interact with the children at other times during the day. TLC classes are arranged in an open classroom style. The day is divided into time slots, but within those times, the children engage in learning activities in small groups with teachers. The classes have a relaxed environment which allows visitors (parents, etc.) to take part in the activities.

TLC offers programs for deaf children from infancy through high school, including a special needs program for deaf children with additional disabilities. All of the programs are housed in three buildings situated close together, except the high school classes, which are held at a nearby public high school. The school embodies a total communication philosophy, and as such both recognizes the importance of sign language as a means for communicating ideas and concepts, and gives the children opportunity to benefit from appropriate amplification and training for hearing and speaking. TLC emphasizes an early exposure to sign language, supporting this with their Parents and Infants program, so that children can have a natural language to use from the beginning of their development.

This study included only children at the Preschool and Primary ages. The two classrooms were adjacent to one another and had very similar schedules; since three of the children were in Primary (and thus I spent more time there) I will begin by describing the Primary classroom and note ways that the Preschool setup was different.

3.1.1 Primary Classroom Setup

The Primary area was a large open room, separated into areas by bookcases, teachers' cabinets, and other useful structures. There were three teachers (all hearing) and an aide (who was deaf). Of the fourteen children, only one had deaf parents. Each teacher and her group of four or five children had a 'home base' area in which "small group" activities were held in the morning. During "free choice" each of the areas housed a different activity: art, math, science, blocks, and dramatic play. The "blocks" area, bounded by a semi-hexagonal set of shelves (whose movable outer limbs were attached by hinges), was more commonly used as the group meeting area and for other full-group activities. Eating took place in the part of the room nearest the sink, but also utilized parts of two groups' areas and some nearby open space. It should be evident by now that room rearranging (furniture moving, supply shifting) was common, and included a mobile computer that travelled each day to a different area.

3.1.2 Location of Computer

Upstairs, a mezzanine encircled and overlooked the Primary area. It contained offices, the library, a kitchen / eating area, a media corner (where a VCR and monitor were set up), and shelved teaching materials. Along one side of this active zone, between the library and the kitchen area, and against the railing overlooking downstairs, was where the computer we used was situated. This placement resulted from a discussion with teachers, who could not think of any other place where space could be spared. They also did not want the computer to be part of the classroom area because all the children were not part of the study, and they did not want the responsibility of seeing that each child had a turn. As it turned out, after the initial presentation and discussion, the Primary teachers only met one time to learn about the software. Their time was scarce.

3.1.3 Daily Schedule

The children attend school five days a week, with a half day on Wednesday. An approximate full-day schedule is as follows:

8:20-8:45	Arrival at school
8:30-9:00	General social time, with children putting on their auditory trainers and practicing speech
9:00-10:00	Small Group time, in which the children work on various subjects (reading, writing, math, computer) with their own group and teacher
10:00-10:35	Recess: a free time of play in the enclosed playground behind the building

10:40-10:55	Snack time
11:00-12:00	Some combination of group meeting, free choice, storytelling, story re-enactment, special party
12:00-12:30	Lunch: a social time for children and teachers
12:30-1:00	Recess
1:00-1:30	Rest time-pillows and blankets appear out of the woodwork and all curl up in private corners; very few actually sleep
1:30-2:15	Whole group activity (e.g. swimming, auditory training)
2:15-2:30	Departure

Each "free choice" area (except for dramatic play) was set up the same way every day for a week; the teachers and aide rotated through the areas on a weekly basis. The dramatic play area was set up on a four-week basis and had different themes. The children helped build structures, decorate the area, and assume roles accordingly. For example, the area became a woodworking area one month. One time the area was a t.v. studio with a huge t.v. screen the children could stand behind and be filmed by a home-made camera. Another time the area was Antarctica with painted murals, and an igloo built with plastic milk jugs. Each day the children chose which area they would go to (depending on whether or not the area was already full), but were supposed to visit all of the areas during the week. The idea was that the children had a choice about what they would do when, as well as a responsibility for juggling their time themselves.

3.1.4 The Preschool Class

The Preschool class had three teachers and one teacher's aide, but all were hearing. There were fourteen children in the class, none of whom had deaf parents. The three-year-olds only went half day; the four-year-olds had the same week as the Primary class. Preschool storytelling was in the afternoon, and they did not do story re-enactments. Their free choice areas were art, dramatic play, blocks, and the "thinking area." Because the children were younger, the teachers took more control over what was happening. Also, the children did not work as much on joint projects as they did on the same tasks individually.

3.2 Selection of Children

A total of four children were selected from Preschool and Primary. The selection process began with a meeting where teachers expressed concerns, hopes, dissuasions, and schedule limitations. They agreed that I could spend time working with different children before making the final selection. Some of their concerns were:

- The girl having deaf parents was already "advantaged" since she had normal access to language and concepts.

- Many of the children were considered "learning disabled." Did I want to include them in the study? (I saw no reason to exclude them, since for many the delay seemed to involve communication difficulties at home.)

- Primary teachers did not want children chosen who had been involved in a computer study the previous year.

- Primary teachers thought before-school time was ideal; Preschool teachers said before-school time was out since it was important to the

children's social development.

- Primary teachers thought it was okay for the children to miss one free-choice time and one small-group time. Preschool teachers did not want the children to miss small group, but one free-choice time was okay.

- Preschool teachers thought missing one rest time would be all right. Primary teachers thought it would be unfair to the other children if someone was allowed to miss rest time, since no one particularly liked it.

Keeping the above in mind, and realizing the time constraints on the project, the following criteria were used:

- The children would be of varying abilities and ages, based not on records, but on classroom observation and comments from teachers.

- Two boys and two girls would be desirable.

- Both "learning disabled" and not would be included.

- The children must enjoy working on the computer.

- The children must feel comfortable being away from the others for a fair amount of time.

- The children must feel comfortable with me and I felt comfortable with them.

Three primary children and one preschool child were chosen:

Name (ficticious)	Brett	Angela	Joshua	Kusum
Sex (M/F)	M	F	M	F
Age (at start of study)	4	5	6	7
Learning Disabled (y/n)	n	y	n	y
Bilingual family (y/n)	n	y	n	y
Number of deaf siblings	0	1	0	0
Fluent signer (y/n)	y	n	y	n
Able to read (y/n)	n	n	y	n

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3.3 Schedule

Each of the children was given two time slots at the computer per week, except for Brett with whom I met once a week. The time slots were 45 minutes long, but the actual amount of time spent varied from child to child as well as from session to session. Although the teachers felt that the childrne would not last 45 minutes, they often did, and sometimes more. I usually let them stay at the computer for as long as they wanted until their regular schedule demanded otherwise, unless their attention was far from any possibilites at hand.

From December to May the children each spent approximately the following total number of hours and sessions at the computer:

Brett - 12 hours, 22 sessions
Angela - 18 hours, 33 sessions
Joshua - 24 hours, 33 sessions
Kusum - 38 hours, 36 sessions

I visited the school three times a week. In addition to time at the computer, I also observed the children in their classes whenever possible. Two things made this difficult: 1) I was usually with one of them during their small group and free choice activities. 2) Preschool and Primary time schedules were basically the same, so oberving in one room meant missing what was happening in the other; since three of the children were in Primary (where it was also easier to interact with the children), I spent more of my obervation time there than in Preschool.

3.4 Using the Computer

3.4.1 My Role: A Philosophy

An epistemological goal of this study was to allow the child to take as much control over what s/he did as possible, in order to gain more understanding of what interested the child and how the child worked at new tasks and developed his or her thinking about them. If the study had been set up in an ideal cultural situation, the children would not have been isolated and would have picked up ideas from what others nearby (working on projects of various interest and levels) were doing. However, circumstances did not allow this type of interaction, so the child and I had each other to rely on: I was not there to simply observe the children's work, respond to their questions, or tell them what to do. We were truly there to learn from each other.

In the beginning I introduced the children to SKYDIVERS, BEACH, Logo and The Animated Coloring Book. Always I watched what the children did to see whether they were involved in what they were doing, and if so (or if not), how and why. I also looked at their responses to typing and reading written language to learn about how they viewed themselves as users of written language. Based on these things I would show the children different programs, or continue with the same one. I also wrote a couple of other programs for them to try out. As time went on, I asked them what they wanted to do before we began. (I would, however, try to discourage a continual swapping of programs when it became a problem.)

My role then, was as a "participant-observer" and "teacher-learner."

3.4.2 A Small Community of Users

Another thing I wanted to encourage was the sharing of what they had done

with others. Parts of this were more successful than others. I sometimes encouraged

them to tell their teachers what they had been doing at the computer to see how they

would describe what they had been doing -- what things they felt were worth

mentioning. I also showed them what the others had been doing on the computer,

either by leaving it on the screen for them to see, pointing things out that others had

made when they were using the Animated Coloring Book, or simply telling them

what others had done when an appropriate time came up. Sometimes the Primary

children shared among themselves when they were away from the computer, or they

would ask me what someone else had done. It was exciting to see how they were

interested in and encouraged by the work of their peers.

3.4.3 Communication at the Computer

Communication at the computer differed greatly among the children because of

what they wanted to do and know and because of our ability to successfully

communicate with each other. It took some time for us to get used to each other's

signing and to adjust accordingly. I used a pidgin form of ASL with the children,

and rarely used my voice when I signed; this made it easier for me to incorporate

more ASL constructs when I was trying to explain things, which was more essential

to their understanding than was using my voice. However, since I was not fluent in ASL, this may have made it difficult at first particularly for Brett, Angela, and Kusum to understand me. Joshua had a better understanding of English, and his parents also use a pidgin form of sign language with him. Kusum was the only one who might have used her voice some when she signed with me, but she too mainly used only sign language when we worked together.

In order to learn signs I did not know (such as signs pertaining to the computer) I asked teachers, especially some of the Deaf people at TLC.

3.5 Descriptions of Computer Programs

The following set of programs was used because of the different possibilities for language involvement they offered, including the use of typed language for communicating with the computer, situations for focusing on developing meaning (e.g. storytelling), opportunities for setting one's own goals, or simply for "messing about" to explore programs. I was interested in finding out which programs the children preferred, how they viewed them, how they learned about them, and what they chose to do with them. This group of programs offered a variety of possibilites, both by choices among them and by choices within a single one, which meant that the children could define different entry-points to using the computer by their choice of program, and within that particular program. This flexibility allowed me to understand better the children's learning styles, interests, and preoccupations with language issues.
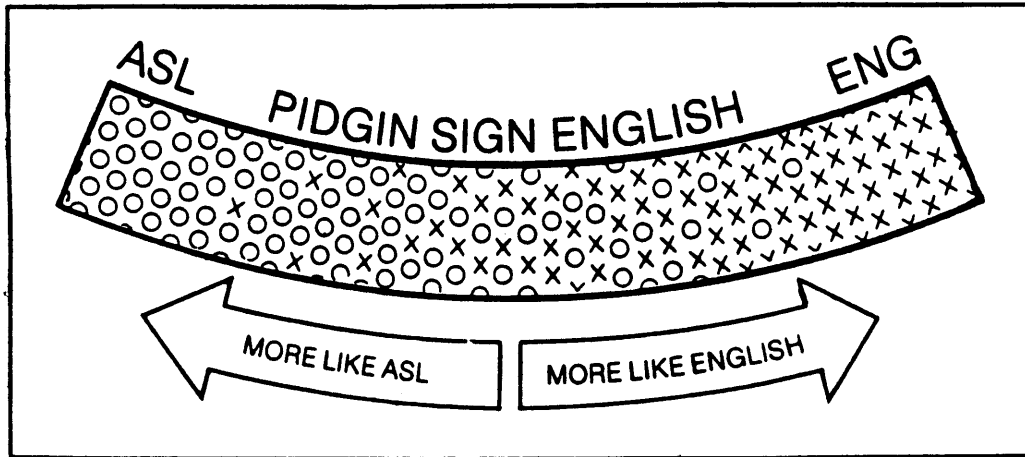
Figure 3-1: The Continuum of Language Forms Between ASL and English
(Diagram from Baker and Cokely, p.73)
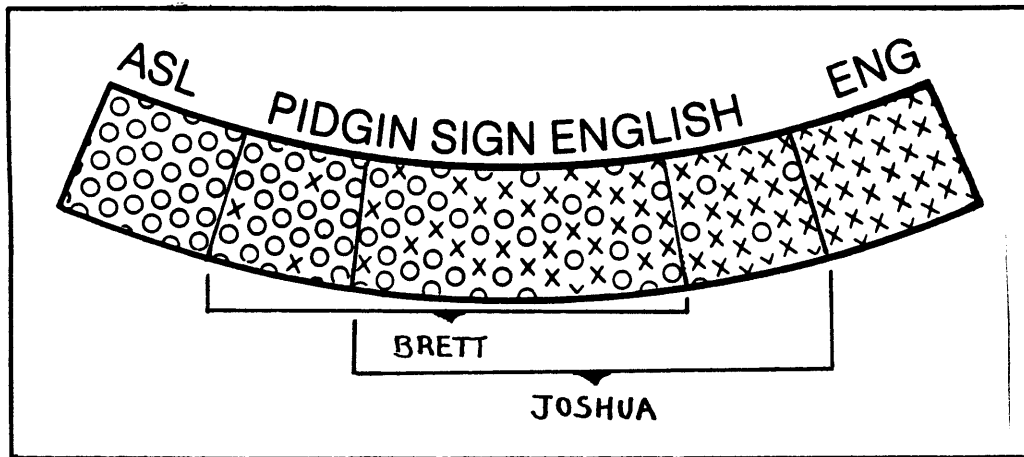
Figure 3-2: Brett and Joshua's Sign Language Forms

The markings in the above continuum show an estimate of sign language forms used by Brett and Joshua. It was difficult to place Angela and Kusum on this scale, especially since their signing was not up to age level. My own signing fluctuated (depending on the child) around the middle of the spectrum (Philip).

Each of the programs used by the children was written in Sprite Logo or was Sprite Logo itself (with the exception of a few uses of Kidwriter). The programs used were The Animated Coloring Book (ACB), a series of "microworlds" developed for a Head Start program by Bob Lawler -- specifically BEACH, BLINKER, EEL, JUMP, and SKYDIVERS -- and a few programs I added: a "mad-lib" fairy tale program, a simple sentence generator, a collection of procedures for printing shapes on the screen, and a Parachuter program for the Markman mini-study. The children spent varying amounts of time with each of them. The program descriptions will begin with Sprite Logo, since it is the foundation for the others. Each description will be followed by a discussion of howtthe program might be used by the children, and the kinds of observations that could be made, with the exception of the last four programs, for which the discussions are part of the description, because they focus on the reason each was written.

3.5.1 Sprite Logo

3.5.1.1 Description

Sprite Logo is an extension of the programming language Logo designed by Seymour Papert and other researchers at MIT. (See **Mindstorms** for an in-depth discussion.) It is geared toward reflective learning. A primary appeal for children is its "turtle graphics," based on geometric concepts and providing an accessible entry into a world that can become increasingly complex. The child programs the

computer in directions s/he wishes to pursue, using primitives to alter the turtle state

of being (e.g., location, color, direction, speed), such as the following:

Command	Abbrev.	Description
Forward x	FD x	move forward x turtle steps
Back x	BK x	move back x turtle steps
Left y	LT y	turn to the left y degreees
Right y	RT y	turn to the right y degrees
Pendown	PD	put the turtle in draw mode
Penup	PU	put the turtle in no-draw mode
Penerase	PE	put the turtle in erase-line mode
Setcolor z	SETC z	make the turtle's color z
Setpencolor z	SETPC z	make the turtle's drawing color z
Setbackground z	SETBG z	made the background color z
Setshape w	SETSH w	make the turtle shape w
Fill	FILL	fill area under turtle with current pencolor
Shade	SHADE	fill area under turtle with current shape
Cleartext	CT	clear text from text area
Clearscreen	CS	clear graphics and text from screen

Sprite Logo has the additional features of 32 sprites, each of which is equivalent

to a turtle. In addition to turtle commands, such as those listed above, each of the

sprites can be set in motion with the command SETSPEED and a numeric speed

between 0 and 125. A sprite will continue at a given speed in its current direction

until commanded otherwise -- it can respond to commands while in motion. The

sprites lend another dimension of interest and possibilities for programming.

