THE EFFECT OF COGNITIVE TEMPO ON PRESCHOOLERS' USE OF A MICROCOMPUTER

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PREFACE

This pilot study was concerned with collecting data to determine whether cognitive tempo affected the ways in which preschool children used microcomputers. An original software package was developed to allow the computer to collect all required data as the subjects used the software. Data were collected and summarized for two groups of children, reflectives and impulsives.

I wish to express my sincere appreciation to all those who assisted in the successful completion of this study. In particular, I am indebted to my major adviser, Dr. Arlene Fulton, for her guidance throughout this study. Appreciation is also extended to other committee members, Dr. Frances Stromberg and Dr. Elaine Wilson.

A special note of thanks is extended to Michael Ford for his assistance with the testing. Thank you, also, to the director, teacher, children, and parents of the YMCA daycare center for their cooperation and participation in this study.

Finally, I am most appreciative of my husband, Teddy Wyatt, who developed the software used in the research and greatly assisted with the word processing for this report. Without his understanding, encouragement and support, this project would never have been completed.

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CHAPTER I

Introduction

The "computer revolution" is no longer confined to the business world, but is affecting the daily lives of Americans. From the time they are awakened until the time they arrive at their place of work, Americans come in contact with at least 50 computerized devices or effects, including alarm clocks, microwave ovens, computer-relayed telephone calls, car fuel in-take, etc. (Clements, 1985a). In addition, more than 50% of the GNP is provided by the information-processing industry (Fetterman, 1981). Many feel that the computers have become the tools of today's society and that for children to learn to function in this society, they must learn to use those tools (Clements, 1985a, Fetterman, 1981).

It was estimated that in 1984, parents of one of every six school-aged children had purchased a computer for their child's use at home, with a total of approximately five million computers in the homes of U. S. families with children (Komoski, 1984). At a 1984 conference sponsored by the National Institute of Education, it was predicted that home instruction would soon be used as a supplement to traditional school instruction, with home computers routinely used for homework, independent learning, and the development of computer proficiency (Holden, 1984b).

Parents (and the media) seem to believe that computers offer the quick high-technological fix for what is wrong with American education (Komoski, 1984). Peter Dirr, of the Corporation for Public Broadcasting, predicted that pressure would mount to find ways to integrate home and school learning experiences with computers, and many believed that the new microcomputer technology would profoundly affect basic education (Holden, 1984b). Clements (1985b) says

> Computers will permeate all areas of society. They can be used to expand children's knowledge of themselves, of others, and of the world, and they can do so in ways that humanize, rather than, mechanize, education. It is the responsibility of educators of young children to use computers in interesting and developmentally appropriate ways (p.51).

Statement of the Problem

In 1981, 38 percent of all schools in the United States had obtained at least one microcomputer for instructing students. By 1982, 85 percent of the nation's secondary schools and 42 percent of elementary schools were using microcomputers for instructional purposes, and it was projected that by 1986 each school would have an average of ten computers, or one for every two classrooms (Tolman & Allred, 1984). Computers are being used in virtually every area of the curriculum. In addition to programming instruction, computers are also being used to teach reading, composition, math and science skills, history, music, and physical education (Tashner, 1984). Even in the preschool, computers are being introduced to children as young as three and four years of age and are being used to teach basic reading and math skills (Clements, 1985b).

There are those, however, who question how effectively computers are being used in the schools. Often, computer usage is limited to a select few children, or is relegated to mundane drill and practice exercises (Becker, 1983, 1986; Williams, McDonald, Howard, Reese, & Raine, 1984). Much of the blame for this is placed on the lack of good educational software; in fact, some feel that software is the most crucial aspect in the successful use of computers (Watt, 1985; Saltinski, 1984).

Much of the software currently available was developed by skilled programmers who had little understanding of how to teach children or by teachers who had little training in high level programming and lacked the time required to develop complex software packages (Tashner, 1984). Tashner (1984) felt it was no more reasonable to expect teachers to write their own software than to expect them to write their own basal textbooks.

Moses T. L. Ma (1985) director of the Association of Videogame Designers, felt that the quality of educational software would not improve until educators began to demand more innovative programs, and software authors became more versed in educational principles. He stated, "An absolute prerequisite for writing and implementing creative programs is some understanding of the learning process itself." If the software does not meet the developmental needs of the learner, it is unlikely to be used successfully (Caissy, 1984).

One of the many factors affecting the learning process has been identified as cognitive tempo (Kagan, 1965). Cognitive tempo refers to a child's consistent tendency to respond slowly or rapidly in a problem-solving situation with high uncertainty, that is, when several alternatives exist simultaneously and the correct choice is not readily apparent (Kagan, 1965). In such situations, those classified as reflective tend to have long response times (latency) and make few errors, while impulsive children typically respond quickly and make many errors (Kagan, 1965).

The reflection-impulsivity dimension is a characteristic which has been shown to remain stable for up to 20 months and which manifests itself across a wide spectrum of tasks (Kagan, 1965, 1966). Research has linked cognitive style to creativity (Fuqua, Bartsch, & Phye, 1975), goal setting during games (Mann, 1973), recognition errors in reading (Kagan, 1965), and transfer of learning (Odom, McIntyre, & Neale, 1971). Ward (1968) has suggested that cognitive impulsivity may be one instance of a broader syndrome that includes high motor activity and short attention span. Kagan (1966) contended that

> New pedagogical procedures should acknowledge this interaction between the preferred strategy of the learner and the material to be acquired and tailor the presentation of material to the psychological

> requirements of the task and the cognitive predisposition of the learner (p. 522).

As supported by the above literature, computers are being widely used in the schools at all levels, yet little research has been done to determine what effect individual learning styles will have on children's use of this medium. Research indicates that cognitive tempo is related to the way in which children assimilate knowledge. It is possible that cognitive tempo may also affect how successfully children can learn by using computers.

Statement of the Purpose

The primary purpose of this pilot study was to determine whether a child's cognitive tempo would affect his use of a classroom microcomputer. Microcomputers are being widely used in early childhood and primary classes, yet little research has been done to determine what effect a child's individual learning style will have on his use of this tool.

The study was a pilot project conducted with one preschool group enrolled in a daycare program located in Stillwater, Oklahoma, during the summer of 1985. The daycare program is part of a nonprofit corporation subsidized by public monies and partially funded through fees paid by parents. Subjects were classified as impulsive or reflective based on the Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP). The Peabody Picture Vocabulary Test (PPVT) and a parent questionnaire were used to determine subjects' approximate cognitive level and previous exposure to computer usage.

A secondary purpose of this study was to develop a computerized observational checklist which would record data as the children used the software. Recorded data included the subject's name, date of session, length of session, total number of responses, and total number of errors per session.

Objectives of the Research

The objectives of this research were to examine the following areas with respect to the stated problem:

1. To determine whether impulsive children made more errors when using the microcomputer than reflective children

2. To determine whether impulsive children used the computer less frequently than did reflective children.

3. To determine whether impulsive children used the computer for shorter periods of time than did reflective children.

Assumptions and Limitations

During this study, it was assumed that all subjects would have equal access to the computer and that the test software would be equally attractive to all subjects. It was also assumed that the computer would record accurate and complete observational data.

Several limitations existed for the conclusions of this study. Subjects were not randomly selected, but were part of an already formed group; thus, results may not be generalized to other groups. The method of this research is, in and of itself, a limitation acknowledged by the researcher. The case study method was chosen in spite of its inability to find specific answers about the population studied. Since the use of computers with young children is a relatively new educational development, little research has been done to determine what factors affect the way in which children use this medium. The advantage of being able to describe computer usage by a small population of children in order to suggest hypotheses for further research was thought to outweigh the disadvantages.

Definition of Terms

The following definitions are provided to explain, as clearly as possible, the meaning of several terms used in the current study.

1. Cognitive tempo--Subject's consistent tendency, as measured by the KRISP, to respond slowly or rapidly when confronted with a problem solving situation where several alternative choices are available and the correct alternative is not immediately apparent.

2. Impulsive--Subject who, based on results from the KRISP, has short response latency and high frequency of errors. Subjects were presented a picture (standard) and

several similar stimuli, only one of which was identical to the standard. The subject was asked to select the one stimulus which was identical to the standard. Variables scored were number of errors and average response time to first selection.

3. Latency--Time between presentation of problem with alternative selections and subject's initial response.

4. Reflective--Subject with long response latency and infrequent commission of errors, based on scores from the KRISP.

5. Turtle graphics--Software which allows children to create line drawings on the computer display by giving specific rotational or displacement commands to a triangular shaped cursor, or turtle.

CHAPTER II

REVIEW OF THE LITERATURE

Computers in Education

In 1975, microcomputers were introduced to the market, making computers available to the general public for the first time (Williams & Welch, 1985). Previously, the size and cost of mainframe and mini-computers kept computer technology out of reach for most consumers. Recent advances in the field of microcircuitry have further increased the power and reduced the cost of computers, making them even more affordable (Garetz, 1985).

Since the advent of this new technology, computers have been moving into the nation's classrooms faster than anyone can count (D. Williams, et al., 1984). According to surveys conducted in 1970, 34% of the public secondary schools were using computers for administrative and/or instructional programs (Tolman & Allred, 1984). By 1975, this figure had increased to 58%, and by 1982, approximately one out of every three schools had at least one microcomputer or a terminal connected to a larger computer (Tolman & Allred, 1984).

Surveys conducted by Johns Hopkins University showed that, as of January 1983, 53% of all schools in the United States had obtained at least one microcomputer for instructing students, with 42% of the nation's elementary schools and 85% of the secondary schools having computers (Becker, 1983). A follow-up survey conducted in 1985 showed that the number of computers in schools had quadrupled in the previous two years (Becker, 1986).

Schools are using computers in a variety of ways, from administration and classroom management to instruction in every area of the curriculum (Tolman & Allred, 1984). The teaching of computer literacy and computer-assisted instruction (CAI) are two of the most popular uses of classroom computers (Becker, 1986). Computer literacy has been defined in many ways and may include instruction in programming, learning about the computer itself, and/or learning to apply the use of the computer in a variety of situations, such as information retrieval, word processing, and statistical applications (Clements, 1985; Flake, et al., 1985; Johnson, Anderson, Hansen, & Klassen, 1984; The, 1984).

Instructional computer programs are usually categorized as drill and practice, tutorials, and simulations (Flake, et al., 1985). Drill and practice programs, usually associated with skill development, range from traditional workbook formats to arcade-type games. Tutorials are designed to teach ideas and concepts through an individual's interaction with the software. As a student responds to the information presented,either reinforcement or corrective feedback is provided by the software. Computerized simulations provide opportunities for students to explore situations which might prove to be too dangerous, time consuming, or expensive to experience otherwise. (Bork, 1981; Clements, 1985; Flake, et al., 1985).