3.5.1.2 Discussion

Certainly the turtle is available to do the child's creative bidding, but there are

several issues at hand with respect to actually making this happen.

The child must realize that one communicates with the turtle through a "new"

language. "New" in the sense that it is only written, has a very strict format, and does not look like English (especially when abbreviations are used), although it makes use of letters and numbers.

I originally thought that because Logo has a specific syntax, it would give a child experience with explicitly thinking about and using this syntax, which could be distinguished from the syntax of other languages the child was familiar with (ASL, written English). This does suppose, however, that his or her uses of the other languages included ways of talking about how language works.

In order to make things happen on the screen, the child must make decisions about what should happen, and the commands needed to make this happen. Acquiring knowledge of commands can take place in a variety of ways -- but they will only make sense to the child either because the child is interested in the commands for the change a particular command produces, or because certain commands are necessary to accomplish some task. Acquiring knowledge of the commands as well as deciding what should be done with the commands are two possible ways to look at the child's use of the Logo language. Because it is a written language, we will look at ways that it might relate to how a child learns about written English. The child's style of interaction can be examined by looking at ways s/he is willing to "mess about," set rigid goals, compromise, etc. with the computer.

3.5.2 The Animated Coloring Book

3.5.2.1 Description

The Animated Coloring Book (ACB), designed by Bob Bickford, was inspired by the observation that children are fascinated with language and are imaginative storytellers. The setup of the ACB consists of selecting backgrounds and characters. Four characters at a time may be used. Setting up is achieved through a series of scrolling menus with each menu leading to a deeper level of menus until the actual items appear for selection. For example, when setting up the characters, one must first choose from a menu of character types (ANIMALS, PEOPLE, TRAVEL...) which then leads to the specific choices (SNAKE, DOG, FLY..., if ANIMALS is chosen). The scrolling menus are stopped and started by pressing the space bar.

Once the scene and characters are chosen, the characters may be moved around with the use of arrow keys, "taught" a path in which to move, given things to "say" (that is print), changed in color, sent home (back to starting position), or induced to make babies. A story can be made by sequencing these commands in a story line. All of these actions are done with relatively few keystrokes. Path-making is begun with [delete]-P. A speed in the range of 0 to 125 is requested. The arrow keys are used to move the character, and the space bar is pressed to leave a "ghost" at a significant point along the path -- not unlike connect-the-dots. Path completion is indicated by pressing [return], or when the maximum number of points has been reached. One types P to view the character moving through the path. "Talk"

operates similarly: [delete]-T allows the user to enter words for the current character; [return] indicates the end of the text; pressing T causes the character to print its "talk." Pressing C changes the character's color, by proceeding to the next color in its cycle each time it is pressed. Pressing H sends the character home. Pressing B makes a character produce babies of the same shape and color, but of smaller size. The four characters are called upon one at a time by their corresponding numbers (1, 2, 3, 4). A story can be sequenced from the above described pieces: [delete]-S asks the user to type in the story, which consists of the different character numbers each followed by the desired action(s) (P, T, C, B, or H) for that character.

In addition to using the scenes and characters that are already a part of the ACB, a child can also create new scenes (using Logo) and characters (using the Sprite Editor through the ACB). These new additions become a permanent part of the ACB to be shared with others who use the system.

3.5.2.2 Discussion

The ACB can be used at several levels of involvement. Children can easily find things to do with the ACB; for example, a child can simply use the arrow keys to move a character around against the background. Because the program has a level of immediate access, the ACB supports a focus on what is happening on the screen, so that meaning can be an immediate priority as opposed to forms of commands.

However, the manipulations for working with the ACB increase in complexity

for such tasks as making a path for a character, operating the menu system to set up the scene and characters, and creating new characters. Because of this the ACB offers a challenge to a child who is interested in learning the workings of the program.

Children might show different approaches for learning about the ACB; for example, some might build their understanding of the program from the simpler commands, focusing on what was happening, into more complex ideas about using the ACB. On the other hand, the child might explore most of the command possibilities for using the ACB, later combining them into meaningful events.

The version of the ACB for hearing children had a voice synthesizer connected so that the TALK function both talked and printed. For the deaf children, this feature was not used, so that TALK had the single result of printing the dialogue. The child's ability to use this, then, depended on his or her understanding not only of dialogue (signed or spoken) but also of written dialogue.

One of my goals for using the ACB was to see how the children got involved with making up stories (in sign language) about what was happening on the screen, and the kinds of characters or scenes they wanted to add and their reasons for doing so. These observations would give clearer understandings of the child's interests (with respect to story content), knowledge of story, and reasons for telling the stories: e.g. preoccupations with communication, enjoyment of storytelling, or real-life narrations.

A capability also existed for a focus on sequencing events, in a way that allowed for "scribbling" (messing about): that is, stringing together allowable actions, then seeing the results. For a child to plan out a story, create pieces on the computer, and put them together would show abilities to identify story pieces and logically reconstruct and resequence them at the computer. Thus, observations of a child working with the story capability would include how the child learned its possibilities, and whether the child planned or tinkered with the story pieces, with or without a finished story in mind, not to mention the final story itself.

THe ACB was a complex material for the children to work with, but only as complex as each child wanted it to be.

3.5.3 BEACH

3.5.3.1 Description

BEACH is a microworld built of Sprite Logo procedures for setting up and moving objects using single-word commands. The BEACH background has horizontal bands of water, sand, grass, train tracks, a road, sky, and clouds. Possible objects are created by typing in their names, e.g. house, boat, girl, boy, people, sun, etc. The most recently displayed object can be manipulated in several ways: the child can "paint" it a different color, set it in horizontal motion using action words (e.g., sail, walk, run, fly), vary the motion (e.g., fast, faster, slow, slower, zoom, turn, halt), or statically postion the object using commands having fixed distances and

directions (up, down, left, right). Since the program is a collection of procedures, it is used in the Logo environment so that Logo commands can be used or new procedures added.

3.5.3.2 Discussion

BEACH relates words to pictures and action words to movement, all within the context of the scene. At the computer, however, the distinction is blurred in the sense that both kinds of words cause an action by the computer; depending on the child, this broader action may be what is important. I made a set of cards to go with the words: blue lettering for "things," red for "actions," and color names with corresponding color spots. With these a child had access to particular spellings, and could try out words without knowing what they spelled. Observations of the children would include memory for new words or their existence, whether or not they took an active role in planning the scene, if they spatially situated the objects, and how they decided on words they wanted to use.

On a first glance, BEACH could be described as a place to learn new words through using them to set up a scene. But, a child's view of BEACH could vary depending on what s/he knew about words. For one who knew very little, BEACH could be a place to notice the importance of the exact left-to-right pattern of letters for making the computer perform the desired action. For one who found strings of letters meaningless or inaccessible, using the program could develop confidence in using the words in a meaningful way.

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3.5.4 BLINKER

3.5.4.1 Description

BLINKER is a program for creating square-tiled designs. A blinking square, which leaves its trail behind it, can be moved around the screen using A for up, Z for down, and the left and right angle brackets to go left and right respectively. The color of the blinker can be changed using the left and right arrow keys to cycle back or forward in a cycle of colors. One use of this program is to visualize and design things in a block format -- as does the Logo Shape Editor.

3.5.4.2 Discussion

BLINKER's single key commands allow the child to focus on what is happening on the screen. The layout of the keys is such that the child could also use two hands for typing, the left hand to control up and down, the right for side-to-side motions. A child could conceivably be interested in pressing these keys, in a touch typing manner, to see what kind of design would result. Things interesting to note about the program's use would be whether the child was interested in abstract or concrete drawings; the extent to which the child "scribbled" with the program; whether s/he had a specific picture in mind (a plan), or looked for meanings in the abstract; the significance of the picture for the child in terms of content and completion; and the use of strategies (e.g. for the uses of color or making a particular shape). Some themes that arise are ones of meaning, action, problem-setting, and

planning.

3.5.5 EEL

3.5.5.1 Description

EEL has capabilities for constructing designs from given shapes. Along each vertical edge of the screen is a column of numbered shapes: a total of 18 different shapes. Along the bottom are squares of colors, meant to be paint buckets in which a chosen shape may be dipped. The child commands a little man to GET a particular shape (by number), PAINT it some color (by giving the color name: RED, BLUE, PURPLE, etc), then PUT it in a particular location. Commands for giving the PUT directions are F (forward), I (inch forward), B (back), R (turn right), L (turn left), D (done positioning), Q (quit without dropping the shape). The program thus has an inherent story in it -- a little man does the child's bidding of getting, painting, and putting shapes.

3.5.5.2 Discussion

Understanding the story of EEL is an important part of being able to use the program, because one needs to realize what the possible actions are when one reaches a particular point in the sequence. Thus, it would be important to notice to what extent the child could keep abreast of the story as well as remember the commands and their syntax for the different story parts. The program is more complex than it

might at first seem, especially for someone who does not read, or has not explicitly put story sequencing into action.

3.5.6 JUMP

3.5.6.1 Description

JUMP is more like a game than may of the other programs. The object is to estimate direction and distance in order to make a little man jump onto a target. Each round begins with a single ring of spots, whose size changes with each round. The spots are black, except a red one which is the target. The little man begins in the center of the ring; typing R or L turns him a small fixed amount to the right or left, respectively. When the child decides the man's head is pointing towards the target spot, s/he presses J for jump, then types a number for the distance of the jump (the distances are the same as those in Logo). If the guess is incorrect a shadow of the man is left where he landed, and the child can try again (T) or quit (Q). If the man lands on target, the child can begin with a new round of spots. Upon quitting the game, the program tallies and prints the number of successfully hit targets.

3.5.6.2 Discussion

JUMP has single key commands (except for the compound J command that asks "HOW FAR?"), which could be viewed as dialogue with the man in the center of the screen. Things to observe are the child's view of the challenge, interest in the

problem, how s/he reacts to misses, and the kinds of strategies and theories about numbers the child applies and develops. An obvious strategy would be to make use of the shadow to help with the next try; in addition, however, the child might also count the number of turn increments made (e.g. 3 R's). Theories of numbers would include ideas about "more," "less," "between," and the amounts of each.

3.5.7 SKYDIVERS

3.5.7.1 Description

SKYDIVERS introduces a child to simultaneous movement and drawing by multiple sprites in the shape of stick figures who move and draw in the sky. Initially, the child chooses how many skydivers there will be. The skydivers appear in a circular formation all facing the same direction. Using single-letter commands they can be directed to turn left (L), right (R), and toward the center (C), to move forward and back (F and B), to put down and pick up their drawing pens (D and U), and to alter the drawing color (A and a number designating which color). Simply typing any digit sets the skydivers in continuous motion. While in motion, their paths can be altered using any of the previously described commands.

3.5.7.2 Discussion

SKYDIVERS lends itself to making abstract designs in the sky. The child can attend to several factors, such as color, motion, number of skydivers, and the

aesthetic of drawn lines. Observations of a child would include what the child found interesting about the program (in its underlying idea), and how the child explored different commands (such as setting the skydivers in motion) and appropriated their use (e.g. focusing on the change of color in the design, developing strategies of combining motion with turns).

3.5.8 "Mad-Lib" Fairy Tale

This program was written especially for Joshua. It had two parts. The first was a series of questions about himself, his friends, and his likes and dislikes. The second part was a short fairy tale in which the answers to the questions were inserted. With this program I wanted to see the level of Joshua's reading abilities, whether he would want to get involved with making up his own story, perhaps for a friend to try, and whether he would be interested in some of the Logo primitives used to generate such a story.

3.5.9 Sprite Shape Designs

This collection of procedures was written especially for Angela and Brett. There were words for different Sprite shapes such as HEART (a favorite of Angela's), ROCKET, CAT, DOG, STAR, and TRUCK. Procedures enabled one to change the Sprite's color and pencolor. Initially the procedures only placed one shape on the screen -- in a random location. Later this was changed to putting up a specified number of shapes. The objects were randomly placed on the screen because Angela

had shown no interest in positioning objects in other programs (such as BEACH), but was interested in typing in words. There was a command FLY for Brett to use with different speeds to set sprites in motion. The children and I added new words, but the original set was based on shapes and colors in the Logo manual so that the children could read them out of the manual (which they greatly enjoyed).

3.5.10 Sentence Generator

This program was written especially for Joshua and Kusum. It randomly generated sentences of the form adjective-subject-verb from three corresponding lists of words the children came up with. The children could use this in different ways: for reading sentences made up of words they had decided on, for devising lists of words, for predicting combinations that might arise, for seeing humor in absurd combinations that arose, or for playing with grammar and adding to the structure of the sentences.

3.5.11 Parachuter

This program was used by each of the children as part of the mini-study related to Markman's work. Upon pressing P, the parachuter would begin its fall, appearing randomly in the top part of the screen. The goal was to put up the parachute to stop the character's fall before it hit the ground (a strip of green along the bottom of the picture). This was done by pressing H. In addition to using the program for the mini-study, I also asked the children how they might want to change the program,

and helped them make changes (only Joshua and Brett did so) to the Logo procedures.

Chapter Four

Portraits of the Children

4.1 Portrait of Brett

4.1.1 Background

Brett is an outgoing, friendly, alert four-year-old (he turned five in March). He communicates easily with both adults and children and, being very sociable, does not hesitate to initiate conversation. He is interested in language and acquiring and sharing information. Brett is profoundly deaf, is a fluent sign language user, and does not use speech at all for communication.

Brett's parents began learning sign language when he was seven months old. According to his teacher, they sign pretty well, but do not consistently do so the whole time he is present in the room. If they do not know a sign, they will fingerspell it for him; he reported one day at school that he had gone with his parents to a m-u-s-e-u-m (fingerspelled).

4.1.2 Classroom Involvement

Brett was attentive in class, worked well independently, and generally got along with his classmates (except when they started bickering over little things and taking sides against each other, as was their wont). In class he responded with

detailed answers to the teacher's questions, for example, about a story they had read or about himself. He could also explain why he had done something: one day another boy complained that Brett had yanked him by the arm out on the playground. When questioned, Brett explained that he had done so to prevent the boy from being hit by an approaching tricycle. He particularly enjoyed free choice activities. One time, when I came down to see if he wanted to go work on the computer, he informed me (even before I had asked) that after lunch, during rest time, he would play on the computer. (I also think it was more exciting for him to get out of rest time.)

4.1.3 Knowledge of Written Language

Brett knew the alphabet in capital letters and was learning the lowercase letters. He knew how to spell his first name (which he spent a weekend at home practicing on a typewriter). He seemed to have a pretty good memory for remembering words: one day his teacher spelled "baby" for one of the girls in his class who had brought her doll to school. Even at the end of small group time he still remembered how to spell it.

4.1.4 Early Use of the Computer

The first time Brett used the computer was a special event. He had just made a robot out of some spiny construction pieces and was making it fly through the air when I came to get him. This was ideal, because his robot resembled the little people in the SKYDIVERS program. Brett was interested in the program, not only for the

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experience of typing at the computer (which he did very carefully), but also to sit back for a minute and watch the people flying about. Sometimes he would make his robot follow the same path through the air.

4.1.5 Overall Use of the Computer

Brett spent less time at the computer than the other three children did: usually only one session per week. He was always fascinated by what the other children had added to the ACB -- part of his interest was to find out who the other children were. An important part of his work at the computer was exactly this type of thing: discussing other things that were related to what was on the computer. He was interested in rockets, trucks, robots, monsters, and animals. And, whenever anyone walked by, he was sure to engage them in conversation, or at least inquire who they were.

Sometimes he had attention for the computer, other times not. By the end of the year, he seemed less interested -- too many other things on his mind.