Computers are also being used to administer, score, and generate tests (Clements, 1985). Some software packages provide diagnostic analysis of errors; others employ a technique of "branching" in which the instrument is adapted during testing by selecting items on the basis of the response to the previous question. This process (also called computerized adaptive testing) allows individuals to be evaluated at their own skill level by eliminating questions which are too easy or too difficult (Bennet, 1984; Clements, 1985; Katzaman, 1985; Mason, 1984).

In spite of these varied uses of educational computing, many question how effectively computers are being used and, indeed, whether they are necessary at all in today's education (Cuffaro, 1984; Culliton, 1985; Weizenbaum, 1984). Some question the wisdom of investing in expensive equipment which does essentially the same tasks as more traditional, less expensive educational tools (Haavind, 1984; D. Williams, et al., 1984). Weizenbaum feels that computer usage tends to focus only on science and scientific rationalization, losing the context of learning situations (Rosenthal, 1983). Cuffaro (1984), sees skills-oriented software as nothing more than "animated workbooks", observing that computers provide only a two- dimensional surface which eliminates direct manipulation and physical experience.

The lack of good educational software is an often cited problem. Detractors say that, for the most part, currently available software is expensive, poorly written, difficult to use, and not developed to meet educational goals (Anderson, 1984; Bork, 1984; Holden, 1984b; Ma, 1985; Saltinski, 1984; Watt, 1985). According to the Educational Products Information Exchange, 80% of educational programs have gone on the market with little or no research or testing (Holden, 1984b).

The expense of computer hardware and software limits the number of computers schools can purchase and maintain, and this in turn limits the amount of time students have access to the computer (Becker, 1983). Surveys estimate that students average 15 to 60 minutes of computer time per week, with a limited number of students using the computer at all (Becker, 1983, 1986; Demetrulias, 1985; Tolman & Allred, 1984).

Most teachers have little knowledge of how to use computers effectively and hesitate to implement their use because they don't understand what computers can and cannot do (Bork, 1984; Rizza, 1981). Many also fear that computers may "dehumanize and de-skill" education, making teachers nothing more than monitors of computerized curricula developed by universities or computer companies (Chorover, 1984). Educators need an understanding of how computers can be used to improve their teaching before they can effectively integrate computers into the curriculum (Aiken & Braun, 1980;

Rosenthal, 1983). While computers can and should be used to meet educational goals, too often schools do things backwards, first buying expensive hardware, then choosing complementary software, and finally trying to decide if the system already in place can be used to accomplish the educational goals of the school (Chorover, 1984; Clements, 1985).

Some leading educators feel that computer buying has become a fad among schools (Anderson, 1984a). Weizenbaum (1984) fears that computers are being used as a "quick technological fix" for the problems in education without asking why there are problems in the first place. Others believe that computers may have a novelty effect on learning, inspiring students to work harder than they otherwise would and causing teachers to think more carefully about the best ways to help students learn, (Culliton, 1985; Staff, 1984; Weizenbaum, 1984).

While acknowledging the shortcomings of current educational computing, there are those who feel the technology has become so much a part of society that schools have an obligation to educate students about computers and their uses (Bork, 1984; Fetterman, 1981; Komoski, 1984). It has been said that ignorance of computing will soon render people as functionally illiterate as does ignorance of reading, writing and arithmetic (Clements, 1985). Some have suggested that if schools fail to successfully integrate computers into education, more and more of the learning process will take place on home computers or in special schools developed by computer industries, possibly eliminating the formal educational system of today (Bork, 1984; Holden, 1984a; Rizza, 1981).

Proponents of the educational use of computers cite many advantages over traditional instructional methods. Computers have infinite patience in repetition and can provide students with immediate feedback (Lepper, 1985). Also, the individual nature of the machine makes it possible to tailor educational programs to match the needs and learning styles of individual students (Bork, 1981, 1984; Bower, 1984; Flake, et al., 1985; Samways, 1981). Computers can make learning an interactive process and can encourage students to learn through discovery and error, teaching them to logically analyze their thought processes (Bork, 1981; Bower, 1984; Clements, 1985). Clements (1985), however, emphasizes the need to consider the goals of education first and then use computers as a tool to meet those goals.

Papert (1980), co-creator of the LOGO programming language, envisions the computer as a tool which will change the way people learn and think. Using the LOGO graphics programming, children as young as three and four years of age can "teach" the computer new commands by combining primitives, basic words which the computer understands (Clements, 1985). Papert (1980) has proposed that by having children teach the computer, instead of the computer teaching the child, even young children can learn abstract ideas, such as geometric principals, normally not introduced until junior high or high school.

Computers can make the abstract concrete and personal as they help children learn better by helping them think about their own thinking (Clements, 1985). In programming with LOGO, children are encouraged to plan their designs, break the task down into small parts, and think about how they would carry out the task themselves. Problems are inevitable, and children learn to debug (isolate and correct mistakes) their programs by "walking it through", or physically carrying out the commands just as the turtle would (Papert, 1980). These thinking skills can provide the schemata for children to use in new situations not involving the computer, allowing the child to learn through discovery, assimilation, and accommodation (Papert, 1980).

Not all children use the computer with equal success. Research indicates that preschoolers most interested in using computers tend to be older and exhibit significantly higher levels of cognitive maturity, representational competence, and abstract forms of free play behavior (Clements, 1985; Johnson, 1985). Other research suggests that computers may stimulate social interaction of four year olds in problem solving and may positively affect student's attitudes toward themselves and toward learning, but results are tentative (Clements, 1985).

While experts do not agree on the role of computers in education, many point out the need for further research on how this new technology will affect learning (Bower, 1984; Katzaman, 1985; Lepper, 1985; Rosenthal, 1983; Zigika, 1983). Clements (1985) states that a knowledge of child development should be the guideline in determining appropriate computer usage.

Cognitive Tempo

The cognitive tempo construct was identified by Kagan, Rosman, Day, Albert, and Phillips (1964) to reflect individual differences in response style. Cognitive tempo refers to problems with some degree of uncertainty in which several response alternatives are available simultaneously and the correct response is not immediately apparent. In such situations, some children respond relatively quickly but with a high incidence of errors, while other children respond more slowly but with fewer errors.

Subjects' cognitive tempo may be classified as impulsive (fast inaccurate), reflective (slow accurate), efficient (fast accurate), or inefficient (slow inaccurate). As measured by the Matching Familiar Figures test (Kagan, 1965), impulsives score below the mean on latency and above the mean for errors, while reflectives score above the mean on latency and below the mean for errors. Efficient subjects score below the mean for both latency and errors, and inefficient subjects score above the mean on both measures.

In general, research studies have classified approximately 35% of each sample population as reflective and

35% as impulsive, with the remaining 30% divided equally between the efficient and inefficient categories (Wright, 1978). Subjects classified as efficient or inefficient are assumed to differ more in efficiency of performance than in cognitive strategy and have generally been excluded from further study (Wright, 1978).

Kagan's (1965) Matching Familiar Figures (MFF), Form F, has come to be regarded as the primary index for measuring the dimension of reflection-impulsivity (Cairns & Commock, 1978; Salkind & Nelson, 1980). This test is a match to standard task which consists of a standard line drawing of a familiar figure (e.g., tree, house, boat) and an array of six similar drawings, one of which is an exact duplicate of the standard and the other five of which differ from the standard in one detail. Two practice items and twelve test items make up the MFF.

Normative data for the MFF were constructed by Salkind (1978) from a pool of 2,846 administrations of the test by 97 individual researchers. Subjects were all described as normal, middle-class children between the ages of four and one half to twelve and one half years.

Wright (1971) developed the Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP) as a simpler form of the MFF. The test contains five practice and ten test items on each of two forms (A and B). Of the ten problems, four present four choice alternatives, four present five choices, and two present six alternatives. As in the MFF, each item presents a line drawing of a common object and an array of similar drawings. The child is asked to point to the one exact copy in the array, while the evaluator records latency to first response and number of errors.

Norms were developed based on first administration of the KRISP to 1,221 children. The sample population ranged in age from two years, five months to six years, eight months.

The cognitive tempo construct has been shown by Kagan (1965, 1966) to be stable over time and across a variety of tasks. Research has linked cognitive tempo to flexibility of cognitive style (Bush & Dweck, 1975), problem-solving strategy (Zelniker & Jeffrey, 1976), and transfer of learning (Odom, et al., 1971).

Several studies have indicated a relationship between cognitive tempo and cognitive abilities. In a study conducted by Bush and Dweck (1975), reflective nine year olds were able to modify their conceptual strategy to match task characteristics. On speeded tasks of increasing difficulty, reflective subjects were faster and more accurate than were impulsive subjects. This flexibility of cognitive tempo and style was supported in a study by Bartis and Ford (1977) who found a positive correlation between reflectivity and the ability to conserve numbers and amounts among a sample of kindergarten children. In a color - form sorting task, Katz (1971) found that reflective children made more form responses, more comparison glances, and had longer latencies than impulsives. She suggests that a color response requires only one fixation on any point of the stimulus while a form response requires more analysis since the subject must scan the entire perimeter of the stimulus. Impulsive children employ a more global-processing strategy of problem solving, while reflectives prefer a detail-processing strategy; however, reflective children were found to be more flexible in employing their unpreferred strategy than impulsives (Zelniker & Jeffrey, 1976). Kagan (1966) found that an analytic conceptual style was associated with long response times. He found that young boys who preferred analytic concepts were more capable of sustained attention to visual inputs than less analytic children.

Odom, et al., (1971), suggest that cognitive tempo plays an important role in both original and transfer learning. In learning a training task, impulsives made twice as many errors to criterion as did reflectives. Though reflectives took more time than impulsives on first choice responses, they required fewer trials to criterion. In transferring learning to a new situation, impulsives continued to make more errors than reflectives. The researchers suggested that impulsive subjects' cognitive style limited the amount of evaluation and analysis of task information available to them.

Some researchers question the validity of the cognitive tempo construct and its primary measure, the MFF, especially among preschoolers. Denney (1972), disputes Kagan's position that cognitive tempo is correlated with cognitive style, finding that cognitive tempo was changed with no effect on cognitive style and vice versa. Brodzinsky (1982), in a two year longitudinal study, found the reflection - impulsivity construct to be generally unstable and of questionable reliability during the preschool years. Egeland and Weinberg (1976), Wilson (1985), and Wright (1978) have also found cognitive tempo difficult to measure among preschoolers.

In a study of 100 preschool children, Block, Block, and Harrington (1974) found that accuracy on the MFF was significantly correlated with IQ scores, usually in the negative mid-.40's, indicating that brighter children made fewer errors and were reflective or fast accurate, not impulsive. Since the cognitive tempo construct is operationally defined as MFF scores with a negative correlation between errors and latency in the mid-.40's, errors and IQ bear the same relationship to response latency (Wilson, 1985). In defense of the cognitive tempo construct, Kagan and Messer (1975) stressed that cognitive tempo is an interaction between both latency and errors. They also pointed out the need to consider the sources of anxiety that affect performance: anxiety over ability can lead to impulsivity, but anxiety over making an error can lead to reflectivity. Finally, they stressed the importance of considering older children, not preschoolers, because cognitive tempo does not appear to be measurable until age six.

Although no instrument has yet been developed which can reliably measure the cognitive tempo construct among preschoolers, it appears that there are distinct differences between children classified as reflective and those classified as impulsive. These differences seem to have a definite effect on how children learn.

Summary

For good or for ill, computers have become a fixture in today's classroom and, if the current trend continues, will have an even more integral role in the learning process in the future. Advocates of this new technology point out the benefits of being able to individualize instruction with computers, allowing teachers to develop instructional materials which meet the individual needs of students at their own developmental levels. More research is needed, however, to determine what factors affect how children learn and how such factors affect children's interaction with computers.

Research has characterized preschoolers most interested in using computers as being cognitively more mature and exhibiting significantly higher levels of representational competence and abstract forms of free play behavior (Clements, 1985). Children classified as having a reflective cognitive tempo have also been described as having greater cognitive maturity and analytic problem solving ability, and exhibiting more representational play. Research has linked cognitive tempo with various learning tasks including flexibility of cognitive style (Bush & Dweck, 1975), transfer of learning (Odom, et al., 1971), and flexibility in problem solving styles (Zelniker & Jeffrey, 1976). It may be that cognitive tempo also has an effect on how children use computers as learning tools.

CHAPTER III

METHODS AND PROCEDURES

The primary goal of the described study was to determine whether cognitive tempo had an effect on preschoolers' use of a microcomputer. A subgoal was to develop a computerized observational checklist which would record data as subjects interacted with the test software. The Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP) was used to assess subjects' cognitive tempo. The study was conducted during the summer of 1985.

Subjects

Subjects were those preschoolers, aged four years, six months to five years, 10 months, enrolled in the prekindergarten class of a Stillwater daycare program. Two girls and 11 boys were enrolled in the program. The daycare program is part of a non-profit corporation and is funded with public monies and fees paid by parents. Subjects were not randomly chosen, but belonged to an already-formed group; thus, results may not be applied to other groups. Stillwater is a city of approximately 50,000 residents and is the site of one of the two major state universities in Oklahoma.

Instrumentation

The KRISP

The Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP), Form A, was used to classify subjects as reflective, impulsive, efficient, or inefficient. The test is a match to standard task in which a subject is to identify the one figure among four to six variants which exactly matches the presented standard (see Fig. 1). The standard and the

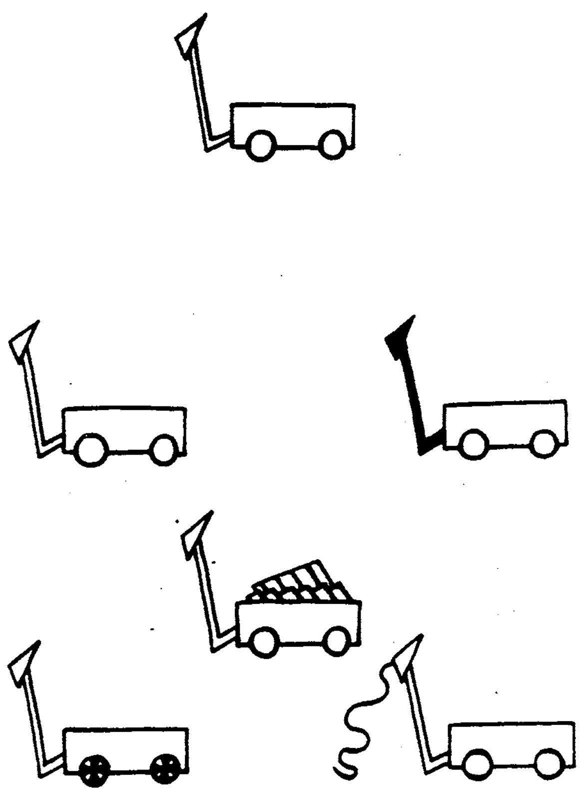

Figure 1. Sample Item From KRISP Test

variants are presented simultaneously and are always available to the subject. See Appendix A for a copy of the score sheet.

According to Wright (1978), test-retest reliability for the KRISP is reported as .581 for latencies (time taken to respond) and .746 for errors. Equivalent forms reliability is reported as .718 for latencies and .586 for errors. Concurrent validity was established by correlating scores from the KRISP and the Matching Familiar Figures Test (MFF). Wright (1978) reported a moderately significant correlation between the scores, given the limited test-retest reliability of the KRISP and the MFF.

The Peabody Picture Vocabulary Test

Since cognitive tempo has been correlated with cognitive ability, the Peabody Picture Vocabulary Test-Revised (PPVT-R), Form M, was administered to determine subjects' approximate cognitive level. This is a test of receptive language which contains 175 items. The examiner reads a word (eg. whale, catching, caterpillar) and the subject chooses a picture of that word from among an array of four line drawings. The examinee responds to items between the "basal" (lowest eight consecutive correct responses) and the "ceiling" (highest eight consecutive correct responses). A raw score is obtained by subtracting the number of errors from the ceiling score. This raw score may then be converted to a percentile, age equivalent, or standard score using tables provided in the test manual. Internal consistency for the PPVT (form M) is reported as .61 to .86, and test-retest reliability is reported as .78 (McCallum, & Wiig, 1985). A copy of the score sheet is provided in Appendix A.

Computerized Checklist

To collect data for this study, a checklist was developed by the researcher to record the number of times each subject used the computer, length of each session, total number of keystrokes per session, and number of errors (invalid keystrokes) per session. This checklist was incorporated into the software, enabling the computer to record pertinent data. Appendix B contains a listing of the raw data.

Materials/Apparatus

Microcomputer

Data were collected using an IBM PCjr. This microcomputer consists of a color monitor, keyboard, system unit, and one floppy disk drive.

Software

The software provided for the children's use was an origingal program developed for this project. The software was written the Pascal and assembly languages and employed turtle graphics. The program was initiated by typing in the current date and time and the child's name. The subject was then able to use the screen turtle to draw designs or pictures as desired. Seven keys were functional: F (moved the turtle forward 1 space), B (moved the turtle backward 1 space), R (turned the turtle 15 degrees to the right), L (turned the turtle 15 degrees to the left), E (erased the previous one-space movement without changing the directional orientation of the turtle), C (changed the color in which the turtle drew), and W (cleared the screen of all previous drawing). These keys were marked with color-coded dots: blue for movement keys (F, B), red for directional keys (R, L), and yellow for function keys (E, C, W). All other keys were unmarked and, if pressed, had no effect on the visual display.

This software also recorded observational data. Use of any marked key was recorded as a correct keystroke. Use of any unmarked key was recorded as an incorrect keystroke. Appendix C provides a flow chart for the program. A listing of the program may be obtained from the researcher.

Research Design

The case study was chosen as the research design for this pilot study. Reasons for selecting the case study were:

1. A case study can develop ideas that could lead to conclusions or hypotheses needing testing by a statistical method.
2. Qualifiable data obtained from the case study method should give insight into the differences in the use

of classroom computers by preschool children.

3. The case study can provide insight into the development of design criteria for software intended for preschoolers.

Procedure

Before beginning data collection, University Form HEC-A, Summary of Project Involving Human Subjects, was filed with the Graduate College. (See Appendix D). Parental consent forms were also distributed. (See Appendix E).

The Kansas Reflection-Impulsivity Test for Preschoolers (KRISP) was administered to all children between the ages of 54 and 70 months who were enrolled in the prekindergarten class of a daycare program in Stillwater, Oklahoma. All children were allowed equal access to the computer; however, only data for those children classified as impulsive or reflective were considered for this study.

An IBM PCjr was set up as an additional interest center in the prekindergarten classroom of a Stillwater daycare center. The children were introduced to the parts of a computer during a group time through the use of a hand-drawn poster of a computer. A poster was also used at this time to explain the color-coding system of the computer keyboard. The children were also instructed that only color-coded keys would work when using the computer during this time. The color-coded chart was available at all times while the children used the computer, and the researcher was also present at all times to answer questions. Appendix F provides a reproduction of these charts.

All children in the program were allowed access to the computer during the morning self-select play time (approximately 9:30 to 11:00 a.m.) on Monday through Thursday for a period of three weeks. This time period was chosen based on observations by another researcher. Rutledge (unpublished) found that children maintained interest in a particular software package for approximately three weeks. Due to the prohibitive cost of software, only one software package was available for use during this study. Children signed a waiting list to use the computer, and were allowed to sign up for more than one turn per day if they wished. Other activities were available to the children while they waited for a turn to use the computer.

At the conclusion of the computer session, parents were asked to complete a survey regarding their children's previous computer experience. (See Appendix E). Upon the completion of the three week session, the PPVT was administered to all subjects. The time period for testing was extended to three weeks. This was necessary due to several schedule conflicts with subjects' family vacations. Data collected from the computer session, testing, and survey were summarized using frequency tables.

CHAPTER IV

RESULTS OF THE STUDY

Introduction

The major purpose of this study was to determine whether there was a difference in computer use by children classified as having impulsive or reflective cognitive tempo. Subjects' cognitive tempo was determined based on scores received on the Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP). Additional information about the subjects was obtained from the Peabody Picture Vocabulary Test-Revised (PPVT-R), Form M, and from a survey completed by the parents. Another purpose of the research was to develop a computer program which would record observational data as the subjects interacted with the software.

Results of Tests and Survey

This research was conducted during June, July and August of 1985. Subjects were those children aged four years, nine months to five years, ten months, who were enrolled in the summer prekindergarten program of a Stillwater daycare program. All subjects (N = 13) were administered the KRISP to determine cognitive tempo. An identifying number was assigned to each subject for the purpose of reporting data. Using a double-mean split for latencies and errors, three children were classified as impulsive, five were classified reflective, four were efficient, and one was inefficient. (See Fig. 2).