4.2 Portrait of Angela

4.2.1 Background

Angela is a very energetic, mischievous, sturdy, and lovable five-year-old; her primary means of communication is sign language, although she will sometimes try, for example, to vocalize people's names in order to get their attention. Not a
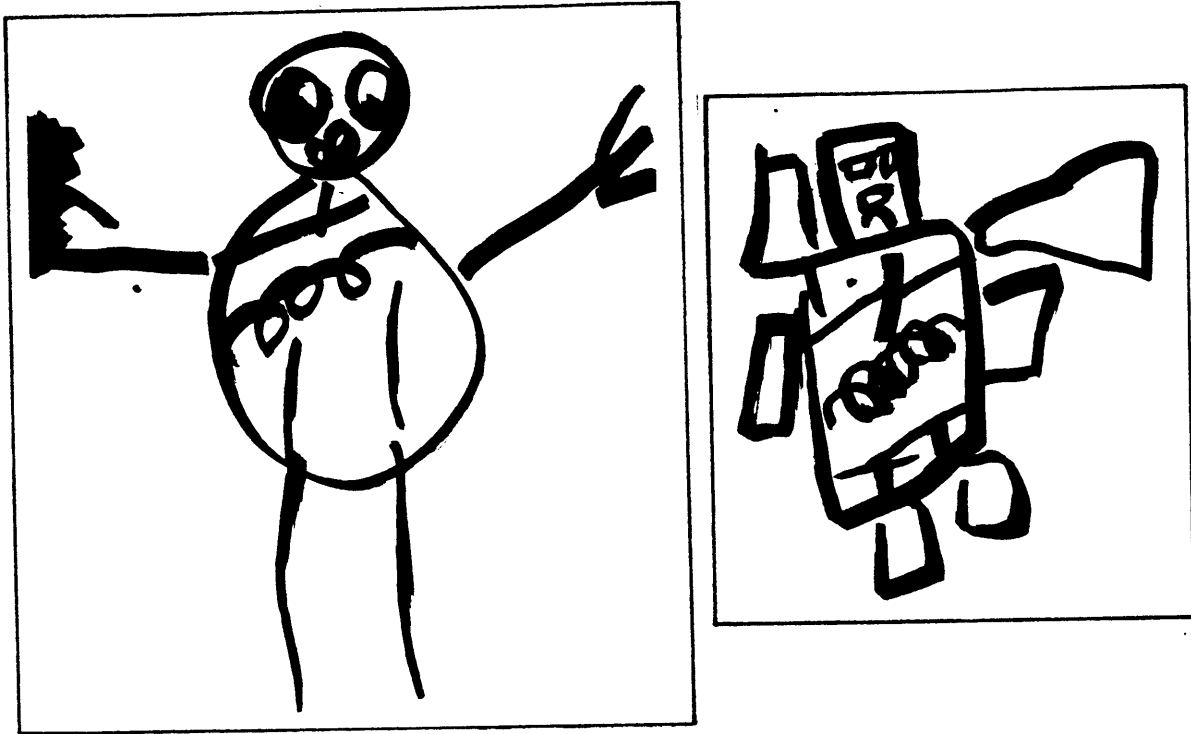
Figure 4-1: Two of Brett's First Characters for the ACB:
"R" Monster and "B" Robot

Brett did not actually name these two creatures "R" and "B," per se: when I
asked Brett what he wanted to name each character, he gave them each a
sign-name. That is, he designated a sign location and used a letter
handshape, as sign-names are often made. This reflection of his sign language
preference interestingly left no immediate name translations for typing in,
except for "R" and "B."

surprising use of her voice -- she often wants to get someone's attention. She has a little bit of hearing (as demonstrated by her interest in making the computer repeatedly beep!), but her speech is basically unintelligible.

Angela's family is from Puerto Rico, and Spanish is the primary language spoken at home. Her father speaks English and has taken a class in sign language. Her mother speaks scarcely any English and knows only a little bit of sign language -- with which she speaks Spanish when using it. Angela has two older brothers, one of whom is deaf and also attends The Learning Center.

4.2.2 Classroom Involvement

There is no question that Angela was comfortable using signs at school, she just had not mastered many useful structures of questioning, time constructs, and ways to reference other events or elaborate on narratives / explanations. Her communication included other actions and gestures, especially pointing. As for understanding, Angela sometimes chose not to watch an explanation, and in any event, had a short attention span. Her short attention span might have come from being easily distracted, or it might have been a defense mechanism because she did not expect to understand. The times she seemed most attentive were when she was watching a Deaf woman who came in to tell stories in American Sign Language. One time she was following so closely that her hands moved with the signs. This would seem to indicate that not only was she interested in the content of the stories, but also had an easier time understanding things in American Sign Language than in a form of signed

English.

4.2.3 Knowledge of Written Language

When Angela began the project she was interested in letters and could almost spell her first name -- often she left one letter out. She knew the capital letters of the alphabet pretty well, but did not yet know the lowercase ones. One of the first times I observed her she drew a picture of a rainbow and made up a spelling to go along with it. Her teacher said this was the first time she had tried writing something herself; usually if she wanted to write something she would ask someone for the spelling of the word. Surprisingly enough, Angela spelled 'rainbow' RAMML, but her teacher said it was coincidence that she had gotten off to such a good start.

Asking for help spelling words was indicative of her behavior in the classroom. She had a difficult time focusing on schoolwork; she always needed to have a teacher working with her. Her teacher told me that the computer was one thing that got her attention -- she really enjoyed using it; however, her usual way of using it was to randomly type until the computer would go haywire, making the screen black out or flash strange patterns. Perhaps this was her way of getting the computer's attention!

4.2.4 Early Use of the Computer

Her first time at the computer Angela used the BEACH microworld, and showed her preference for this program for a long time afterwards. She enjoyed typing words to make things happen, not necessarily to set things in motion or to lay

out a particular scene, but rather to add new objects and change their colors. When objects were set in motion, she may have felt she lost control of them. Initially, she was not familiar with the keyboard and had difficulty finding letters, or would hold a key down too long so that it repeated; despite her impatience and exuberance, she insisted on doing things herself and learned to make optimal use of the delete key -- when she chose to, she could delete back to exactly where she had made her mistake and continue from there.

4.2.5 Overall use of the Computer

Every day Angela would sign to me "Computer?" or "Me computer with you?" She was always eager to come upstairs with me to the computer; how long she actually spent at it once she got there varied. Statistics about her time with me show, for example, that from mid-November to mid-March, she worked on the computer with me 20 times for a total of 11 hours 40 minutes. This does not, however, reflect the amount of time she actually spent using the computer. There were times when she could barely sit still: she would pretend she had to go to the bathroom so that she could get up, or begin asking questions about things around the mezzanine -- insisting that her mommy told her she could have one of the candies on the teachers' lunch table; decide she wanted to use the nearby electric typewriter which was not ours to use, or, even more presumptuously, decide that she wanted to use the video equipment; or simply watch what was going on downstairs from our bird's eye vantage point. Our dialogue always tended to the here and now, related to

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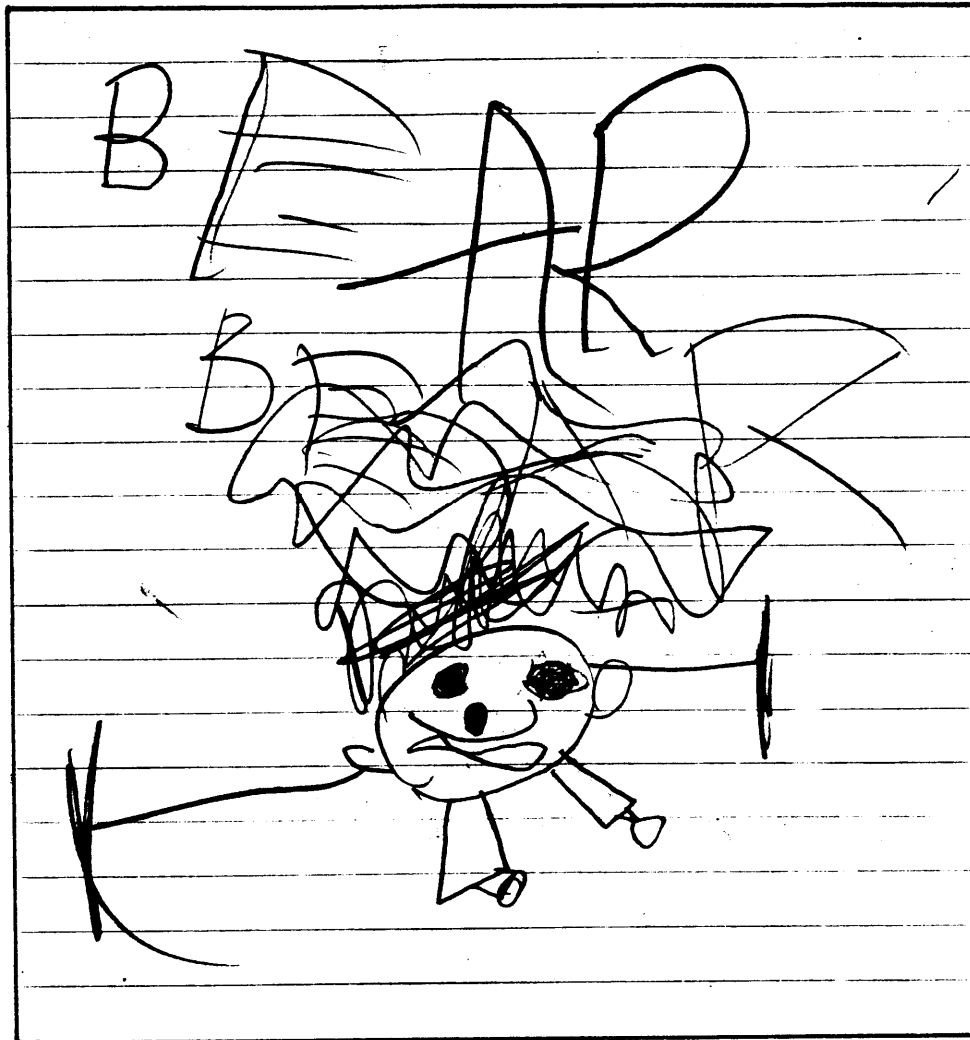
Figure 4-2: Angela's Bear

Angela drew this after telling me she wanted a bear (on the computer), and I asked her to draw it for me. She seldom drew when at the computer; she would occasionally copy words from the computer, write her name, or ask me to fingerspell a word for her to write.

the computer or other things around us. She had many ploys for turning the focus of what was happening on the computer back to her own whims and fancies. This varied greatly from session to session. Even the time of actually using the computer was not always purposeful -- she would randomly type, sometimes causing the computer to go haywire; sometimes she would type something and then delete it, continuing to press the delete key long after there were any characters on the line, because she could "hear" the computer beeping.

On the other hand, we had some wonderful times at the computer.

As time went on, Angela would still engage in random typings, but seldom to the extent that they would force the computer to give up. Her typing and focus on words and letters greatly improved. She found that she had a use for reading from a book, as she used the manual to read the names of colors. At the end of the year she even tried reading some of the words I had written in a notebook while she was typing them.

4.3 Portrait of Joshua

4.3.1 Background

Joshua is a knowledgeable, confident and independent six-year-old (he turned seven in March). He is profoundly deaf, but is considered an "advantaged" child: his whole family learned sign language, including grandparents, cousins, aunts and

uncles. His parents "take him everywhere" and really explain things to him, fingerspelling where no signs are available and to show distinctions (such as between a butterfly and a moth). Joshua is a fluent signer, does not use speech himself, but is good at reading lips.

Joshua's grandfather has a computer which his mom uses for their business. Joshua has helped her by typing in names for her. Thus Joshua has already experienced a "real-life" use of computers, which may have added importance to knowing how to use them as opposed to playing with them.

4.3.2 Classroom Involvement

Within the classroom, Joshua was considered bright by the teachers and other children. Teachers would take time to explain extra subtleties to him (such as a pun on a greeting card). He was chosen to take the central role in the Christmas play. In this, as in the other stories the class acted out throughout the year, Joshua easily remembered lines and actions, and ad-libbed according to his character and the story-line. During Show'n'Tell children often picked him to ask a question because he asked "such nice questions" (as his teacher often pointed out). At lunchtime, he was often seen relating lengthy stories and events to other children (or adults).

4.3.3 Knowledge of Written Language

Joshua enjoyed reading and was encouraged by his parents, who took him to the library each week to get out a new stack of books. When Joshua's father came to school for the Christmas play, the two of them sat down together afterwards to read a book; Joshua signed the story, asking his father or the Deaf teacher for help with words. He preferred reading silently rather than with sign language, though, because it took too long to do a sign-per-word translation. Joshua told me Curious George was his favorite, and that he had many Curious George books at home.

Joshua knew a great deal about the structure of English from his reading, and enjoyed correcting spelling or syntax of sentences his teacher wrote up on the chart. (He could be pretty insistent about a correction, even if more than one possibility was acceptable!) He had a more difficult time with writing, which he found a somewhat frustrating process. He had a hard time remembering how to spell words he knew. It was interesting to watch him type things at the computer -- sometimes he would play with the spelling of a word until it looked right to him, as though he had an image in mind of how the word should look, but did not know exactly how to spell it. For example, he would have a pretty good idea of the letters in a word, but would not get them in quite the right order, and, of course, could not make use of the sounds of the letters to make that decision. Or, he would ask for the spelling of a word, but after being told a couple of the letters could finish it himself. Again, he could not make use of letter sounds to get him started on the spelling. Things that

he wrote often had the flavor of a storybook text, containing descriptive words and pieces of dialogue, again showing the influence of his love of reading.

Joshua was proud of his English skills and made concentrated efforts to learn and remember new words. He expected to get information from what he read, so he was always sure to pay attention to printed matter and ask for an explanation when he did not understand.

4.3.4 Early Use of the Computer

The first couple of times we worked together we used Sprite Logo. Joshua recognized the turtle on the screen and associated it with an "instant" form of Logo he had used (in "instant" Logo, complete commands are abbreviated with a single letter). He immediately began typing "FFFFFF" and was surprised when nothing happened -- ordinarily the turtle would have moved forward. Then he looked to me for explanation. This was a forerunner of many such times: whenever possible, Joshua liked to try to figure things out himself, relying on his past experiences in similar situations.

Joshua's first choice, after I explained that the command FD (forward) needed a number to tell the turtle how far to move, was 100. I then told him he could try a large number if he wanted to and quickly found out that he had a broad sense of "large": he typed 10000000000 (approximately) and got an "out of bounds" error message -- his number was too large for the computer; it did not "know" that

number. After this he often experimented with large numbers, in order to get the most for his efforts, and developed that the computer was stupid and did not know as much as he did.

Joshua told me he wanted to change the color to black, as Angela had done. At some point he had found out what she had done at the computer only a little while before. Throughout the remainder of the year he was influenced by what others had done -- wanting to do at least as much as anyone else, even to the point of trying again a little harder when he found out that someone else had accomplished what he was about to give up on. I gave him a choice of changing the color of the lines that the turtle left or the color of the background. He chose the background, and a little later asked how to change the pen color. During these first 20 minutes he learned and played with Forward, Back, Left, Right, Setbackground (color), Setpencolor, Cleartext, and Clearscreen. To see what he understood about the commands, I let him stay a few minutes and explain how to use them to the next little girl who came up. He began by giving her a choice of Forward, Back, Left, or Right. She chose Left. He gave her a choice of 1000 or 5000, perhaps so that she could get a feel for numbers that were acceptably large. She chose 5000. When the turtle ended up facing a little bit to the right, Joshua pointed out that it had actually turned to the left -- he understood that it had turned left so much that it looked like it had gone to the right.

4.3.5 Overall Use of the Computer

Joshua enjoyed learning all there was to know about the computer, so he tried out many different programs. He liked to do things for himself and asked for explanations as to why things happened. Although he did add some of his own animals and a scene to the ACB (and was very partial to his own creation), he seemed to find this secondary to knowing how to run the programs himself. His comfortableness with written English facilitated his work on the computer. He was alert to everything that happened or that I told him, and aptly retained commands he had learned. A few times he asked to bring someone up with him. This did not work out well, because he liked to have things his way and do everything himself. Although he seemed to enjoy having someone else there to share with, the other person had a hard time actually participating.

4.4 Portrait of Kusum

4.4.1 Background

Kusum is a playful, winsome, sensitive, and attentive seven-year-old who reacts somewhat shyly when she encounters a new person or situation. Her family is from India. Her parents speak Hindi to each other and English with Kusum and her two younger sisters (the youngest is just a baby). Kusum's parents do not use sign language with her; her mom said she does not have time to learn it (both parents work full time). Her three-year-old sister is picking up signs from her. In general,

Kusum's hearing is not adequate to understand speech. Her speech is limited and not intelligible enough to be consistently understood. Kusum's parents continued to show concern about her progress in speech, although staff at the school and others who have tested her have urged them to use sign language with her.