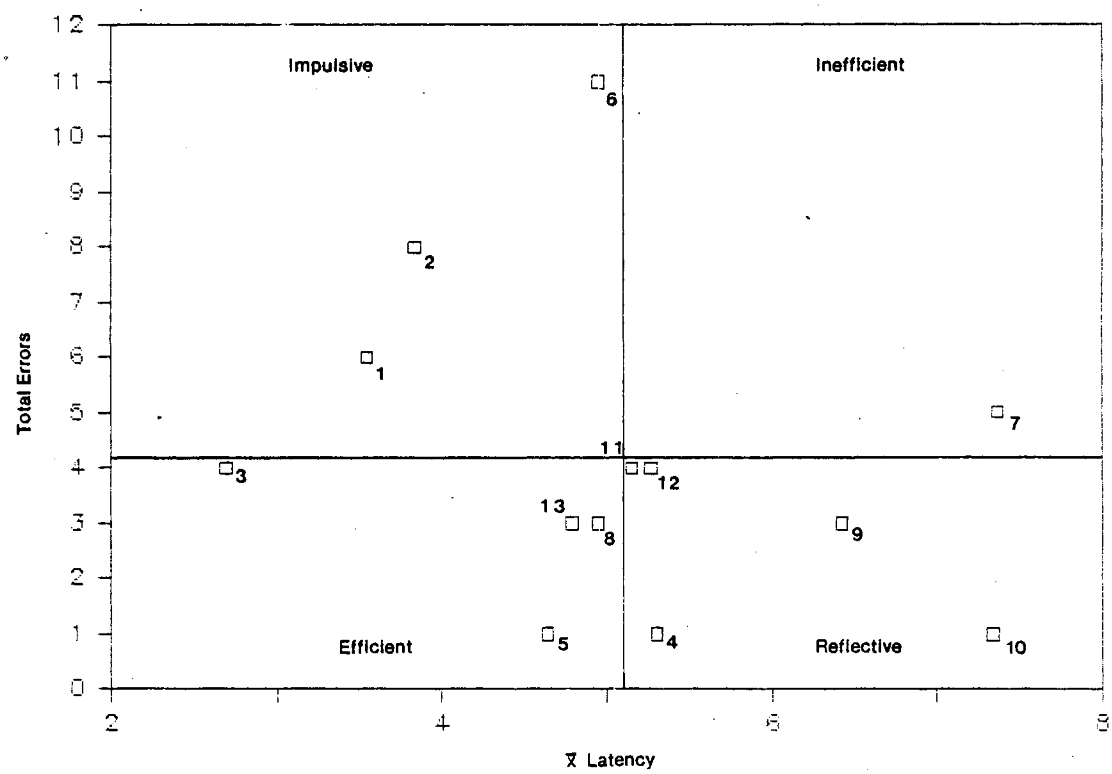

Figure 2. Scatterplot of KRISP Scores

Of the original thirteen children, three dropped out of the program prior to the completion of the study, including two reflective children. This study does not include data for children classified as efficient or inefficient, or for those who dropped out of the program. All of the six subjects considered in this study were males. The two girls enrolled in the program fell into the efficient or inefficient categories and were not included in this report.

It was thought that several factors might have an effect on the results of the study, and measures were taken to control for these factors. Since cognitive tempo has been linked with age and with cognitive maturity, the PPVT-R, Form M, was administered to provide an approximate cognitive level for each subject. One child was not tested due to his illness during the three week testing period. Since previous experience with computers might also affect how receptive children were to using the computer, parents were asked to complete a survey regarding their child's prior use of computers. Surveys were completed for five of the six subjects. Table I summarizes the results obtained from the tests and the survey. Ages are reported as year - month.

The subjects' ages were within a range of 13 months, with both the oldest and the youngest subject classified as reflective. The PPVT-R scores were higher for reflective subjects than for impulsive subjects by one to two and one-half years. None of the subjects had any significant computer experience, with only one child having used the computer infrequently prior to this study.

TABLE I

DESCRIPTION OF SUBJECTS ACCORDING TO KRISP, PPVT-R, AND COMPUTER SURVEY

Subject	Sex	Age	KRISP Class.	PPVT-R Age Equiv.	Previous Computer Experience
1	M	5-4	Imp.	4-1	none
2	M	5-5	Imp.	4-5	none
6	M	5-1	Imp.	4-3	survey not returned
4	M	5-10	Refl.	6-10	none
9	M	5-5	Refl.	5-6	observed others occasionally; parent uses at work
10	M	4-9	Refl.	ill during testing	observed others often; used 1-10 days/month; computer in home

Results of Computerized Checklist

Software

For the purpose of this study, a graphics software package was developed which utilized only seven computer keys. These keys were color-coded and their function explained and demonstrated to all subjects. As the subjects interacted with the software, a separate part of the program (the checklist) recorded the length of the session and the number of correct and incorrect keystrokes. The use of any unmarked key was counted as an incorrect keystroke.

Frequency of Errors

Mean errors per minute and mean errors per keystroke were calculated for each subject. The reader may refer to Table II for a summary of the data. In general, impulsive subjects made more errors than reflectives when considering both errors per minute and errors per 100 strokes. When subjects were rank ordered according to error scores on the KRISP and the computerized checklist, order was preserved with the exception of the two subjects occupying positions three and four. (See Table III).

TABLE II

FREQUENCIES OF ERRORS IN COMPUTER USE
FOR IMPULSIVE AND REFLECTIVE CHILDREN

Subject	KRISP Class.	Mean Errors/ Minute	Mean Errors/ 100 Strokes
1	Imp.	0.83	2.94
2	Imp.	7.33	11.34
6	Imp.	6.03	18.38
4	Refl.	0.89	1.87
9	Refl.	2.26	4.36
10	Refl.	0.67	1.33

TABLE III

RANK ORDERING OF SUBJECTS BY ERROR SCORES FROM KRISP AND CHECKLIST (HIGHEST TO LOWEST)

Subject	KRISP Errors	Subject	Checklist Errors (per 100 strokes)
6	11	6	18
2	8	2	11
1	6	9	4
9	3	1	3
4	1	4	2
10	1	10	1

Frequency and Length of Computer Sessions

The number of computer sessions and mean length of the sessions were also observed for each child. Data for individual subjects is presented in Table IV. Table V compares impulsives and reflectives as groups. It appears that there was no real difference in frequency of computer use when considering impulsives and reflectives as groups. Session length was an average of 15 percent longer for impulsives than for reflectives.

TABLE IV

NUMBER AND LENGTH OF COMPUTER SESSIONS
FOR INDIVIDUAL SUBJECTS

Subject	KRISP Class.	Number of Sessions	Mean Length of Sessions (Min.Sec.)
1	Imp.	1	13.17
2	Imp.	5	15.35
6	Imp.	4	20.17
4	Refl.	2	17.07
9	Refl.	5	13.15
10	Refl.	2	16.12

TABLE V

MEAN NUMBER AND LENGTH OF COMPUTER SESSIONS
FOR IMPULSIVE AND REFLECTIVE SUBJECTS

KRISP Class.	Mean Number of Sessions	Mean Length of Sessions (Min.Sec.)
Impulsive	3.33	17.14
Reflective	3.00	14.46

CHAPTER V

SUMMARY

The purpose of this study was to determine whether cognitive tempo had an effect on computer use by preschool children. The Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP) was used to determine subjects' cognitive tempo. In addition, an interactive graphics program was developed which recorded observational data as the children used it. Specific objectives of the study were:

1. To determine whether impulsive children made more errors when using the microcomputer than did reflective children.

2. To determine whether impulsive children used the microcomputer less frequently than did reflective children.

3. To determine whether impulsive children used the microcomputer for shorter periods of time than did reflective children.

Methods of the Study

Subjects for the study were chosen from a group of children, aged four years, nine months through five years, ten months, who were enrolled in the summer prekindergarten program of a Stillwater non-profit daycare facility. Subjects were not randomly selected; thus, results may not be applied to other groups. This study may, however, provide insight into the need for future research in this area.

The KRISP was administered to all children enrolled in the program (N=13). Using a double-mean split for latencies and errors, three boys were identified as impulsive and five boys were identified as reflective. Two of the reflective children dropped out of the program prior to completion of the study; their data are not included in this report. The remaining seven children fell into the efficient/inefficient quadrants of the KRISP. Their data are also not considered.

All children enrolled in the program were given equal access to the computer for a period of three weeks. As the children used the computer, the software recorded the length of the session and the number of correct keystrokes (use of functional keys) and incorrect keystrokes (non-functional keys). Parents were also asked to complete a survey regarding their child's previous experience with computers. At the end of the three week computer session, the Peabody Picture Vocabulary Test - Revised (PPVT-R) was administered to obtain an approximate cognitive level for each child.

Results of the Study

Errors in Computer Usage

The age range for the subjects was 13 months, with both the oldest and youngest child being classified as reflective. The PPVT-R Mental Age Equivalent scores for reflective subjects were higher than those for impulsive subjects by one to two and one-half years. This seems to indicate a higher cognitive level among the reflective subjects, a finding consistent with that of other researchers (Block et al., 1974, Bush & Dweck, 1975). This factor may have had some affect on the number of errors made by the subjects. Errors were counted as the use of non-functional keys, meaning that subjects had to remember which keys would change the graphics display and which would have no effect. It was noted by the researcher that impulsive subjects asked for help in deciding which keys to use more often than did reflectives, even though the functional keys were color - coded and their functions described pictorially on a nearby poster. Previous experience did not appear to be a factor in how subjects used the computer since only two children had minimal exposure to computers prior to this study.

An interesting relationship between computer errors and KRISP errors was noted. When rank ordered according to error scores on the KRISP and the computerized checklist, order was preserved except that the two subjects occupying positions three and four switched places; that is, Subject 1 made more errors on the KRISP than Subject 9, while Subject 9 made more computer errors.

In future studies, it may prove useful to modify the software to calculate latencies for keystrokes as well as total errors. In this way, a comparison for both latencies and errors between KRISP scores and use of the computer could be made. If rank ordering for both latency and error scores were consistent, it may be possible to measure children's cognitive tempo using a computer program similar to the one employed in this study.

Software for the present study did calculate mean latency and standard deviation of latency for each session; however, the general shape of the latency distribution curve is not known, thus this data is of minimal use. This problem could be remedied through a software modification which would create a frequency histogram for response latencies within specified ranges.