4.4.2 Classroom Involvement

Kusum attended Preschool at TLC for almost two years; this is her second year in the Primary class. She is comfortable using sign language, but has a difficult time expressing herself in conversation. It is hard to tell how much she understands -- she rarely asks questions when she does not. Kusum has developed the habit of watching others carefully to know what she should be doing. When a teacher asks her a question, it almost seems as if she tries to read the answer on the teacher's face. During a group meeting, if a general question is asked, Kusum will often look to see what others are signing and then begin signing herself. In her class activities, if she is not sure what to do she will try, if possible, to follow someone else's example.

Kusum usually ate lunch with two other girls (Angela was one of them), who were both a couple of years younger than her. She had a peer within her small group: a boy about her own age, who also came from a bilingual family and who, like Kusum, was somewhat behind the other three children in their class. The two of them got along well working together.

One activity that Kusum enjoyed was drawing. She would often draw with

some of the children in the morning before school and would frequently bring in drawings from home to give to teachers and even other children. These were very important to her. She called them 'letters,' and as such they were a form of communication.

4.4.3 Knowledge of Written Language

Kusum was comfortable with the alphabet (upper and lower case) and could spell her full name along with some names of people she knew. She also knew a few other words. She had difficulty reading things. One of the things the children did during small group was to work on their own booklets to go along with a storybook their teacher read to them. The booklets had pictures on every other page, which the children pasted in and colored, and lined pages in between on which the children wrote their own stories -- they would tell the teacher what was happening in the story (as related to the picture), and she would write it up on the chart for them to copy. Kusum had a hard time reading her booklet. For example, a word she had read on one page she would not necessarily recognize on another page.

4.4.4 Early Use of the Computer

The first time Kusum worked at the computer she used SKYDIVERS. She was hard to work with because she would not look at me so that I could explain things to her. When she did look at me, she did not seem to understand me (even after repeated explanations). This may have been because she was not used to my signing

Figure 4-3:A Letter from Kusum

Kusum brought me many "letters" that she had drawn at home. This drawing shows several themes, including computer-ese: arrows (arrow keys) and question marks (the Sprite Logo prompt).

(particularly for this new computer program) -- it may not have been close enough to ASL for her to easily understand me.

However, after asking for paper and writing down some of the command letters, Kusum became more intent on what was happening on the screen. Although she did not master the two-step command for changing the color of the lines, she became intent on filling the screen with different colors as the skydivers left their trails of lines. She had found an interest (the use of color) and set a goal for herself (to fill the screen with different colors) that gave her a new interest in the commands that could make this happen.

The next time she used the Animated Coloring Book. This time she remembered various commands and became proficient at making characters' paths (a multi-step operation) herself. She asked for a cow, which did not yet exist, but which led to using another part of the ACB to make new characters. This was the start of her involvement with personalizing the ACB. Often she would say she wanted to have things, but which she did not know how to do, or which might not have been possible to do. Together we made what we could -- Kusum sharing her ideas, building on them, and also getting involved with the how-to's -- because the end result mattered to her.

4.4.5 Overall Use of the Computer

Of everyone, Kusum spent the most time at the computer. She used the ACB most of all, but also worked with some of the other programs, including Logo, EEL, and BEACH. Her attention to words increased as did her interest in typing (which at first tired her when there was too much). While she enjoyed using the computer, she also built up a relationship with me. Especially at first, she would not only use the computer, but would ask for paper and magic markers with which to write or draw. Sometimes she would just feel like typing at the computer. More often than not, she had some plan in mind. She would type names and ages of people she knew or perhaps her numbers from 1 to 100. Eventually she began to tell me things about herself, and ask me questions. Then, she began dictating stories for me to write down about what was happening on the computer. It seemed that something new was always happening; there was a continual building on things we learned from and about each other.

Chapter Five

Analysis of What the Children Did

This chapter will look more specifically at what the children did: their styles of learning and doing, ways that they set and solved problems, their engagement in storytelling, the ways they got involved with written language at the computer, and their influence on each other. The discussion will describe and reflect on the children's work at the computer. The chapter is organized with respect to issues of learning to read and write.

5.1 Styles

The children, especially Joshua and Kusum, had contrasting styles of working at the computer. Joshua and Kusum differed in how they approached the computer, what they wanted to learn and do, and their interests in programs. In the ETS study and from Manson's observations, we saw how children can arrive at the same ends by very different means, as well as how personality and knowledge can affected the means that "work" for the children. Turkle identified hard and soft masters at the computer (104-122), and Levi-Strauss discussed the notions of bricoleur versus engineer (19-20). All of the studies share an image of a dichotomy between attention to an overall meaning and attention to an accurate meaning of pieces, that affects the way a person works with materials or the goals that s/he sets. Although accomplishing a task may involve both, either one can provide the momentum for

pursuing the task at hand.

Since Joshua and Kusum showed such contrasting approaches, we will consider them first. Joshua and Kusum worked with the Animated Coloring Book and Logo more than the other two children, although Kusum used the ACB more than Joshua, while Joshua used Logo more.

5.1.1 Developing Patterns of Actions

Each learned about the programs in a different way. Joshua devoured all the information he could about what he was learning to use. With the Animated Coloring Book, he immediately took over setting it up -- typing responses as requested and learning to work his way through the menu system. He then proceeded to learn all the commands he could to use the ACB, and would try them out in sensible ways -- changing all the characters' colors to black (his favorite color), or changing them to red and signing that they were hot. He moved the snake by the tree and signed that it was sleeping, then moved other characters to different sleeping locations.

With Sprite Logo, he quickly learned commands, understanding how they worked, and even taking an interest in the full words for the commands. He found immediate ways to explore the commands, such as filling the screen by having the turtle draw lines. In so doing, he tried to get the most for his efforts, investigating how large a number he could use, and using short-cuts such as "Control-y" to re-do

the previous command. He took pride in his knowledge, and loved sharing it with anyone who was available to him at the computer -- teacher or peer. He remembered how the commands worked, and developed concepts of how they could be used. One time when he had forgotten to put up the turtle's pen (so that it would not draw a line) before he moved it to the center of an area he wanted to shade, I explained that he could erase that line, rather then having to erase the entire picture. He quickly understood the idea of putting the pen in erase-mode, backing up over the undesireable line (using the same length), then going forward again and putting the pen down (in write-mode) before giving the command to shade. This new technique excited him, and he began explaining it to a former teacher of his, who happened to pass by.

Joshua's pattern of actions intertwined with his desire to know more about the computer. Because he knew about some capability, he thought of things he could do with it: when he learned how to make new characters for the ACB, he decided he wanted to fill his section (an area named after him, within the ACB, where he could add new characters). This meant he had to come up with ten new ones. By the end of the year, he had gradually worked his way through them all.

Kusum developed certain patterns of actions which she then would repeat in an inventory sort of way, similar to how Manson described young children writing an inventory of letters or words because they knew them. With the ACB, she developed a routine of actions: one by one she changed each of the characters to blue, made
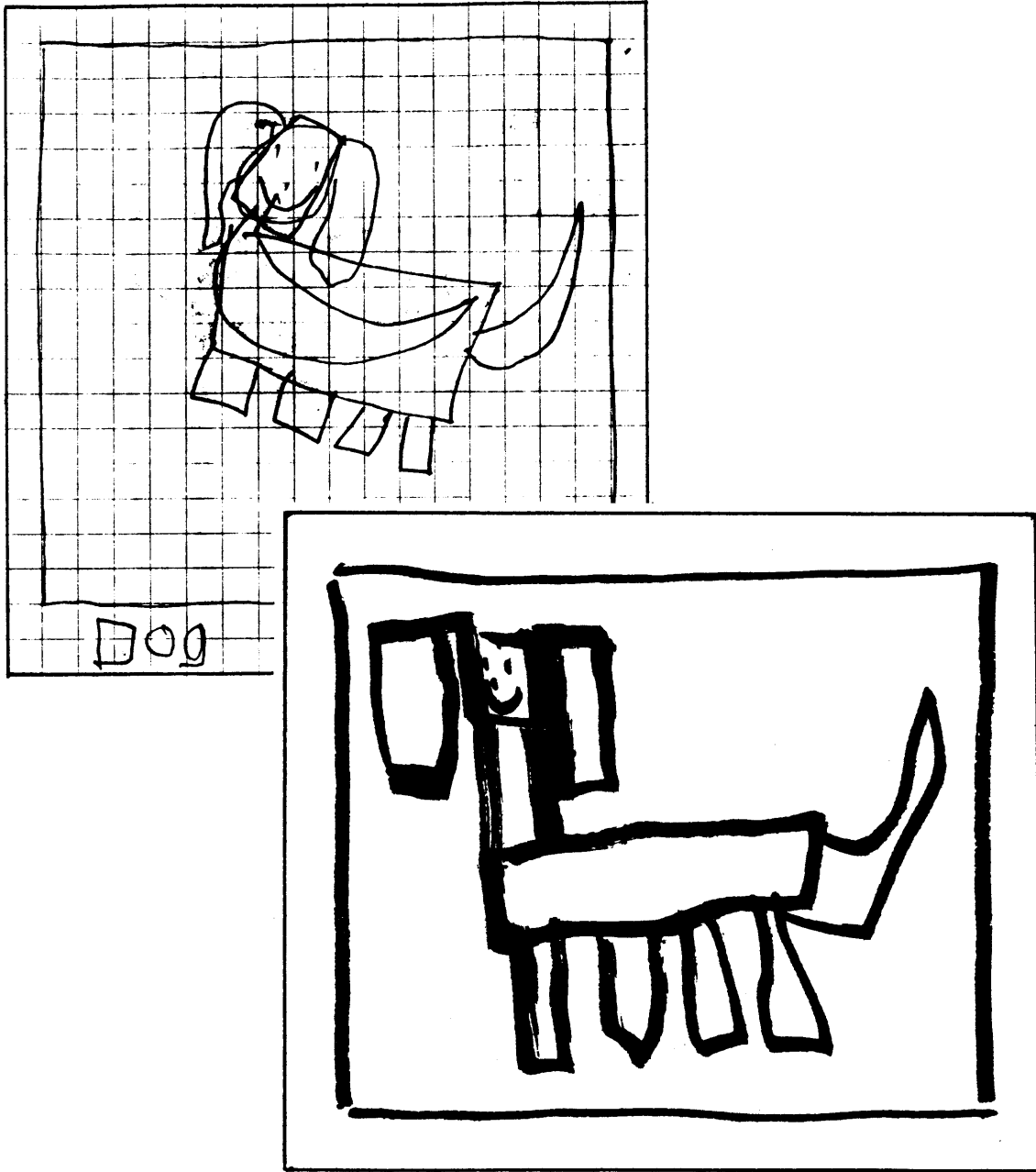
Figure 5-1: Joshua's Dog Drawings for the ACB

These two drawings were done almost 3 months apart. Joshua drew the later one (below) on regular lined paper. One might say he had become fluent in block-style drawings. The second drawing was of his dog at home: Spinnerbait.

them "disappear" in the sky (which was the same color blue), and made a path for each one, which, after a while, she would not even look at, finally reducing it to a single point. The significance of her actions lay in doing what she knew. Whereas Joshua would challenge the limits of the computer, looking for large numbers that the computer could handle, Kusum would use similar numbers for which she had seen a pattern. One such pattern was a two-digit pattern. Character paths have a speed indicated by a number from 0 to 125. When Kusum found that two-digit numbers were safe, she used those. Similarly, she often used two-digit numbers for inputs to Logo turtle commands such as Forward and Right. By doing this, she was able to type things that worked and that she knew, without having to stop and think about them. Whereas Joshua conserved by finding ways to get the most from his typing, Kusum conserved by doing what she knew would work.

5.1.2 Building on What They Learned

As we began to see in the last section, Kusum and Joshua had different ways of building on things they knew. Joshua's method was to build in understandable bites and was punctuated with calculated actions; Kusum's was characterized more by leaps, in which she suddenly combined pieces of things she knew well.

5.1.3 Reaction to Difficulties or Mistakes

Joshua tended to avoid situations he felt were too difficult; sometimes he was able to come back to them, having gained confidence in some way (e.g. using JUMP,

working with the Shape Editor). Kusum would plunge into situations, whether they were possible for her or not (making eyes, using the Shape Editor). She had a great deal of patience for doing and re-doing things to reach a goal she had in mind, although she, too, would occasionally change her course of action.

Joshua more easily learned from mistakes, asking about error messages he could not understand, or learning from an explanation I gave about how he could correct something (such as the line-erasing described above). He also asked questions about error messages he did not understand, and even discovered a new command SHADE one time that was referenced in the error message. These were pieces he could specifically attend to and add to what he already knew about them. If he chose to do something which was not immediately accessible to him (such as making a spider's web) -- something which required more thought or planning than he knew how to do -- he would prefer to give up the idea rather than try to work through it with help. His ideas were only as important as their perceived do-ability. Kusum, on the other hand, would have ideas that she simply wanted to have happen. She looked to me for help, yet was actively involved with making decisions and executing directions. This was an important way that she learned new things about the ACB and Logo.

5.1.4 Incorporating Other Knowledge

Joshua used other knowledge to further his work at the computer: he used his experiences as sources of ideas for things he could make. He also relied on his knowledge of English for reading messages on the computer; his confidence and

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memory for English helped him remember commands and allowed him to write pieces of dialogue.

Kusum gradually incorporated her concerns about her family, as well as her own interests and experiences. These forces motivated the things she worked on. The difference in her use of experience and knowledge, was that it led to new possibilities for using the computer, as well as for incorporating things she already knew about it. Joshua used his own experiences to give content to what he was learning about the computer. Kusum used her experiences to extend or build on the content of what she was already doing -- it was also part of the dialogue that evolved between us.

5.2 Problem-Solving / Problem-Setting

Problem-solving skills are important to reading and problem-setting skills are important to writing. In reading, one must actively build the meaning of a story, based on one's own experience and knowledge, and in light of what one learns from the story itself. Reading requires a certain focus of attention, confidence in one's abilitites, and involvement. Problem-setting is important to writing in terms of deciding what one will write about; then problem-solving becomes essential in the actual process of writing, for one must put together content using English constructs, making decisions based on who will be reading the result, and considering what should be said and elaborated on. An underlying skill is simply the ability to narrate a story or event that one knows or invents. Below we will look at the children's

approaches to setting and solving their own problems, and their awareness of their abilities to do so.

5.2.1 Solving Given Problems

Joshua showed an ability to work through a problem in his own way, wanting enough information and tools to feel secure, but working in an independent manner, not wanting to look to me for specifics on method. One time I left a message for him by the computer suggesting that he try to make a square using the commands Forward 50, Right 90. The problem he saw was to make a square. He began with the reverse order: a 90-degree turn to the right, then Forward 50. I asked as he came to the remaining turns whether he wanted to go left or right, and used a "turtle protractor" I had made to help him visualize his angle decisions. (The turtle protractor had a triangle-shaped turtle in the middle, like the one on a Sprite Logo screen, which from its starting position of 0 -- that is, with nose pointed upwards or forwards -- could be turned to the right or left. Right and Left were marked as well as the angle sizes in increments of 10 and 45.) Joshua soon picked up on how to use this; he would set the turtle card to zero and turn the card so that the turtle's orientation matched the one on the screen, as he had seen me do. Then he would turn the card turtle to the direction he wanted to go, and read the angle off of the card. One time when he had turned the turtle right instead of left, he used the turtle protractor to turn the turtle left 180 degrees. When the turtle did an about-face, Joshua was surprised at the action, although it was what he wanted. He made the

square as follows:

```
RT 90
FD 50
LT 90
FD 50
RT 90
LT 180
FD 50
LT 90
FD 50
```

Joshua showed independence in his interpretation of the problem I gave him. He knew I was asking him to make a square, and from that and the information about size he had read in the problem, he felt confident to begin. After he began the problem, he abandoned the written "clues," and set about making his square. He welcomed the use of the turtle protractor because it gave him another degree of independence -- he could apply a technique that insured his finishing the problem by himself.