Frequency and Length of Computer Sessions

In comparing computer use by impulsives and reflectives as groups, there appeared to be very little difference in the frequency of use among the few children involved in this case study. There was, however, much variation in the number of times individual subjects used the computer, with one reflective and two impulsive subjects using the computer at least twice as frequently as the three other subjects. As a group, the impulsive subjects' sessions were longer than the reflectives' by 15%. Once again, however, there was great variation among indiviual subjects, with one impulsive and one reflective child having the greatest mean length of sessions. Because of the small sample size, it is difficult to make comparisons between groups; however, the results indicate that, while impulsives did make more errors than reflectives, this did not diminish their use of the computer.

Several factors may have influenced both the frequency and length of computer sessions. This study was conducted during the summer months, and several subjects were absent frequently due to family vacations and other activities. This limited the number of times the children were able to use the computer. Also, all of the children in the program were allowed equal access to the computer, not just those for whom data is included in this report. Fewer than half of the computer sessions recorded by the software were sessions of reflective and impulsive subjects. Computer access for the children was limited due to the fact that only one machine was available for their use.

The software itself may also have been a limiting factor in how much the computer was used. The researcher observed that the reflective children tended to learn how to operate the software more quickly than the impulsives. They also explored the software's functions more quickly and then lost interest in it. A more complex software package employing a greater variety of functions may have been more interest sustaining for the reflectives.

The current study employed an interactive graphics program for which there was essentially no negative feedback. Many of the most popular educational programs do employ such feedback, however. It may be that utilizing a more structured program which provides positive and negative feedback would affect the frequency and length of computer sessions.

Use of the Computer as an Observational Tool

The researcher found several advantages to using the computer as an observational tool. One of the problems faced by researchers conducting observational studies is the influence of the Hawthorne Effect, in which subjects' reactions in a testing situation are biased due to the attention they receive from the observer. In the present study, subjects were unaware that they were being observed due to the automation of the checklist. Also, since observations were recorded by the computer as subjects interacted with the software, observer bias was greatly reduced. The computer was not affected by fatigue or distractions during the recording of observational data, as is sometimes the case with human observers. Though computerized observations will not be appropriate for every type of study, certainly the use of this tool could ease the collection of some types of data.

Recommendations for Further Study

The findings of this study indicate that cognitive tempo may influence the number of errors children make when using a computer program, but that these errors do not necessarily affect how often or for how long a period of time children use the computer. It also appears that the computer may be a valuable tool for use in observational research. Based on these findings, the following recommendations are made for further study:

1. Conduct a similar study using a larger population and random sampling techniques. This would allow statistical analyses to be applied to the resulting data in order to determine the degree of correlation between cognitive tempo and computer use.

2. Modify the software to include collection of latency data. Such modification would be necessary in order to accurately compare cognitive tempo as measured by the KRISP and the observational checklist.

3. Conduct a similar study using more than one computer per classroom.

4. Conduct a similar study comparing reflective and impusive subjects' use of more structured software which provides positive and negative feedback.

5. Apply basic principles of programming used in this study to other testing situations.

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APPENDIXES

APPENDIX A

TEST SCORE SHEETS

SCORING SHEET <u>KRISP</u> FORM A

Number___________

Subject________________________________ Date of birth__________ Date_________

Experimenter____________________________ Reliability____________ Sex_________

Stimulus	Correct Answer Seen by E	Response Time	Number of Errors	Comments
P-1 Circle	X 1			
P-2 Ice Cream	X 1			
P-3 Silverware	X 2 1			
P-4 Hat	3 X 1			
P-5 Umbrella	4 X 2 1			
A-1 Ball	4 X 2 1			
A-2 Candle	X 3 2 1			
A-3 Coat	4 3 X 1			
A-4 Pail	5 4 2 X 1			
A-5 Wagon	5 4 2 3 X			
A-6 Pan	4 3 2 X			
A-7 Kite	5 X 2 3 1			
A-8 Truck	6 X 4 3 2 1			
A-9 Mouse	6 5 4 X 2 1			
A-10 Kitten	5 4 2 3 X			

PPVT Peabody Picture Vocabulary Test—Revised

INDIVIDUAL TEST RECORD

FORM M

by LLOYD M. DUNN & LEOTA M. DUNN

NAME ____________________ SEX: M ___ F ___

HOME ADDRESS ____________________ HOME PHONE ________

SCHOOL ____________________ GRADE PLACEMENT ________

TEACHER ____________________ EXAMINER ____________________

LANGUAGE OF THE HOME: ☐ Standard English ☐ Other ____________________

Date & Age Data

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

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

Notice to Users

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

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

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Publishers' Building, Circle Pines, Minnesota 55014
AGS®

Obtained Test Scores

Raw score .... (from page 4)

Standard score equivalent .... (from Table 2, Appendix A)

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

Stanine .... (from Table 3, Appendix A)

Age equivalent .... (from Table 5, Appendix A)

TRUE SCORE CONFIDENCE BAND

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

Data from Other Tests

Test	Date	Results
PPVT–R FORM L		

Observations

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

Performance Evaluation

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

Recommendations

FORM M

TEST ITEMS AND ABBREVIATED INSTRUCTIONS

Administering the TRAINING ITEMS

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

Training Plate	Initial Practice Series Words & Keys	Additional Practice Words & Keys: Alternate Series 1	Alternate Series 2	Alternate Series 3
A	bed (1)	baby (2)	spoon (4)	dog (3)
B	chair (4)	banana (3)	knee (1)	kitten (2)
C	sleeping (2)	eating (1)	drawing (3)	crying (4)
D	ship (2)	airplane (4)	canoe (3)	truck (1)
E	mopping (1)	riding (2)	sawing (4)	mowing (3)

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

Administering the TEST ITEMS

Basal: Highest 8 consecutive correct responses
Ceiling: Lowest 8 consecutive responses containing 6 errors
Starting Point: For a subject assumed to be of average ability, find the person's age circled in the margin, and begin the test with that item. Otherwise consult Part I of the Manual for further instructions.
Recording Responses and Errors: Record the subject's response (1, 2, 3, or 4) for each item administered. For each error, draw an oblique line either through the plate number of the item missed, or through the geometric figure, as illustrated below.

12 full . . . . . (3) 2 ♡ or 12 full . . . . . (3) 2 ♡

Every eighth figure is identical to help determine the basal and ceiling.
(Complete directions are given in Part I of the Manual.)

NOTE: Ages in circles refer to the lowest age in a 6- or 12-month interval. For example, item 1 is the starting item for ages 2-6 through 3-5, and item 30 for ages 5-0 through 5-5. Use item 110 for ages 16-0 and over.

Plate Number	Word	Key	Response	Error
1	car	(2)		○
2	ball	(4)		□
3	money	(3)		△
4	broom	(2)		Ω
5	bee	(3)		♡
6	bottle	(1)		☆
7	circle	(4)		◇
8	candle	(2)		○
9	plant	(1)		□
10	reading	(4)		△
11	ladder	(2)		Ω
12	bull	(3)		♡
13	mail	(1)		☆
14	horn	(1)		◇
15	pulling	(1)		○
16	neck	(3)		□
17	gate	(2)		△
18	kangaroo	(2)		Ω
19	lock	(3)		♡
20	kite	(1)		☆
21	desk	(3)		◇
22	pouring	(4)		○
23	farmer	(4)		□
24	broken	(1)		△
25	picking	(4)		Ω
26	ambulance	(1)		♡
27	somersault	(2)		☆
28	time	(3)		◇
29	bush	(1)		○
30	whale	(2)		□
31	wooden	(2)		△
32	catching	(4)		Ω
33	cobweb	(3)		♡
34	river	(3)		☆
35	track	(1)		◇
36	peeking	(4)		○
37	pail	(1)		□
38	sharing	(3)		△
39	caterpillar	(3)		Ω
40	branch	(2)		♡
41	saddle	(2)		☆
42	dentist	(3)		◇
43	eagle	(2)		○
44	rough	(4)		□
45	counter	(1)		△
46	uniform	(4)		Ω
47	jewelry	(1)		♡
48	furniture	(3)		☆
49	coin	(1)		◇
50	tugging	(2)		○
51	liquid	(4)		□
52	ankle	(4)		△
53	floating	(1)		Ω
54	binocular	(3)		♡
55	wrist	(2)		☆
56	hive	(4)		◇
57	argument	(1)		○
58	printing	(4)		□
59	waiter	(3)		△
60	root	(2)		Ω
61	walrus	(2)		♡
62	swamp	(1)		☆
63	angle	(2)		◇
64	jaw	(4)		○
65	entertainer	(1)		□
66	directing	(2)		△
67	artist	(3)		Ω
68	shore	(2)		♡
69	pair	(3)		☆
70	ceiling	(4)		◇
71	secretary	(4)		○
72	cliff	(1)		□
73	flaming	(3)		△
74	funnel	(3)		Ω
75	woolly	(4)		♡
76	nutritious	(3)		☆
77	construction	(2)		◇
78	thimble	(1)		○
79	grain	(4)		□
80	furious	(1)		△
81	sorting	(1)		Ω
82	musician	(2)		♡
83	greeting	(3)		☆
84	competition	(3)		◇
85	weary	(3)		○
86	antler	(4)		□
87	harvesting	(1)		△
88	snarling	(1)		Ω
89	plastering	(3)		♡
90	triplet	(4)		☆
91	assisting	(1)		◇
92	grooming	(2)		○
93	tropical	(2)		□
94	scholar	(4)		△
95	applauding	(4)		Ω
96	bugle	(2)		♡
97	nuisance	(1)		☆
98	gnawing	(3)		◇
99	easel	(3)		○
100	compass	(2)		□
101	escorting	(4)		△
102	wedge	(3)		Ω
103	beverage	(1)		♡
104	cubical	(4)		☆
105	arctic	(2)		◇
106	pod	(3)		○
107	fragment	(3)		□
108	banister	(1)		△
109	composer	(4)		Ω
110	archaeologist	(4)		♡
111	parallel	(4)		☆
112	astonished	(3)		◇
113	liberated	(1)		○
114	portable	(2)		□
115	physician	(4)		△
116	canine	(3)		Ω
117	agriculture	(4)		♡
118	solar	(2)		☆
119	precipitation	(2)		◇
120	hovering	(3)		○
121	amphibian	(1)		□
122	dome	(3)		△
123	descending	(1)		Ω
124	embracing	(1)		♡
125	judicial	(2)		☆
126	mason	(4)		◇
127	fowl	(3)		○
128	lubricating	(1)		□
129	porcelain	(2)		△
130	appraising	(3)		Ω
131	beacon	(4)		♡
132	attire	(4)		☆
133	nape	(2)		◇
134	salutation	(2)		○
135	concave	(3)		□
136	incisor	(1)		△
137	dwelling	(1)		Ω
138	orating	(1)		♡
139	illumination	(4)		☆
140	submerging	(4)		◇
141	laminated	(2)		○
142	convergence	(2)		□
143	angler	(2)		△
144	receptacle	(1)		Ω
145	enticing	(3)		♡
146	stamen	(3)		
147	expunging	(3)		
148	prodigy	(1)		
149	encumbered	(3)		
150	depleted	(4)		
151	recumbent	(1)		
152	equestrian	(2)		
153	caliper	(4)		
154	impale	(1)		
155	ellipse	(4)		
156	apparition	(2)		
157	gable	(4)		
158	rapture	(3)		
159	edifice	(4)		
160	perusing	(2)		
161	penal	(1)		
162	bovine	(2)		
163	mendicant	(3)		
164	arable	(3)		
165	morass	(3)		
166	ingenious	(2)		
167	siding	(1)		
168	laciniate	(1)		
169	deciduous	(4)		
170	casement	(4)		
171	copious	(2)		
172	sumptuous	(4)		
173	imbibing	(4)		
174	consternation	(3)		
175	pedagogue	(1)		

Calculating Raw Score

Ceiling item . . . .
minus errors* . . . .
Raw score . . . .