I gave Kusum the same problem, except that I signed the problem for her. She immediately typed Right 90 and Forward 50. Then she looked at me questioningly, so I suggested she try them again. She did so, and went on to complete the square: Right 90, Forward 50 repeated four times. This was consistent with her way of repeating what she knew, without really stopping to think about what was happening. But then she continued:

```
FD 90
RT 90
FD 50
RT 50
FD 90
```
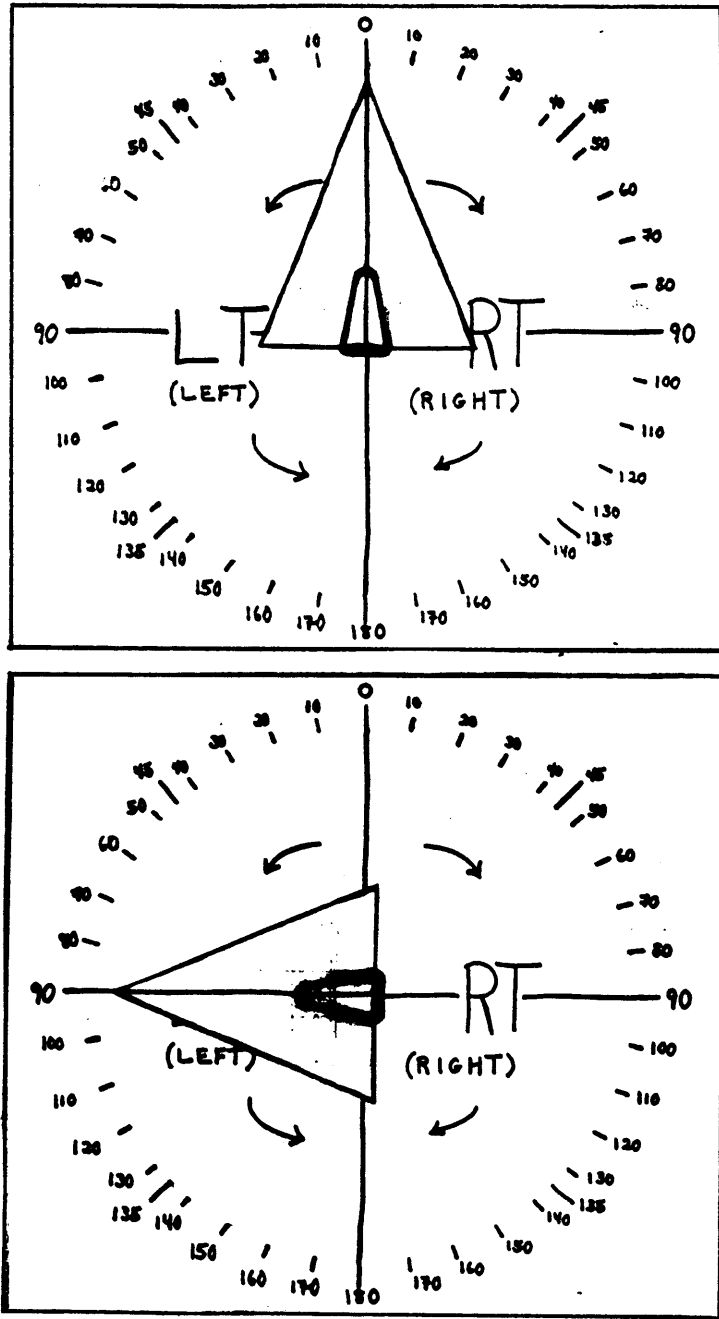
Figure 5-2: Turtle Protractor

The triangle-shaped turtle, matching the one in Sprite Logo, could be turned to help the child get his/her bearings about the direction s/he wanted to face. Above, the turtle begins with "nose" pointing up, then makes a right angle turn to the left.

This time she did not like the results: the pattern was broken, and the lines were out of order. She quickly cleared the picture away. A week or so later, I gave her the commands Forward 60, Right 120, and asked her if she could make a triangle; I wanted to see if she would repeat the two commands as she had done before. She typed them once and then began experimenting with other two-digit numbers. She did end up with a small triangle contained in her drawing, but after a bit, signed that the picture was messy and erased it.

Kusum did not try to think through the problem. She turned it into a time of exploration, but was not pleased with the results because they meant nothing to her. They were empty actions, meaningless and disappointing.

5.2.2 Setting Their Own Problems -- Initiating Ideas

Here I will include things that the children decided they wanted to make or have on the computer. Joshua would often give up on the things he wanted, but with a few things, gradually developed expertise and patience for accomplishing them (such as using the Shape Editor and working with the Jump program). Kusum did not often construct things with the computer by herself. Whether she did or not, she used a great deal of patience and determination to accomplish what she wanted. To look at their involvement in deciding what they wanted to do, we will look at some of the ways they initiated ideas, then the extent to which they carried through on them.

Kusum's ideas usually arose out of things that did not exist or that she could
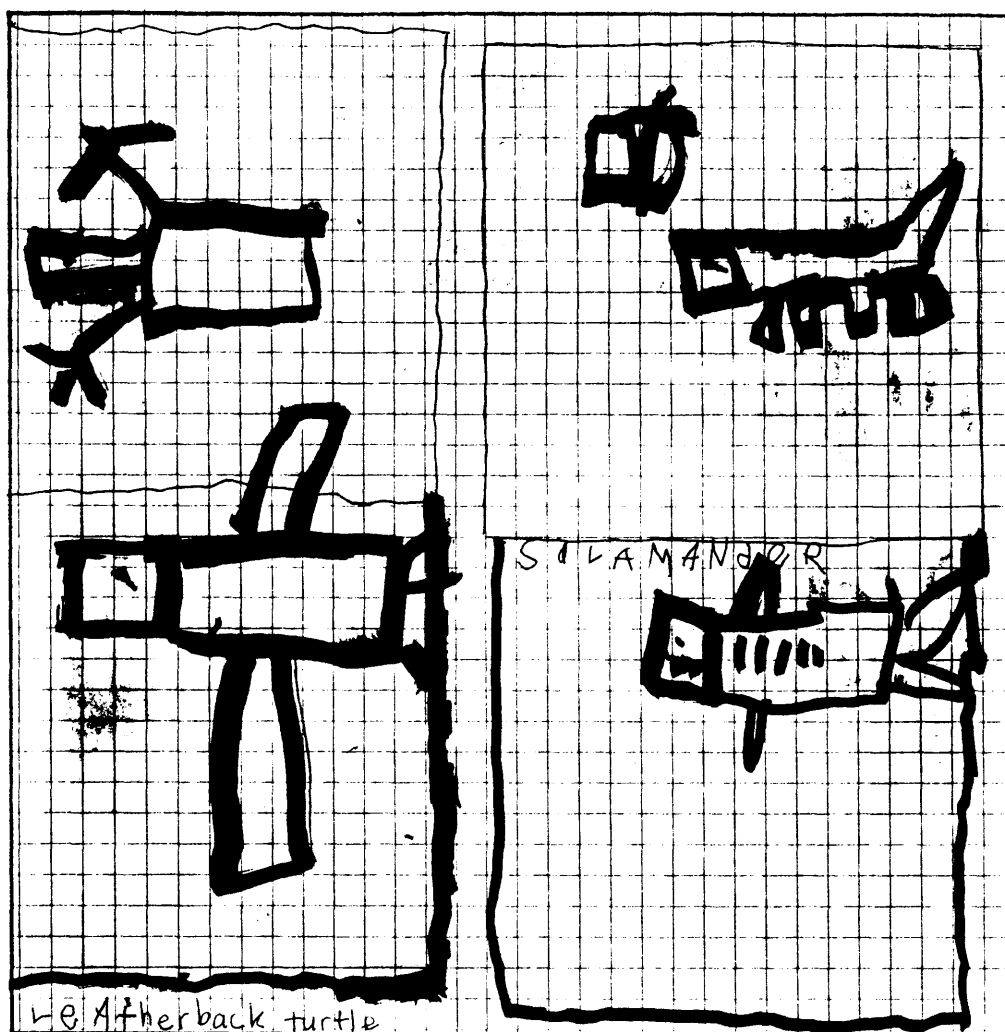
Figure 5-3: An Interest of Joshua's Tied into Words

Joshua was interested in animals; after he made the Sea scene for the ACB, he decided to add (clockwise from upper left) an Alligator (hatching), a (red) Salamander, a Shark, and a Leatherback Turtle. We looked through a reptile and amphibian book -- initially he wanted to look at a picture of an alligator, but he ended up with ideas for the other three. He pointed out creatures that he knew (which were quite a few!), interweaving his own experiencs and information.

not make happen, or they arose out of what she was doing at the time -- she was always looking for meaning in things she did at the computer. Sometimes her ideas were do-able, sometimes not. One of the first "problems" Kusum set was to make a new character for the ACB. Actually, she did not pose it as a problem, she simply said she wanted a cow, which did not yet exist as one of the characters. This happened during one of her first few times at the computer. Since it was possible to add a cow to the ACB, I thought it a perfect time to introduce a part of the ACB she had not yet seen. One of the first few sessions using the ACB, Kusum changed some little pigs to match the sky. She kept moving around another character. Finally she told me she was trying to put it in the sky, as she had done with the little pigs. I explained that it had to be the same color blue as the sky. Another time she wanted to make a character to go into the barn; when I asked her how, she explained, by opening the doors.

5.2.3 Evaluating the Difficulty of a Problem

Joshua was quick to decide whether a task was too difficult for him, but also had ways of controlling the difficulty. He would set somewhat tame goals, or would simplify what he needed to do to achieve them (such as investigating a new program, or simplifying drawings for the Shape Editor -- he even did this with his Beach scene). If Kusum did realize the difficulty of a problem, she usually did not let the difficulty bother her, because if she could not do it alone, she would look to me for help. She did not seem to consider a problem's difficulty, or what steps it might take

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to do it.

Joshua understood why the drawings for the Shape Editor needed to be in block style, and tried to alter his drawings accordingly. At the same time, he also tried to simplify them; for example, his kangaroo only had a head, and his alligator was a baby one poking a head and two arms out of a box-shaped egg. The Sea scene he designed for the ACB had simply a rectangular section of sand, a slightly larger one of water, and the sky (with a few birds in it). He might have had the impression that what was do-able on the computer needed to be simple, but other drawings he made, unrelated to the computer, were similar: a cat's head and a clown's head. He tended to give up quickly on projects in Logo. One of his ideas was to make a spider's web. When I began asking him about the web and how he might make it, he got as far as drawing it and then gave up. The next time we met, I brought a printout from home of a web made with concentric circles and lines crossing through it, having based the circle part on one of his drawings. Since he was often encouraged by seeing what someone else had done, I thought this might make the problem less intimidating. There were circle procedures that he could use as well, which would give him a start on the problem. He began with one circle, then decided he wanted to use a different program. Other ideas he abandoned were a volcano and a pair of eyes. He drew the volcano, signing that it would be "easy" to make, but after a few moves of the turtle gave up, giving the impression that the progress was not fast enough for him. He gave up at the beginning before his uncertainties about proceeding became realities and he lost control of the situation. He abandoned the
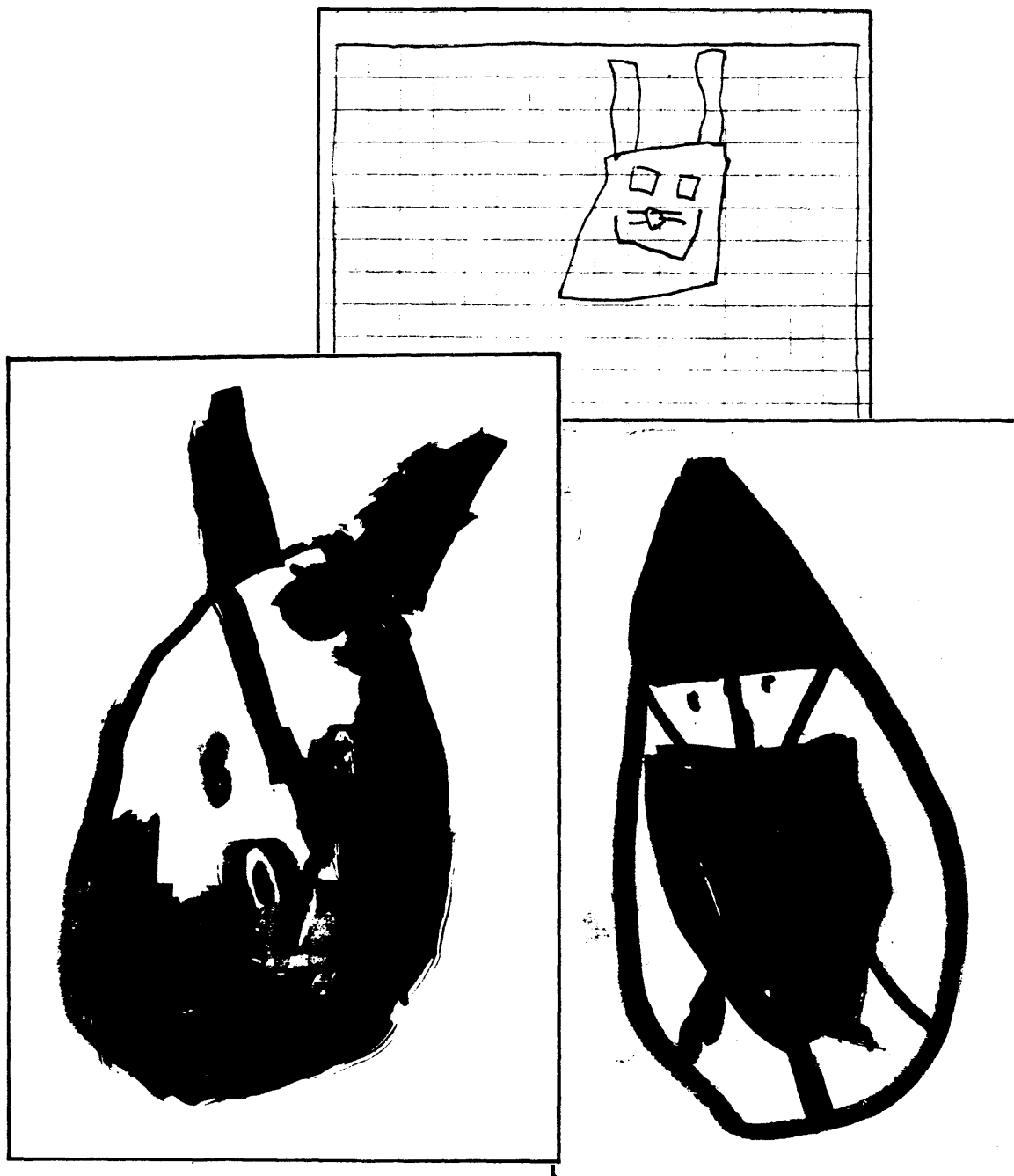
Figure 5-4: Keep It Simple: Faces Only

Joshua avoided situations he thought were difficult. The kangaroo's head (above) was drawn for the ACB; the cat and clown's head (below) were not. Leaving off the body meant he did not have to struggle with drawing it.

pair of eyes as well, adding some other shapes to his initial circles, the last of which was a large triangle that wrapped around the screen (size 9000). The final result was quite pleasing to look at, although not his original idea. He enjoyed surprising results from the use of a large number. Unlike Kusum, he enjoyed "messing about" and the abstract results he got.

Joshua's decisions were related to the extent to which he could maintain control himself. Unfamiliar or difficult situations challenged his security. He had confidence in his ability to learn; to maintain that, he avoided threatening situations.

Kusum did not seem to think much about what she could or could not do. Part of the way she dealt with unfamiliar situations was to rely on other people for help -- either by directly imitating them, by doing nothing until someone helped her, or by doing something different.

The two children's expectations of what they could and could not do greatly influenced the ways that I worked with them. If Joshua was confronted with an overwhelming task he would give up. I needed to give him accessible chunks of things to do, or the concrete tools that gave him an "in," or even the encouragement that one of the other kids had done it. Joshua like to explore, and thus would rather be given pieces to play with than have to discover the pieces within the context of a project. Part of this may have been that he was still young and fairly new to Logo, but it seemed to be more his way of doing things.

With Kusum, I helped her work through things, but while doing so, would ask her questions about what she thought should happen next. I encouraged her to try things herself even though she might not get the results she wanted. Interestingly, when I questioned her about things that she did not know, she would make an effort to remember or notice them from then on (such as asking her what certain words on the screen said, or asking her about a number she had previously used with a Logo command in a similar situation). Because of her patience with doing things, it was beneficial to work with her, asking questions and suggesting ways of doing things; she caught onto them and began to get a feel for how they worked. Usually one thinks of explaining the mechanics first, then letting children work from there and perhaps think up something to do as they go along. But Kusum took an interest in what she was doing because she had an idea in mind. Perhaps the most significant example of this was when she decided she wanted to make a house with rooms in it. With this goal in mind, and after discussing and sketching the rooms, we spent an exciting three hours working together using Logo to draw the rooms and their furnishings. Through this she began to develop an understanding of Logo commands, the significance of the numerical inputs, and ways that one could accomplishing something with a command, such as using FILL to color in an area.

Joshua did not have much patience with Kusum's way of doing things. One time I had them up at the computer together. Joshua tried to run things and did not like the choices Kusum made. He wanted to make a turtle, so each of them drew one, Kusum drawing one like Joshua's (an indication of her lack of self-confidence in her

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own abilities). He did not want to use the Shape Editor to actually make it himself, but wanted me to. I asked Kusum if she wanted to try. She began clearing the shape box. Joshua had no patience for this, feeling that she was just messing things up, rather than understanding that this was a way of learning how to use something. He knew what should be done to make the turtle with the Shape Editor, he just did not have the patience to work his way through it. It frustrated him to see someone going about things the "wrong" way.

Joshua would probably work well with someone whom he saw as a peer and who had similar ideas about things to do, because then they could work at making something happen together. Learning to work with someone at the computer and acknowledging someone else's way of doing things would actually be a good experience for him, for he often had little patience for others' ideas or preferences.

5.2.4 The Importance of Accomplishing Their Own Ideas

As we have seen in the previous sections, Joshua and Kusum placed different values on their ideas when deciding whether or not to continue a project. Joshua often gave up on his idea if it seemed beyond his own doing. Otherwise, he would eventually complete an idea, the most outstanding case being his addition of ten new characters to the ACB, which he accomplished over the course of the study. This project was important to him because it was his own and because of his interest in knowing about animals. Kusum, on the other hand, got involved with the process of making things because of the significance of the idea. What she did with the pieces

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became a continuing dialogue of characters and events (both on and off the computer); for her there was a closer relationship between her real world and the computer world.

The value they placed on what existed, particularly in the Animated Coloring Book, again varied, but oppositely for each of them. Joshua's involvement with the animals and his Sea scene did not lead to any stories, relationships between characters, or things he wanted to say about them. He took great pride in things he made and would usually prefer to set up his own creations rather than anyone else's. Kusum was interested in things that others made, but used them as they fit in with her own schemes and were relevant to her stories. She did not hold onto her own characters and Rooms scene because she had made them. In fact, a couple of things she made near the beginning were obsolete by the end, as new and more important characters regularly took their places.

5.2.5 Realizing What They Don't Know -- A Mini-Study

Markman set up two kinds of tasks: one that was a game, the other a magic trick. In the first one, she left out some information about what a special card in a card game was. The assumption was that children are used to playing games with rules they have to remember. For the second task, she chose a magic trick because one would expect not to understand a magic trick and thus would be more likely to ask a question about how it worked. For my mini-study with the kids, I wrote a program on the computer to have the kids use, since they were used to me explaining
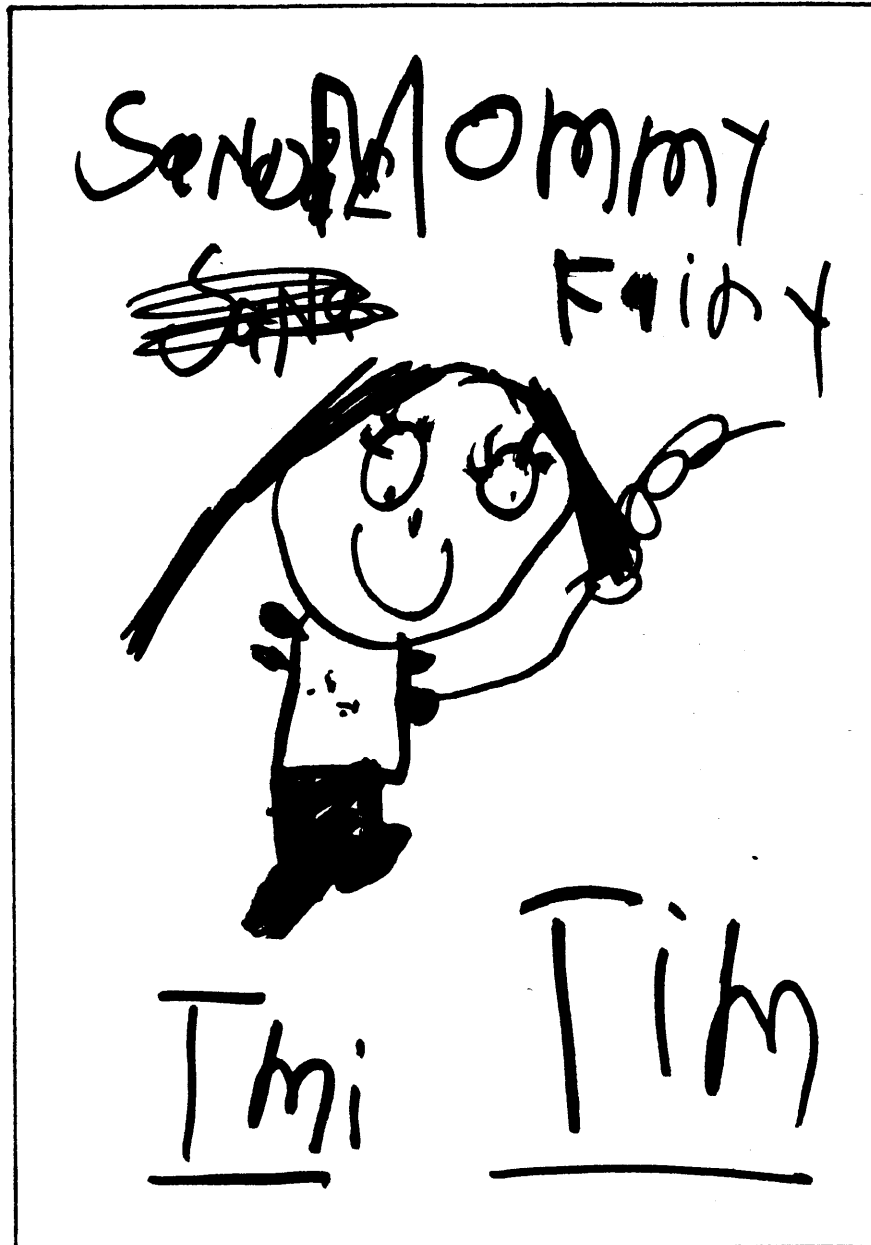
Figure 5-5: Mommy Fairy

Mommy Fairy was one of the characters Kusum made for the ACB that grew out of a discussion we had about the movie "Sleeping Beauty," which we had both seen. This picture was one of her "letters" given at a later time.

things to them about the computer. The supposition was that they would not feel uncomfortable asking me something they did not understand about it.

The program consisted of a little man who, upon pressing a particular key, would appear on the screen (at some random spot) and would begin "falling" toward the bottom of the screen. The child needed to press a different key before he reached the bottom so that his parachute would go up and the man would stop his rapid descent. What I did not tell the children when I explained the situation was which key made the parachute go up and stop the man's fall. This seemed to be a significant piece of information that the children would realized they needed.

As might be expected, Joshua closely followed my description, and had asked me "how?" regarding making the man stop before I had even finished explaining the program. Brett had to actually try the program before he asked how to make the man stop. I had asked him before we started the program if he knew how to start it. He told me "yes, p," but answered "don't-know" when I asked him how to make the man stop. Upstairs, at first he tried some other keys to start the program, but then when I asked him how to begin it, he answered and typed "p." After watching the man a bit he asked me "stop?" to find out how to stop it. He knew prior to using the program that he did not know both keys to press, but did not choose to ask until he was in the midst of the program.

Neither Kusum nor Angela asked how to make the man stop. Kusum did not remember how to start the fall, which I had told her. Angela would not watch me

long enough to try to understand what I was telling her about. In general Kusum did not expect to remember how to do something -- she would remember things about people, but not this other kind of "unrelated" information. She remembered things she had experience with better, but even that did not seem to be enough -- a greater significance than that was required. Angela's lack of attention seemed to be a defense mechanism for what she thought she would not understand, although at times it seemed to be a more deliberate action -- spunkily expressing an independence.

Markman attributes "not realizing" one's lack of understanding to superficial processing of information. Learning to read and write requires an explicit kind of processing. Although the study required an oral demonstration of this realization, it is the existence of an inner questioning or reflecting that is essential to becoming literate. The two boys were both attuned to the workings of language; Kusum and Angela were both just becoming so. Their progress was evident in their work at the computer.

5.3 The Mechanics of Language - Interacting with the Computer

This section will discuss ways that a computer can become a tool for reflecting on written language in terms of making connections between the same text appearing in different contexts, remembering text that is meaningful, noticing the spelling of text that has been typed, and developing the energy for text.

5.3.1 Useful Text has Direction

From the beginning, Angela was interested in typing words. She did not like programs as much that had single-key commands. Her favorite programs were Bob Lawler's BEACH microworld and a collection of procedures I wrote for her where she could type in object names, numbers, and colors, to fill the screen with shapes. Angela could not read, could barely spell her own name, and only knew the uppercase letters of the alphabet. Her enjoyment of typing was evident by her "pretend" typing, which frequently caused the computer to go haywire. This nevertheless was evidence that the computer acknowledged her typing.

Angela began to focus more deliberately on getting the computer to responsd to her actions. I provided cards of words that she could copy to place different objects in the BEACH scene. Interestingly enough, Angela was not interested in setting the objects in motion, nor did she try to set up some particular scene by moving objects to different locations. Unlike her usual distracted behavior, many times Angela became engrossed with what she was doing at the computer. She gained control over the keyboard, learning how to correct mistakes with the delete key, carefully backing up to where the mistake had occurred. She developed an attention to matching spellings between what she had typed and the word she copied.

Angela did not initially have a stable knowledge that words are read from left to right. This was evident a couple of different times when I pointed at a word for her to read. I pointed to the word "house" written on a book cover and she began

spelling E-S-U.... Another time I was holding the manual up so that she could read it, and again had my finger near the right-hand end of the word. She began typing the word from the end near my finger. I reminded her that the beginning was at the other end. These backwards spellings ceased happening, however. She paid careful attention to words she copied, correcting mistakes as she caught them. Despite the fact that she (usually) typed letter by letter, looking at the keyboard in between, she did so without losing her place even in a long word.

Because of Angela's interest in words, I developed procedures to go along with the named Sprite shapes and colors listed in the manual. The Sprite shapes were pictured, and some had names printed nearby in uppercase letters. Among them was a heart, a significant symbol to her. I also wanted to add to the list other words that were special to her. The color words did not have related pictures, and only the basic colors had names spelled out in uppercase letters. The first time I introduced her to the procedures, she immediately took over the manual. She was unusually intent on what she was doing. She pored over the list of colors, using them to repeatedly change the background colors of the screen. She based her reading on the first letters of the words, as evidenced by her signing of blue for black. The signs for many colors are initialized (use an alphabet letter for the handshape), so this was probably her source of information.

Angela's attention and energy at the computer was directed at paying attention to the forms of words which resulted in the corresponding objects

appearing on the screen. It was not concern for the meanings of the words, because she could not usually remember which words were which, nor could she remember how to spell most of the words.

5.3.2 An Energy for Form and Meaning

Initially, Kusum, unlike Angela, got tired when she had to type too much. One might be inclined to attribute this to her unfamiliarity with the keyboard, but she was not unfamiliar -- she had used the computer some in her class activities, such as to type the letters of the alphabet. Imagine not being able to read some words, yet having to type them. Angela did not mind doing this -- this was, in fact, her delight. Kusum was beyond learning her letters, however; she desired to make meaningful things happen. Thus, her preference at the beginning and for most of the study was to use the ACB, because it necessitated fewer keystrokes for making things happen. She could more easily concentrate on what was happening rather than on how it happened.

As time went on, however, Kusum gained more experience with reading words that were part of the ACB and in her stories that I had written down, and also became more comfortable remembering and typing Logo commands and program names. Initially, when she had tried the BEACH microworld or even Logo, she soon would pause, signing "tired," and decide to do something different. Near the end of the study, one time after Angela had used the BEACH microworld, Kusum decided to use it that day as well as the next time she worked at the computer. She used it

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differently than Angela. She would arrange a portion of the cards around the keyboard and then begin typing them in. When she saw what the object was, she would change its color and move it to an appropriate location. She was conscious of the forms and meanings of words. After typing the word "down" several times in order to move an object down in the scene, she looked at me and signed that she was spelling it "herself" without looking at the card. She also would put aside cards she had finished using, but kept out the one that said "halt," since she knew she would re-use that one after she had set something in motion and wanted to stop it at a particular location. Since she was familiar with Logo commands, I suggested she use SETC (set color) to change the colors of the objects. After I fingerspelled it for her the first time, she remembered it each time thereafter; during her second such session she initiated the command herself, typing SETPC (set pencolor), which she had also used in Logo, instead of SETC.

As she became more comfortable using words at the computer, the forms were no longer an overwhelming unknown. Similarly, she had a different image of her abilities to make significant things happen at the computer. At the beginning, her inability to put together what she might want to do with the mechanics of doing it took away any foothold. Once words were more accessible, combined with more confidence in her ability to be meaningfully constructive, she had the energy to tend to both things at once.

5.3.3 Remembering Meaningful Text

In order to accomplish things at the computer, one uses text. Text becomes an active form of interaction. A child using the computer begins to pay more attention to the text because s/he needs it to dialogue with the machine -- an exchange of words for actions or some other written response. Each of the children responded to the "demand" of the computer to learn some of its language, and in their own ways focused on spellings and remembering commands.

As we saw before, Angela enjoyed typing at the computer, and became adept at typing in words. Perhaps one of her most exciting finds was the Logo command CT (clear text), which erased all text in the command window (a bottom section of the screen). She learned and remembered this after having been told once. This meant that she could type to her heart's content or make a mistake that would result in an error message, and clear it all away and begin again. Her posture for doing this was a knowing, "You-think-this-is-messy?-Watch-this" look.

Joshua, although he was a good reader, had a hard time with writing and spelling. On the computer, however, he had to pay attention to spelling. He would usually try to spell something himself before asking for help. The delete key was helpful to him, but in a different way than for Angela. He would type a word, look at it, re-do some of the letters that did not look quite right to him, and repeat this again, if necessary. Kusum did this to a lesser extent as well when she typed people's names. The computer is an ideal place for deaf children to play with spellings.

Developing the skill of recognizing how a spelling should look, compared to what one has seen before, is helpful for those who cannot rely on sounds to help figure out a spelling.

Whereas a child might be intimidated trying to spell long words, having a place to see and easily change the spelling encouraged Joshua to attempt such words, too. Joshua tried spelling commands such as SPLITSCREEN, and after experimenting with the spelling of STAMP (during different sessions), learned to spell it on the first try.

Kusum learned to recognize and spell words she needed (BLINKER, from retyping the name of the program to restart it; Logo commands, such as FD, BK, LT, RT, PU, SETBG, SETPC; "yes" in response to ACB question of DISK READY?; and the ability to read lists in ACB to get what she wanted -- she knew them well enough to sign back to me the list she was looking for one time.)

5.3.4 English vs. Logo -or- The Computer is a Stupid Machine

Joshua was proud of his English skills, and would try them out on the computer. One can imagine his thinking that if learning to read and write English for a little boy is an important accomplishment and an indication of smartness, then a computer that cannot respond to even simple English sentences must not be very smart. Joshua would occasionally "dialogue" with the computer. He "told" the computer some things to do when in Logo: ST BABBY [sic], to get the "baby" turtle

back (show turtle) after having changed its shape to a sprite-shape turtle), CT!!!!!!!
(emphatically speaking, clear text), WEB (when he wanted to make a web), SAY IT
(after using a procedure SAY to generate sentences), FILLUP (when he wanted to
FILL up an area with color). Sometimes he would sign to the computer, telling it to
"hurry up."