*Count errors between highest basal and lowest ceiling.

APPENDIX B

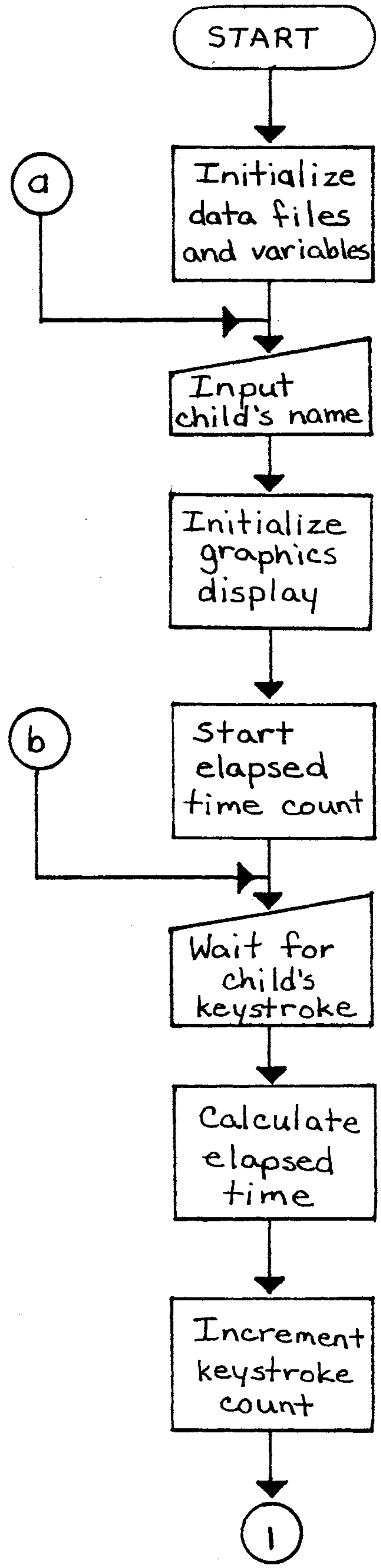
RAW DATA

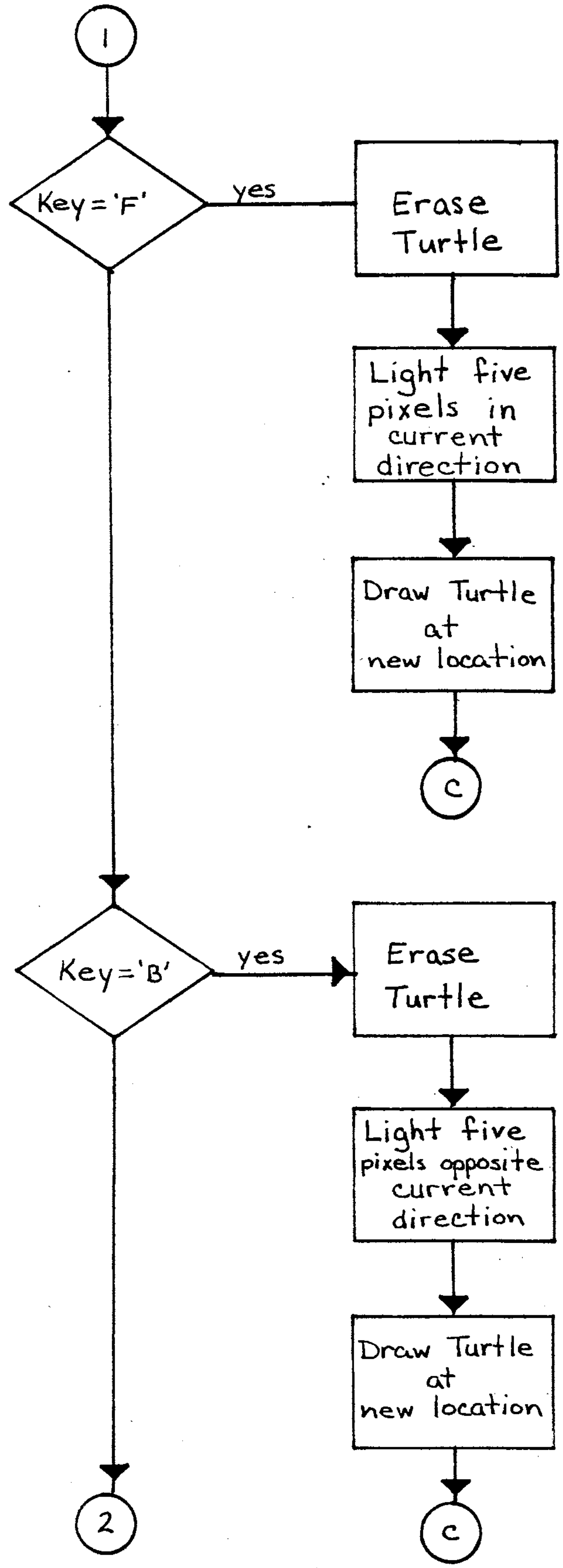
SUBJECT	DATE	TIME	SESSION LENGTH MIN : SEC	STROKES	ERRORS
6	6-25-85	9:30	17 : 41	697	17
2	6-26-85	9:54	23 : 24	1157	77
1	6-26-85	10:09	13 : 17	374	11
4	7-01-85	9:29	19 : 49	796	5
6	7-01-85	10:24	25 : 49	629	121
2	7-01-85	10:25	1 : 01	1	0
2	7-01-85	10:53	25 : 44	950	62
9	7-01-85	11:04	9 : 51	618	51
9	7-02-85	9:39	23 : 46	1083	38
10	7-02-85	10:03	23 : 16	1173	26
4	7-02-85	10:18	14 : 23	705	22
6	7-02-85	10:58	14 : 26	427	70
9	7-03-85	10:01	20 : 07	886	34
2	7-08-85	9:23	13 : 39	669	8
10	7-08-85	9:34	9 : 08	457	2
6	7-08-85	9:59	23 : 03	886	314
9	7-08-85	10:05	5 : 09	264	4
2	7-08-85	10:25	5 : 28	408	159
9	7-09-85	10:19	7 : 18	320	15
2	7-09-85	10:32	9 : 36	388	13