5.3.5 Playing with English on the Computer

One of the programs I wrote for Kusum and Joshua to try was a sentence
generator. One makes a list of Things, Actions, and Descriptions (nouns, verbs, and
adjectives), then simply tells the computer to SAY a sentence. The program
randomly generates some combination of the words, one from each list. Joshua easily
read the resulting sentences, recognizing the humor in the absurd sentences that
resulted. He further amused himself by typing SAY as quickly as possible, and
printing several sentences at a time by repeating SAY several times on the same line.
He made the computer generate English in another way: Joshua would type
commands incorrectly (e.g. SAY IT, CT!!!) so that the computer would respond, "I
don't know how to <word>." When he typed CT correctly (and the computer
responded), he gave it a look as if to say "it's about time!"

Kusum could not read all the sentences, even though she had chosen words and
typed them in (with some help). Except for the words that she comfortably knew,
even after a word reccurred in several sentences she would still not recognize it. The
meaning of the sentences was lost as she tried to figure out words. She continued for
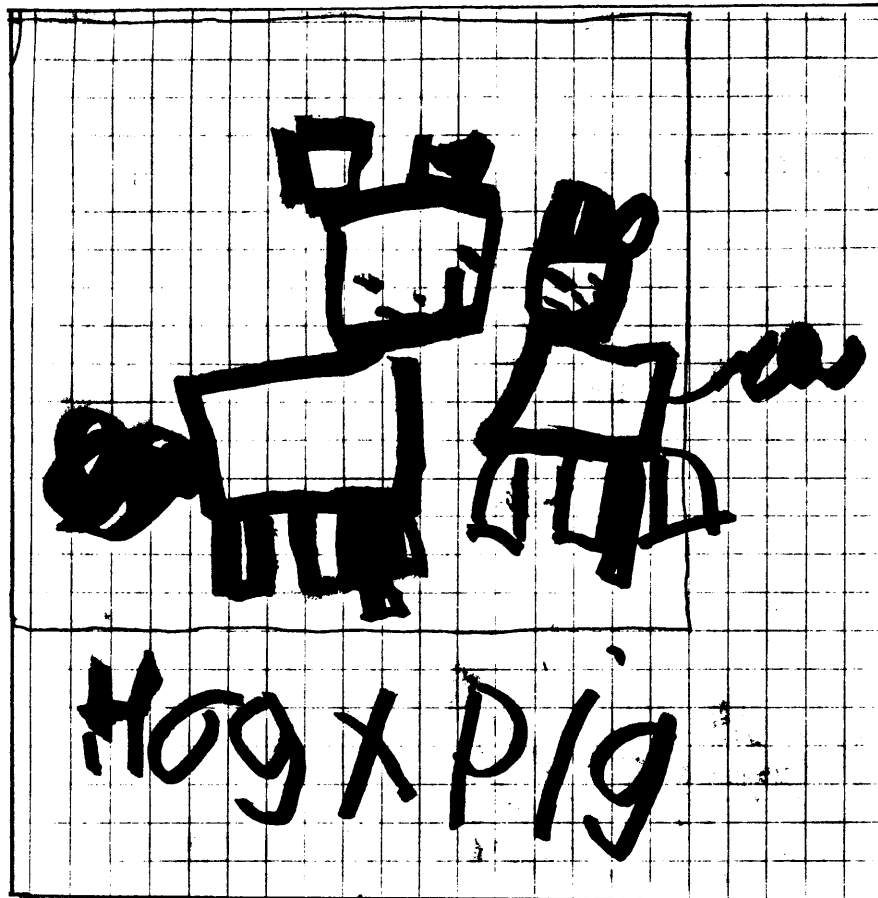
Figure 5-6: Joshua KNOWS that Hog and Pig Mean the Same Thing

This is a good example of how Joshua made use of English in his work at the computer. In this case, the character he decided to create for the ACB was a demonstration of his knowing two English words for the same sign. When he actually made this using the Shape Editor, he only made the heads -- he emphasized what he knew by including the actual words in the Sprite design.

a while, but then wanted to change programs and do some of her own storytelling.

Because of their experience with reading, the two children had very different reactions to the program. Neither one was engaged with the program as s/he might have been. There was not enough at the surface level of the program for Joshua to get into the workings of; involvement with the Logo procedures was still formidable territory to him. The "English" sentences were much less sophisticated than he was capable of reading, and he did not get involved with predicting words that might produce bizarre / humorous results. He enjoyed an earlier program I wrote for him more. It was a "mad-lib" type of program that asked him questions and put the answers into a story. The questions pertained to himself, his friends, and his likes and dislikes. (I wrote the program early in the study to get a feel for what his command of English was, and also to see if he would take an interest in writing a story for someone else to try -- he did not.)

Kusum was unable to make sense of the sentences. She may not have realized that all the words were ones that she had decided on, and that she could guess based on what she knew she had said. Furthermore, she had only recently begun to tell stories at the computer in sign language for me to write down, and was unable to reread those. In this new situation, none of the sentences were familiar, only the words were, so that she had no idea of the possible meaning, nor even picture clues, to help her guess the words she did not know.

5.4 Story-Telling / Imaginative Play

5.4.1 Precursor for Literacy

Both listening to and telling stories provide entry points into achieving literacy and are means for developing oneself. Listening to stories gives one a chance to identify oneself with various characters and their adventures (Bettelheim 23-28 et passim). It also prepares one's attention span for the act of reading and develops one's sense of story. Making up one's own stories allows one to draw on one's own experiences, interests, and daydreams -- a part of developing ideas and personality. It is an opportunity for self-expression. Entering a world of make-believe also occurs when children play alone or together, assuming roles themselves (play-acting), or through the use of other characters.

For deaf children, engaging with others in storytelling or imaginative play for an extended length of time may occur infrequently. Family and friends with whom a child can communicate can be very limited in number. At school, there may be few opportunities for this type of play -- school schedules can be packed with "important" other activities. At home, where this type of play most often happens, deaf playmates may be few, leaving little time for exchange of ideas with other children or adults.

Similarly, a child may not even have anyone with whom to share everyday events. The result may be delayed conversation skills and a lack of confidence in

expressing oneself. Yet children are adaptive and develop ways of compensating for less than ideal situations.

5.4.2 Communicating With Others

As a child grows up, s/he develops the ability to express him or herself -- in a way that someone else can understand. Expression takes into account not only what one knows oneself, but also the assumptions of what the other person knows. Through everyday conversation a child learns the skills of expression and develops a repertoire of what is important to him or her. Deaf children, such as Kusum, do not all have someone with whom to communicate, and have difficulty developing ease and confidence in skills of conversing. They do not expect to be understood, nor to make themselves understood beyond very basic needs that can be attributed to the immediate situation.

Nevertheless, children do develop other ways to communicate, or to become sensitive to what others want them to do. Kusum had several ways -- she would make drawings for people, which she called letters, she would immediately look around to see what answers other children were giving in response to a general question, and she would carefully study the person with whom she was conversing in order to see if she could tell what was the answer she ought to give. (This is similar to Halliday's statement of a child distinguishing when s/he is telling someone something they already know.) At home, when she did not understand what her mother had asked her to do, she made use of the context of the situation in order to

determine what her mother meant.

5.4.3 A Microworld for Imaginative Play: The Animated Coloring Book

One program the children used at the computer was The Animated Coloring Book (ACB). With this I wanted to see to what extent the children engaged in a world of make-believe by telling stories (in sign language or by typing dialogue for the characters). The different reactions of the children to the program reflected personality, style of making sense of a new task, and individual needs for expression.

With the Animated Coloring Book, a child can get involved with the program in a number of ways, not unlike considerations one might make when writing a story or even drawing a picture. The child can create new characters, design a new setting for them, or choose from those that exist. The focus may be on actions, dialogue, or relationships among the characters. The child may have some preconceived ideas of a story, or may play around with the characters or scenes until something catches his or her eye.

However, because the ACB is run on the computer it has another side to it, too -- learning to operate the computer and run the software are sources of involvement in themselves. Besides being a tool for getting involved with the material of the microworld, the computer presents the challenge of mastering its various functions.

5.4.4 Developing Meaning

Kusum became involved in story telling when new characters were added that represented, or nearly represented real people. Her first story had the characters Dady (which was Kusum's misspelling for Baby), Kusum, Mutt and Jeff (to Kusum, a father and son), and Big Pig; it took place at the sea. She signed:

Pig crying. Where-is Baby?
Baby dead.
Kusum find Baby.

Actions accompanied the story. Dady was put in the sand and hidden by changing its color to match the sand. The other characters lingered above the sea. Kusum went to look for the baby; when Kusum found it in the sand, the baby's color was changed to green. Big Pig and Kusum were moved up into the sky, and were identified as clouds. Dady and Mutt and Jeff walked across the screen taking alternating turns -- first the baby moving a little bit, then the other two following:

Big Pig, Kusum clouds
Together go home, baby first.

Kusum told this story several months after we began working together. There were a few significant occurrences that preceded this: Kusum began conversing with me, asking me questions about my life and sharing with me about hers. She had been playing with the ACB and had developed a routine of hiding characters in the blue sky of the Farm scene by changing their colors to match that of the sky. Kusum had also drawn many pictures, both at and away from the computer. For a few of these she had briefly explained or narrated the "story" behind them. She showed concern for making sure that all parts of a scene had meaning: i.e., they were accounted for.

They usually were related to relationships between people.

After this first time of transcribing her story, Kusum would often tell me to write down her stories. Sometimes she would try to read them, other times not. She told lengthier stories, often including several "episodes." The stories usually evolved around a family -- problems with the children, the mother disciplining them, parents deciding what the children were allowed to do (e.g., go to the beach). Sometimes she would break off from the story and would tell something about her own sisters or something that she had done that was closely related to a story she was telling. Here is another one of her earlier stories that began with the one she had previously told (searching for Baby) and continued from there:

> Baby dead (die?)
> Two boys, Angela, Sandie
> Look-for Baby in water.
> Angela find Baby.
> Two boys, Sandie clap.
>
> Angela turn die.
> Baby cry.
> Sandie spank baby.
> Sandie says: not worry Angela.
>
> Brother Daddy Sister Mommy Angela
>
> Mommy mad!
> You go bed!
> Not hug Angela.
> Daddy, Brother, Sister not clap.
> Angela bad.
>
> Baby in bathroom.
> Diaper take-off herself.
> Mommy diaper look-for off.
> Find new diaper in water.
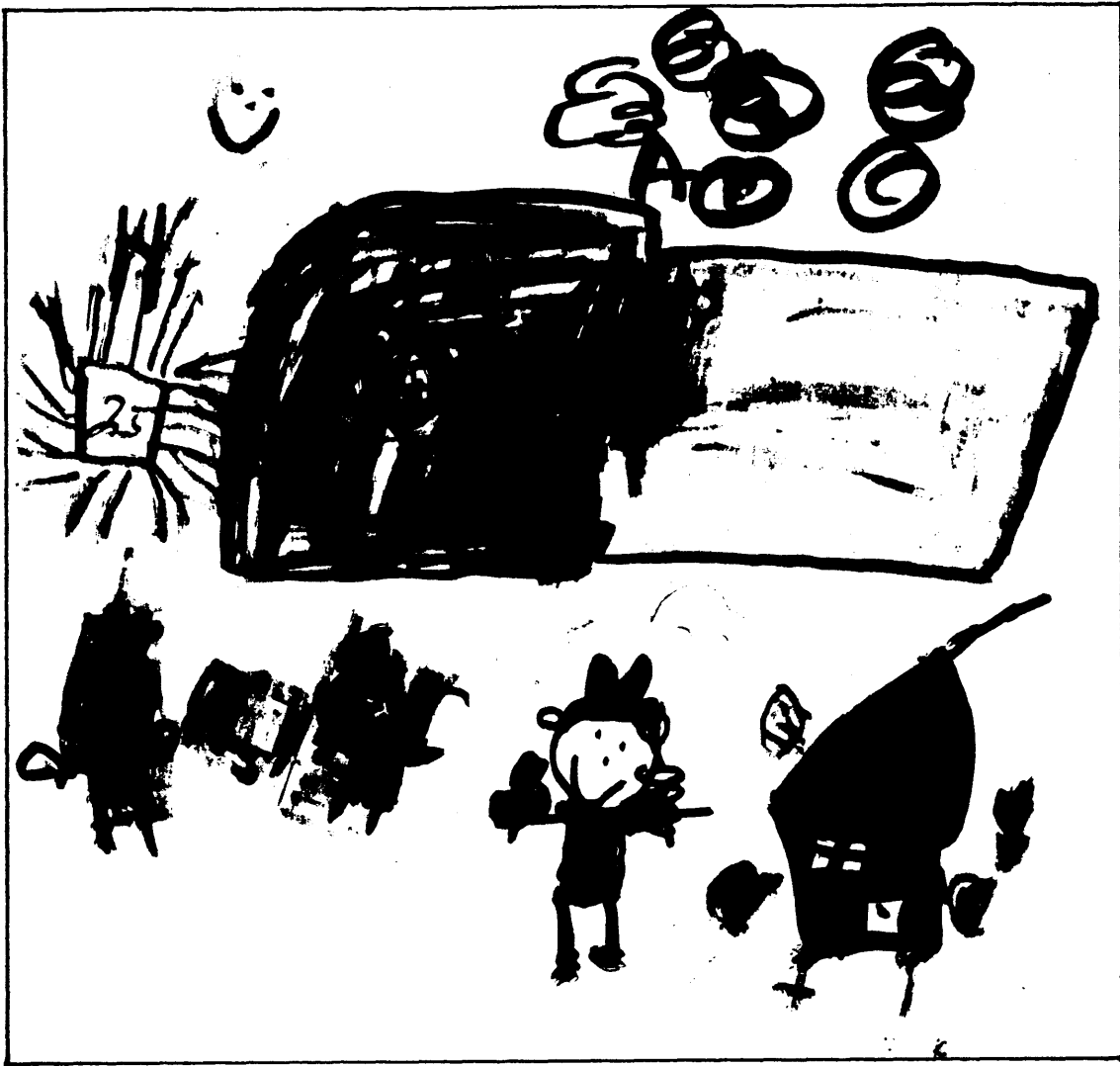
Figure 5-7: Kusum Finds Meaning Using BLINKER

This drawing was the first of Kusum's stories that was related to the computer. It was an evolving picture story that began with Kusum copying the two connected rectangles off the screen, calling them a bed, and eventually turning the drawing into a story about one of the teachers having a baby, with the others coming to visit her in the hospital.

Diaper wet. Throw-away.
Go store. New diaper.
Can't find diaper in water.
Go store drive herself.
Mommy hit-face Baby.
Baby go doctor.
Needle(shot)-in-bottom.
Daddy go with Baby Doctor.
Angela want go Doctor with Daddy
Daddy says yes.
Mommy herself cook dinner
No more go to beach.
Closed.
Baby want go to beach
Mommy says, no closed.
Go home.
Next-week go swimming.
Angela go to beach "ha ha ha ha"
Daddy go to with Baby.
Stay with Baby "ha ha ha" (says) Angela.
Leave home.
Mommy says yes go beach.
Hooray!

Kusum's storytelling was a marked contrast to earlier times of working

together, when she would rarely sign; and when she did the phrase would only be one

or two signs. Often, time spent working on the computer would be interspersed with

drawing. She never stopped drawing altogether, but as she became interested in

telling stories and conversing she relied less on drawing as a means for spending more

time with me at the computer (and as a means for communication).

When she began working with the ACB she developed a series of steps she

would often methodically carry out when she first sat down to work: changing each

character's color to the same blue as the sky, putting it in the sky, making a path for
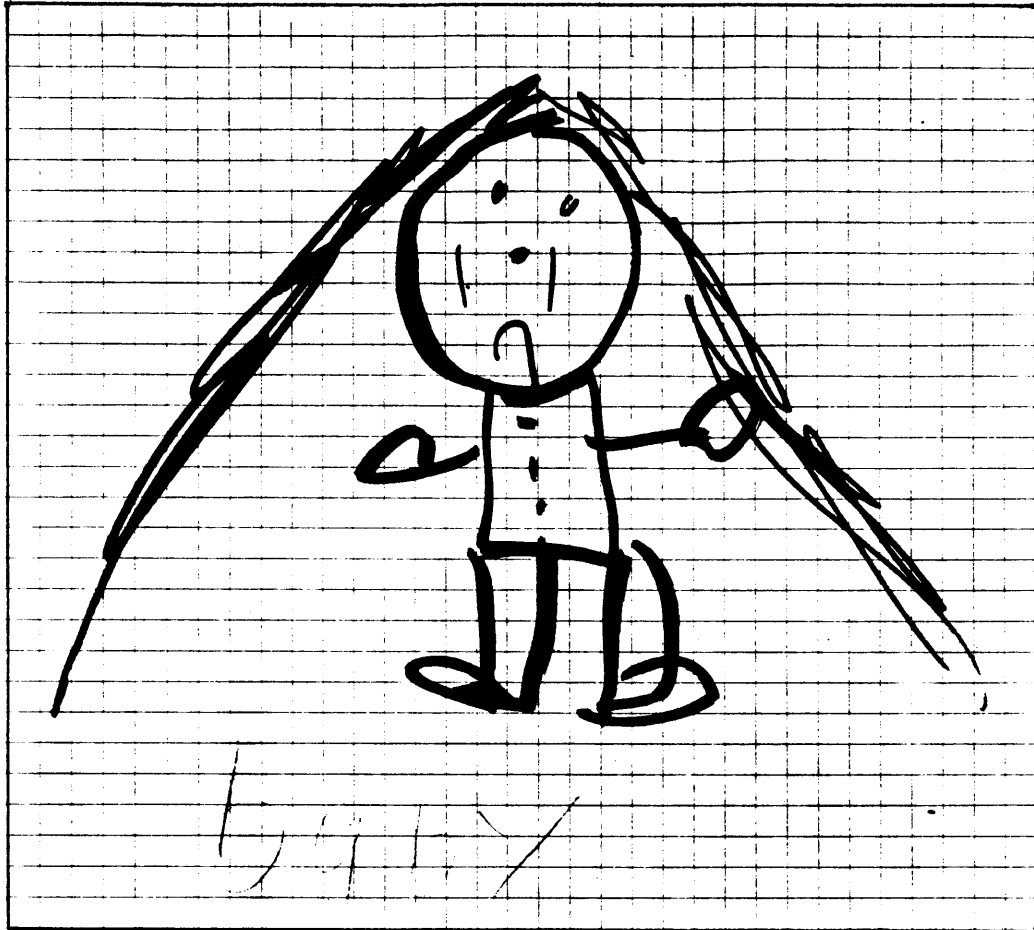
Figure 5-8: Kusum Adds "Baby" to the ACB

This was one of the characters that marked the beginning of Kusum's storytelling with the ACB. "Baby" seemed often to reflect her own baby sister.

the character and sending it home. Kusum did not yet have a story to tell, but she did have a script of actions for the characters to go through. Interestingly, the idea of putting the characters "in the sky" carried over into her stories where she hid the baby in the sand. In this and in other ways, she showed herself to be much more attentive to the details of what was happening than one might have thought.

Chapter Six

Conclusions

6.1 Summary

The computer was a source of information revealing not only the children's current knowledge about written language, but also their preoccupations in learning about it. These preoccupations affected how they viewed the computer, how they appropriated its use, and the concurrent change in its use with new understandings of written language. We began the study of the children with initial portraits. The following concluding summaries of the children show the interrelationships of issues that were related to their language preoccupations: control, self-expression and dialogue, appropriation of the computer, and finding an entry-point for exploring language.

Issues of control will be discussed in terms of how the child wanted to be able to use the computer -- shown through actions, and willingness to engage in learning new things and applying knowledge with or without help. Another issue of control relates to change in control -- whether it remained the same or changed as time went on.

Self-expression and dialogue refer to the type of communication at the computer -- whether the child discussed the computer's workings, and his or her

ability and interest in sharing things about him- or herself. This communication both influenced how the children used the computer and was an area of change for one of the children.

Another issue was their appropriation of the computer. This concerned, in other words, what the children chose to do at the computer, what their view of it was, and how these factors may have changed as they worked at it.

The children identified their own entry-point for learning about written language at the computer. This was evident by their choice of programs and the ways that they used the programs. Change in each of the other areas shows how their entry-point was a step to expanding their ideas of language use.

The above issues raise questions of the children's views of themselves as language users in general, as related to their background and communication support at home. This is important, because many of the skills influencing written language develop in some part through use of interpersonal language. As a deaf child becomes older, the struggle to make sense of the language forms becomes more critical. The older child has already developed an awareness of language's importance and the uses of language, but is involved in a struggle to use them meaningfully him- or herself. The quest of language development for an older child whose language is in some respects like that of a younger child (perhaps misleadingly so) does not have the same sense of free exploration, because the child develops the uses well after the awareness of significance, rather than appropriating the corresponding awarenesses and abilities

at the same time.

6.1.1 Kusum

Because the children had very different levels of communication skills for their ages, one would expect this to affect their views of written language -- as well as their needs for learning about it. For example, Kusum was the oldest, but for a seven-year-old lacked good communication skills. She seemed to know a great deal of sign language vocabulary, but expressed herself with difficulty. Thus, one struggle was her struggle for communication. She knew that writing was a form of communication, and regularly used drawings as letters to people. But she could not write a text message, nor could she read. She did not expect to be able to understand what was written, let alone to construct messages for others. Yet she was aware of the important function of written language. At the computer, she showed her initial reluctance to type English words because they were meaningless strings of letters that she could not remember. She concentrated instead on the ACB, and other programs with abilities to use single letters for significant commands, and built up confidence at remembering not only the commands, but sequences of steps, all the time building the meaning in things she did.

Two things happened. As she used these commands, she was also exposed to other English words on the computer, and with time began to read and recognize these words, gradually taking over more responsibility, e.g. in the ACB, for setting up the program. As time went on, she and I conversed more, not necessarily about

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what was happening at the computer, but about things we both considered important. This led to her storytelling at the computer -- using what she was doing on it -- which in turn led to her desire to make new things at the computer (and thus learn more about its language, Logo). And, finally, this led to her interest in programs she could not use before, but which she had now developed confidence and understanding for, using written words to make meaningful things happen (that is, things that SHE wanted to have happen) at the computer.

Her entry-point was not an interest in English words (she was discouraged by those), but a desire to express herself meaningfully: visual images were very important to her as means for communicating. She was not interested in abstract designs, unless she could quickly find something important about them. Thus she used the visual images and movements with simple text as building blocks for stories (expressive communication), and used text (English words, Logo commands) for interacting with the computer.

Kusum did not take control over all aspects of using the computer. There were several reasons for this. One was her expectation of what she could do with and remember of both written language and what she was told. Thus, she often looked to me for guidance and affirmation of what she was doing. My response varied with the situation. I also tried to ask her questions about written things on the computer and helped her to read them. In this way she began to pay more attention to them, initiating reading them herself or performing the required action. Gradually she

Figure 6-1: Kusum's Drawing Begins with a Bear for the ACB

This drawing was done at the computer, beginning with an idea for the ACB, but turning into a written/drawn conversation piece. She easily crossed things out (showing a transience similar to interactive communication) if she changed her mind, disliked what she started, or as part of a joke -- showing one situation, then crossing it out to replace it with another (e.g., the smiling and frowning faces near my initials S.B.).

assumed more responsibility for setting up programs, reading things herself, remembering how to spell Logo commands and noticing values of inputs that would be needed again.

Her view of the computer was of a tool to appropriate for making meaningful things happen. She did this with each of the programs, never much concerned about how the programs worked in and of themselves, but rather using meaningful visual images as the source of energy for learning about the programs, and later as a catalyst for dialogue and storytelling.

6.1.2 Brett

Brett was extremely interested in dialoguing with people. A competent signer for his age, he was also interested in written language, and was learning to fingerspell words in general. His parents do use sign language with him and began doing so when he was an infant. They fingerspell words that they don't know signs for, so Brett has had reason within everyday communication to pay attention to and learn the spellings of words. He expected to be able to communicate with people both receptively and expressively. His view of himself was as a competent sign language user.

This influenced his work at the computer, particularly in his ability to remember things that I told him, but also in his interest for relating things about the computer to his own life. He shared events with me, and asked questions about what

was going on in our environment and about the other kids (in the study).

His attention at the computer mingled attention to forms and meanings of words, as well as to overall meanings of actions on the screen. He enjoyed, as did Angela, paying attention to typing words, only he would look even more carefully at letters as they appeared on the screen. On the other hand, he enjoyed adding his own ideas to the computer, either through reflections on what was happening on the computer (in a narrative form), or by adding personal characters to the ACB.

Brett enjoyed doing things himself, but did not take over the computer. For example, he made decisions about things he wanted to put on the screen by remembering a list of possibilities I had told him. His foremost activity was a kind of dialogue with me, and he did not really separate out a dialogue for the computer only. He, like Angela, did not engage in the computer's use on a step after step (sequential) basis, but more with respect to the meanings of individual steps.

Forms of words as well as meanings of actions governed his entry-point at the computer. He involved himself with both of these, but it is important to realize that he also had other means for doing so. His preoccupations with language were more exploratory -- he was still quite young, and was also successful for his age. These preoccuations affected his use of the computer, but perhaps not as strongly as for Kusum and Angela because he had other "outlets." He did use the computer differently than Joshua, however, in that he could not make as active a use of written language skills; they could not yet be an assumed basis for interacting with the

computer.

6.1.3 Angela

Angela, like Kusum, came from a bilingual family, but was more outgoing in her efforts to communicate. Although not a skilled signer for her age, she energetically communicated with people with gestures and signs she knew. Her short attention span seemed related to expectations of not being able to understand what someone was signing about. In addition to her short attention span, she acted independently, doing whatever she could in a situation, not wanting to bother with directions. Her use of the computer reflected her impetuosity, but unlike other situations, engaged her interest.

Her initial view of the computer, which affected her use of the machine, was of something that she could get a reaction out of (blanking out the screen), while also getting a teacher's response. Thus her actions initiated a kind of dialogue with others around her. Her use of the computer changed with time, however, as she maintained control of what was happening on it, but gradually included her interest in words and seeing things happen because of an attention to typing.

She preferred programs that allowed her to get a response by typing single words. From this entry-point, she was able to build to an attention to forms of commands that required an additional input, either through prompting, or on the same line. She maintained control, but in the sense of the whole situation, rather

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than just the computer itself. She developed ideas about things she wanted to do, with unexpected results, most significantly learning to spell HOUSE (the first word she remembered how to spell for any length of time besides her name) because she wanted to stack many of them and had to keep typing h-o-u-s-e; reading color names from a book (no pictures given) for typing; and, by the end of the year, realizing that words she was typing at the computer (copying from a book) could be read in a different place (my notebook).

Dialogue was limited and most often centered around what was happening at the computer, or other things she wanted to do (use nearby equipment, go to the bathrooom, inquire about strangers in the area). In the classroom, the computer was still a source of dialogue -- she would always ask me if it was her turn to use it. She was not as concerned with trying to share her thoughts in sign language as was Kusum; her use of language arose more as an action on or within a situation.

Her appropriation of the computer began as one of grossly directed action, which became one of exploring aspects of written language, even including, by the end of the year, exploring numbers, making a jump from 10 and 11 to 100 and to 180! She was learning about the forms of words (spelling left-to-right), remembering spelling (CT for cleartext), and finally (at the end) beginning to realize that she could read these words in other contexts. She judged the importance of these tasks: she enjoyed copying things from a book (a Logo manual) and wanted to use a program Joshua suggested, one that she might have found overwhelming because of

the effort it required. Because of her respect for Joshua's opinion, then, using the program with its words became an important thing to do and she (very impressively) set her mind to doing so.

6.1.4 Joshua

Joshua knew the most English (signed, written, and spoken) of the four children. Thus, his view of the computer differed in his expectations of what he could do with written language: namely, he could learn and remember words (commands) and their meanings, and, additionally, could read messages on the computer. Like Angela, Joshua took immediate control, but his control was not so much of the entire situation (that is, of my attention), as it was an ability to do things at the computer on his own. He understood explanations about how things worked -- he expected to, and thus asked about things he did not understand.

His entry-point for learning language consisted of a challenge to learn and remember commands and to test out what he remembered before asking for help. He was able to look at the computer as a realm of possibilities for him to master: that is, to learn about. He enjoyed exploring commands and seeing the effects. Whether or not the effect was meaningful in terms of its visual content did not matter; he was interested in the meaning of the commands themselves, so that an abstract design was the result of telling the computer what to do in its own language. He showed sensitivity to simlarities and differences between Logo and written English; for example, he would sometimes type English at the computer and then call it stupid

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when it claimed it did not know how to do that.

He viewed the computer as a toolbox of things to learn how to use. He enjoyed exploring their uses, and in new programs, would test out commands from other ones. On a basic level, he was able to think through steps he needed to accomplish something by pursuing them one at a time.

Because, like Brett, his preoccupations with language itself were not a struggle, and because he also had written language to depend on, his style of working could be characterized more in terms of the problems and situations he set for himself to do. Thus, his style of avoiding situations he perceived as too difficult reflected his expectations of himself as a learner in general, and was a mechanism for keeping the situation "safe" and in his control. He did overcome some such difficulties, through encouragement and tools that gave him more access to thinking about the problem. Sometimes he had ideas of things to make but gave up on them when progress came slowly. His ideas were rarely burning desires, as he gave them up quite easily, unlike Kusum, whose ideas hinged on something about which she wanted to communicate.

6.2 Implications and Possibilities for Future Work

The implications of this study are important to parents and educators of deaf children as well as for future research. The study raised issues that stress the importance for deaf children of having a language with which parents and children can communicate. One consequence of lacking such a shared language is to place an

extra burden on the child, who must try to make sense of language in the different forms s/he encounters while working with a weaker language foundation. Having to put the language pieces together later makes a young child's exploration into an older child's struggle.

Despite the variations in age and language abilities of the children studied, they were all actively involved in learning language. But even when written language understanding might on the surface look similar among children, they might be at very different stages of trying or needing to make sense of it. It seemed that for an older child (with delayed language skills), the foremost preoccupation would be with expressing meaning as opposed to attending to form. For a child having a more "age-appropriate" understanding of language as a whole, the balance among attentions to form, meaning, or both would show a less pronounced variation. This agrees with Maxwell's observance of the deaf child of deaf parents, who went through "scribbling" phases with the various language forms and varied her attention to the different forms and meanings in each case. This idea does not relate to the study in reading styles of Bussis et al, in that they found that children truly had a preference for the way they constructed meaning from text -- either on an accurate word-by-word understanding, or from a more global understanding and expectation of story and its structure. More case study oriented research of young deaf children needs to be done before making similar statements.

In this study, the children had a variety of programs available to them, so that

it was possible to explore with them their interests and needs. The result of this flexibility was that the programs the children preferred and the ways they used them were affected by each child's language abilities and preoccupations. What the children needed was to find programs allowing them to "scribble" with words or meanings as they needed to; they also needed places to establish connections between form and meaning, and places they could cross a bridge into yet another level of thinking about language. Because I worked with each child alone, I was the only immediate person to give them information, make suggestions, answer questions, or present a new program. Just noticing the little that happened between the children themselves suggested possibilities for more learning with each other. This idea of culture-oriented learning is part of the Logo philosophy, and one which I think the children could benefit from, in which the teachers and children share in each other's learning experiences.

One other direction for further study would be a media-involved way to incorporate sign language into the children's language explorations. Prinz et al wrote a program that allowed children to see signs (done with computer graphics) or pictures for words and actions of simple sentences, which the children constructed from a limited number of choices on a touch pad. The intent is similar to that of a signed English story book -- except that the sentence patterns are more limited, while the variation is determined by the child's selections. Use of interactive videodiscs would allow more signs to be stored, and greater variation in combinations (except for breaks at the intersections between signs). In addition, the videodisc could also

contain sections using the signs in ASL storytellings. The computer interface could take a number of forms, such that the same material on the videodisc could be accessed in different ways or in different contexts. The levels of involvement a child might choose could range from working with English translations, to graphics renditions, to sequencing of material on the disc. Since deaf children grapple with connections between what is meant in ASL, written English, and the spectrum of signed forms in between, as well as contend with understanding the languages separately, the development and research of such tools for children to explore those connections would add to our understanding of how deaf children develop these different languages.

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