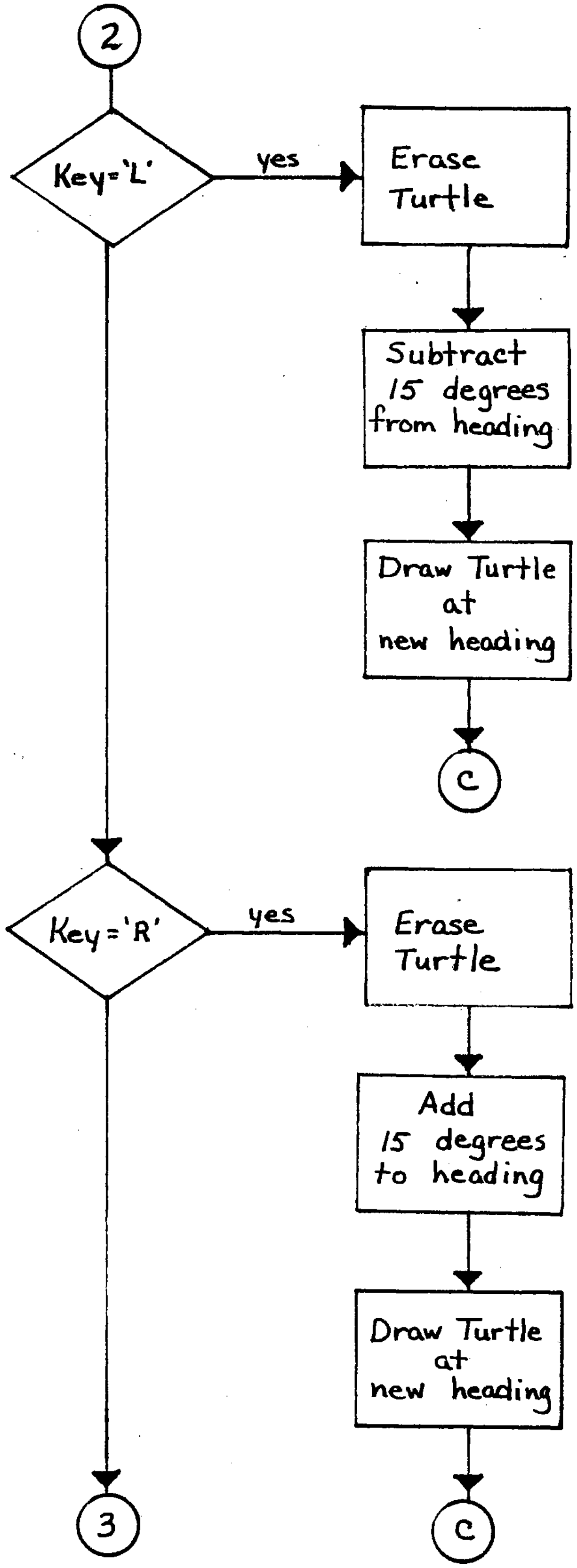
APPENDIX C

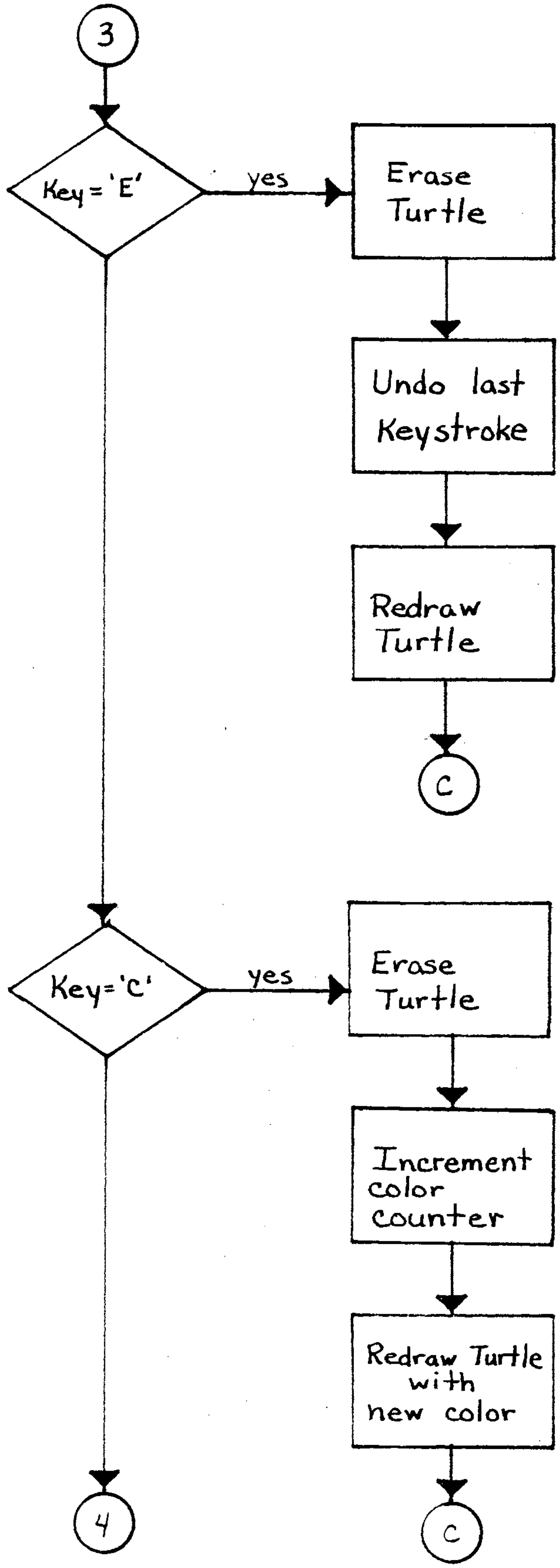
FLOW CHARTS

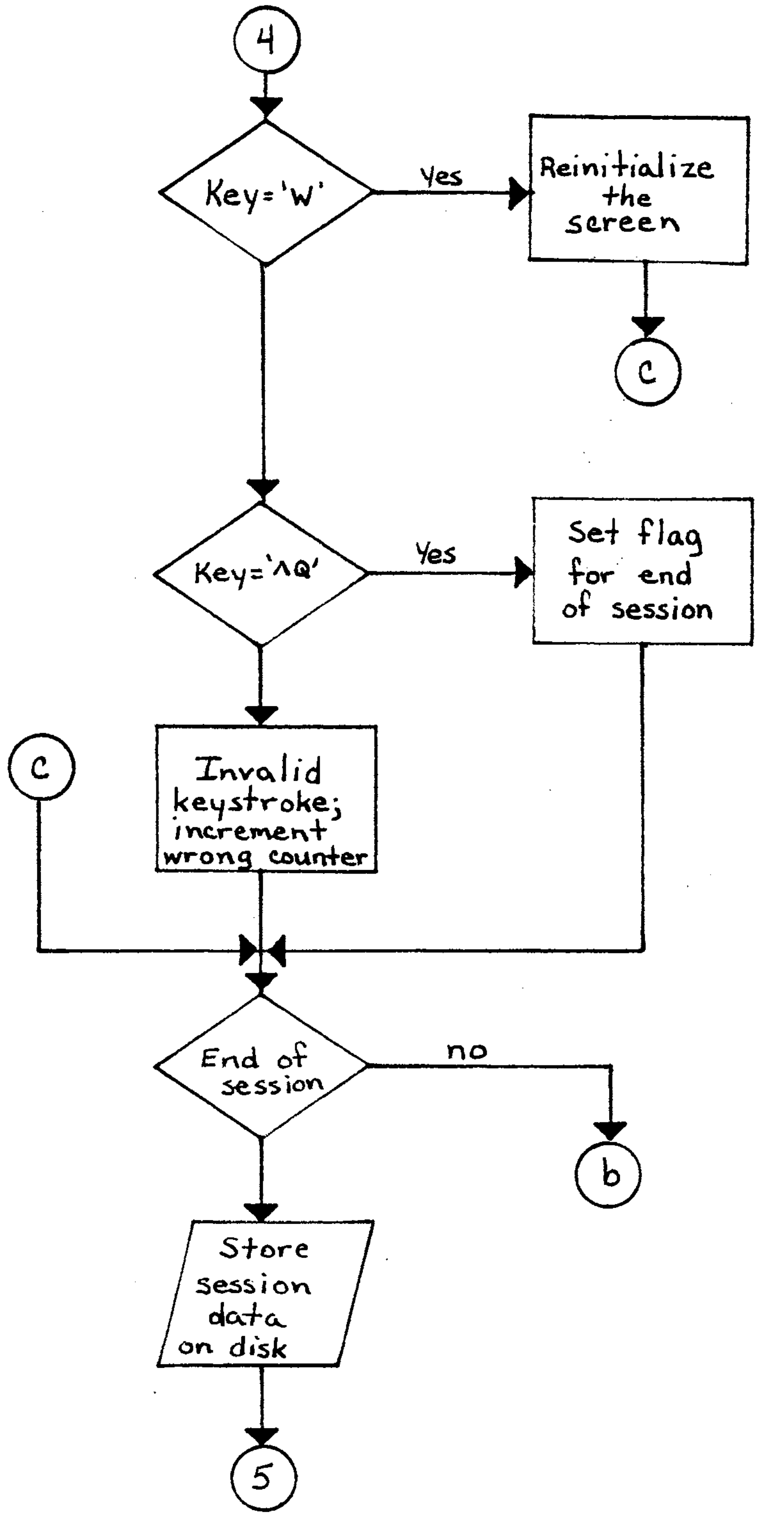
Main Program

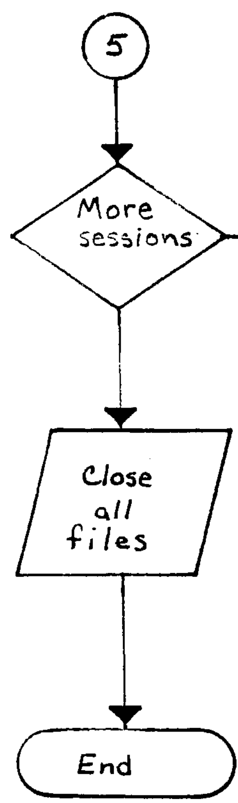



1
Key='F'
yes
Erase Turtle
Light five pixels in current direction
Draw Turtle at new location
C
Key='B'
yes
Erase Turtle
Light five pixels opposite current direction
Draw Turtle at new location
2
C


2
Key='L'
yes
Erase Turtle
Subtract 15 degrees from heading
Draw Turtle at new heading
C
Key='R'
yes
Erase Turtle
Add 15 degrees to heading
Draw Turtle at new heading
3
C


3
Key = 'E'
yes
Erase Turtle
Undo last Keystroke
Redraw Turtle
C
Key='C'
yes
Erase Turtle
Increment color counter
Redraw Turtle with new color
4
C


4
Key='W'
yes
Reinitialize the screen
c
Key='^Q'
yes
Set flag for end of session
c
Invalid keystroke; increment wrong counter
End of session
no
b
Store session data on disk
5


5
More sessions
yes
a
Close all files
End

APPENDIX D

OKLAHOMA STATE UNIVERSITY FORM HEC-A

FORM HEC-A
SUMMARY OF PROJECT INVOLVING HUMAN SUBJECTS[1]

(Research, Experimentation or Demonstration)

College of Home Economics

OKLAHOMA STATE UNIVERSITY

Submit three copies to: Head of Department[2]
a. Prior to submission of proposal involving human subjects to graduate dean (if graduate student project)
b. Prior to initiating any contacts with human subjects

I. Submitted by: Denise M. Wyatt Date 6 - 3, 19 85.

Relation to project: (Check appropriate box.)

☑ Principal Investigator ☐ Project Leader

☐ Other (explain) __________

II. Title of proposal or project: Reflection vs. Impulsivity: The Effect of Cognitive Tempo on the Use of Microcomputers by Preschoolers

III. Funding source(s): personal

IV. Statements of submitter(s):

A. Summary of specific ways in which human subjects will be involved and possible impact upon them as individuals.

Preschool children will be evaluated to determine approximate IQ level and cognitive tempo. Children will be introduced to and encouraged to use a microcomputer. Possible impact includes knowledge of and freedom to use a microcomputer.

B. Statement of submitter's evaluation of possible "risk" to subjects: (check appropriate box)

☐ Subjects will be "at risk".

☑ Subjects will not be "at risk".

Reasons for conclusion

Children will be free to use or not use the computer as they wish. Software has been ~~developed~~ designed to be creative and to minimalize negative reinforcement. An adult will supervise the use of the computer at all times. Wires and plugs will be concealed or inconspicuous to children. Evaluational tools will be presented as "games" and the children will be free to stop at any time in order to reduce anxiety caused by testing (over)*

[1]For use with projects not being submitted for external funds. Copies available in HEW 108.

[2]After processing, Head will send copies to submitter, Associate Dean for Research and department files.

[3]Information and regulations are available for review in Contracts and Grants Office or offices of department heads.

V. Recommendation of reviewers (Each completes A or B as appropriate.):

A. Contents examined and approved:

Two graduate faculty members without conflicting interest in project (other than project staff or major professor if submitter is student):

Signature: [signature] — Date: June 3, 1985

Signature: [signature] — Date: 6-3-85

B. Contents examined and not concurred with as follows:

Recommendation(s):

Signature ____________ Date ____________

Signature ____________ Date ____________

VI. Action of home economics administrator (check appropriate box):

[X] Subject(s) not considered to be "at risk". Submitter is responsible for filing a revised form if project plans change in any way that might affect this decision.

[ ] Subject(s) considered to be "at risk". Submit appropriate OSU form to Chairman, Institutional Review Board. (See footnote 3.) Copies are available in HEW 108.

Signed by: [signature]
Head of Department or Associate Dean

Date: June 3, 1985.

* situations. All test results will be strictly confidential.

APPENDIX E

LETTERS TO PARENTS

May 29, 1985

Dear Parents,

As you are aware, computers are becoming a very prevalent part of our culture and, in some schools, are even being used in classrooms with young children. As a graduate student, I am interested in observing how preschool children approach and use computers; this summer, I will be conducting such a study. I would like to offer your child the opportunity to take part in this study.

During the months of June and July, your child will have the opportunity to use an IBM PCjr, utilizing software designed specifically for preschoolers. Simple evaluational instruments will be used to aid in determining each child's approach to and use of the computer.

If you would like for your child to participate in the study, please complete and return the form at the bottom of this page to your child's teacher by Friday, May 31. If you have any questions or if you would like further information, please feel free to call me at 377-6572 any weekday before 5:00 p.m.

Thank you for your cooperation.

Sincerely,

Denise Wyatt

Please return this form by May 31.

My child has permission to participate in the computer study to be conducted during the months of June and July.

Child's name____

Parent's signature__________________________________

August 5, 1985

Dear Parents,

Thank you so much for allowing your child to participate in the computer study conducted at the YMCA. I trust that your child enjoyed using the computer.

In order to complete this study, I require some background information concerning your child. Please complete the enclosed information card and drop it in the mail by Friday, August 9.

Again, thank you for your cooperation and assistance.

Sincerely,

Denise Wyatt

Child's name____________________ Date of birth ___/___/___

Number of persons in household ____

Prior to this study, approximately how many days per month did your child use a computer?

___ None ___ 1-10 ___ 11-20 ___ 21 or more

Has child observed parents or siblings using a computer?

___ No ___ Occasionally ___ Often

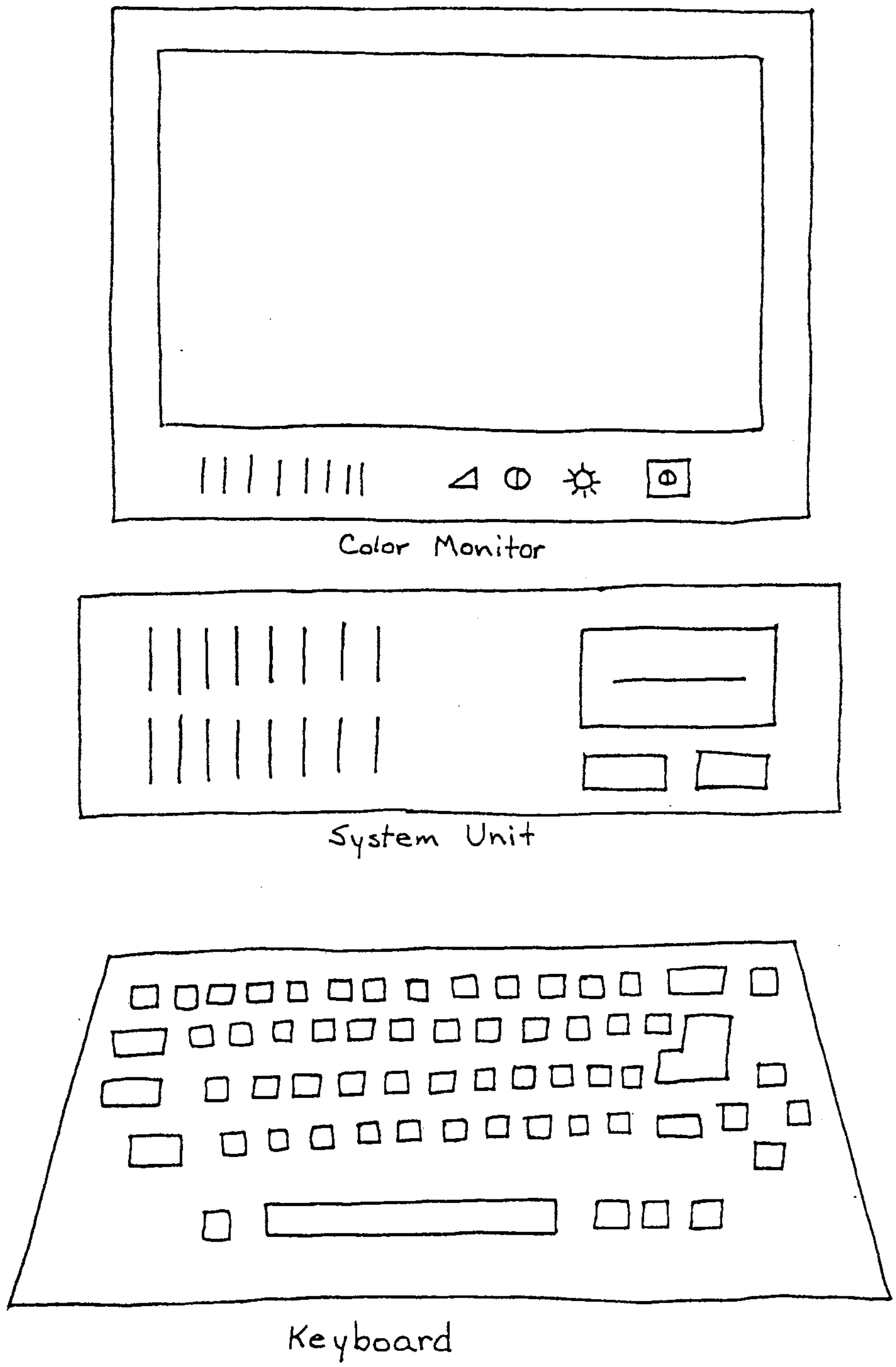
Do you own a home computer? ___ Yes ___ No

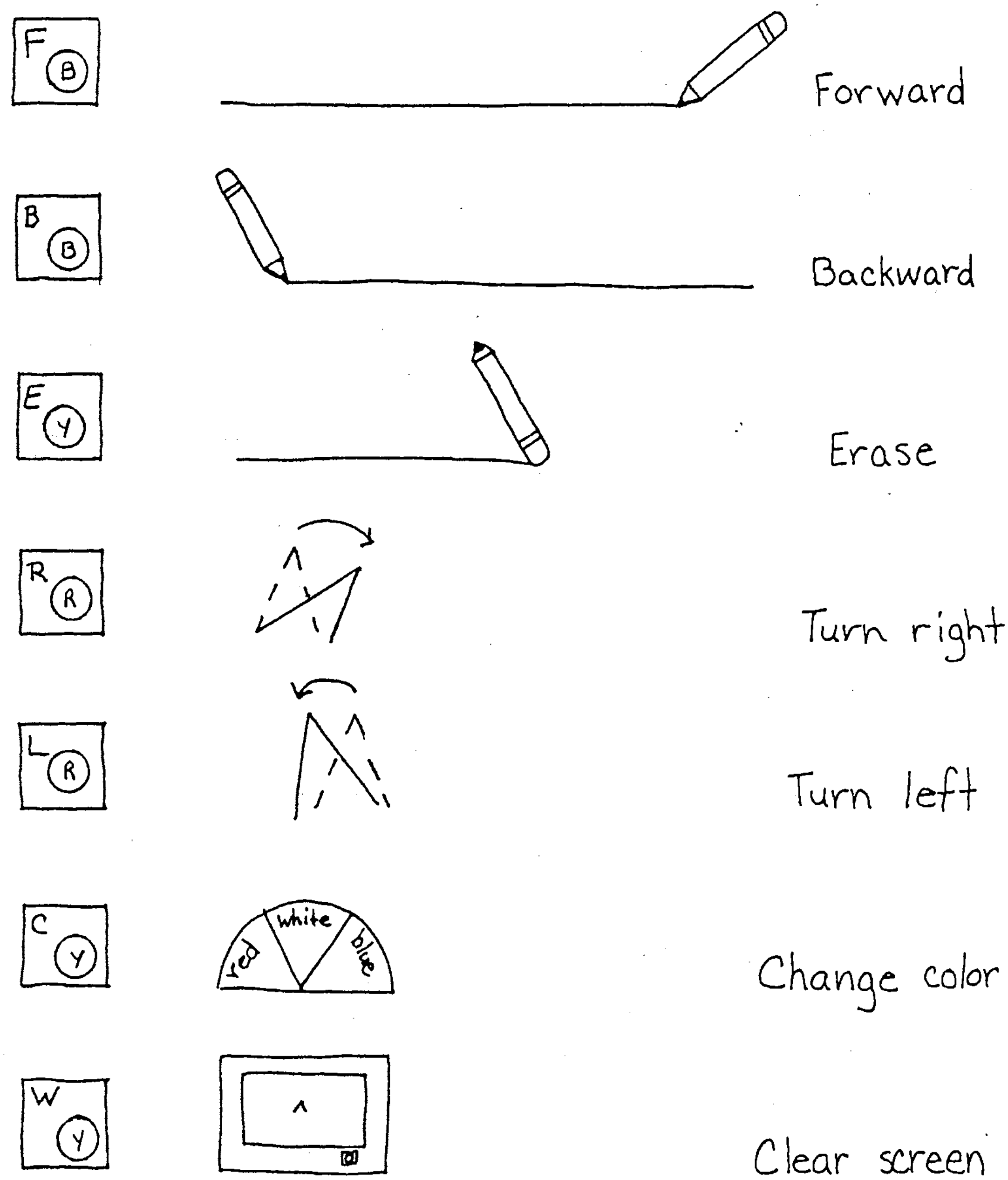
Do you use a computer in your work? ___ Yes ___ No

Comments:

APPENDIX F

CHARTS INTRODUCING THE COMPUTER AND PROGRAM


Color Monitor
System Unit
Keyboard


F B
Forward
B B
Backward
E Y
Erase
R R
Turn right
L R
Turn left
C Y
red
white
blue
Change color
W Y
Clear screen

VITA

Denise M. Wyatt

Candidate for the degree of

Master of Science

Thesis: THE EFFECT OF COGNITIVE TEMPO ON PRESCHOOLERS' USE OF A MICROCOMPUTER

Major Field: Family Relations and Child Development

Biographical:

Personal Data: Born in Rockford, Illinois, March 16, 1960, the daughter of Lawrence A. and K. Faith Waterson. Married to Teddy R. Wyatt on May 28, 1983.

Education: Graduated from Walnut Ridge High School, Walnut Ridge, Arkansas, in May 1978; attended Arkansas State University 1978-1980; received Bachelor of Music in Education degree in 1982 from Oklahoma City University; completed requirements for Master of Science degree at Oklahoma State University in May, 1986.

Professional Experience: Lead Teacher, Wa-Ro-Ma Headstart, 1982-1983; Graduate Teaching Assistant, Oklahoma State University Child Development Laboratories, 1983-1986.