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ABSTRACT

Two studies examined the effectiveness of self-instruction training via a specially developed computer program to modify the impulsive problem-solving behavior of 16 deaf and 10 learning disabled (aphasic) adolescents attending two special residential schools in Canada. In the control condition, students learned the Apple LOGO computing language and practiced problem solving on the computer. In the treatment condition, students were given the same exercises, but in addition given self-instruction training using the "REFLECT" computer program which was designed to elicit overt verbalization of thinking behavior and teach reflective problem-solving strategies. Deaf students participated for 12 weeks, aphasic students for 6 weeks. In the study with deaf students, group comparisons of dependent measures showed significant improvement in the treatment group on errors, global measures of impulsivity, and errors on the Matching Familiar Figures Test. An ordinal aptitude x treatment interaction was noted as was a trend toward transfer as measured by the self-control rating scale. In the shorter study with aphasic students, there was significant improvement in judges' evaluations of global characteristics of impulsivity. Other measures suggested the treatment group became more effective with the LOGO language than the control group. (DB)

COMPUTER AIDED SELF-INSTRUCTION TRAINING WITH IMPULSIVE DEAF STUDENTS AND LEARNING DISABLED STUDENTS

A Study on Teaching Reflective Thought

Education and Technology Series

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It reflects the views of the authors and not necessarily those of the Ministry.

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ABSTRACT

As background for two experimental studies involving impulsive deaf and learning disabled (aphasic) students, the literature on the relationship between language deficit and cognitive impulsivity is reviewed. On the basis of this review, it was predicted that self-instruction training, as a vehicle for cognitive behaviour modification, would result in change toward reflective problem-solving behaviour.

Adolescent students in two residential schools, one for deaf and one for aphasic children, were screened for high impulsivity. Sixteen deaf and ten aphasic children were assigned to treatment and control conditions in two independent studies. In the control condition, the students learned the Apple LOGO computing language (graphic mode) and practised given problem-solving tasks at the computer. In the treatment condition, the students were given the same exercises but, in addition, they were given self-instruction training. This training consisted of intervention by an instructor using videotaped feedback and a specially developed computer program (REFLECT) for the purposes of eliciting overt verbalization of thinking behaviour from the students and teaching reflective problem-solving strategies. The aphasic students participated for 6 weeks, the deaf students for 12 weeks.

Measures of change included scores on the Matching Familiar Figures Test (MFFT), a self-control rating scale completed by teachers, and judges' evaluations of videotaped performance on programming errors and global measures of impulsivity.

In the study with the deaf students, group comparisons of dependent measures showed significant improvement in the treatment group on errors, global measures of impulsivity, and MFFT errors. An ordinal aptitude x treatment interaction was noted. There was also a trend toward transfer as measured by the self-control rating scale. It was concluded that the treatment conditions have the potential for offering a useful approach to reducing cognitive impulsivity in deaf children. In the shorter study with the aphasic students, there was significant improvement in judges' evaluations of global characteristics. Other measures suggest that the treatment group became more effective with the LOGO language when compared with the control group. The brevity of this second study is offered as a contributing factor to the lack of more significant results. An anecdotal description of four students in the studies gives further insight into the effects of self-instruction training on language-deficient children.

The report concludes with observations and recommendations regarding: a) the utility of self-instruction training with highly impulsive, language-deficient children, b) the need for such studies and practice to be of sufficient duration to allow change in habituated thinking styles, c) measures to enhance the likelihood of transfer effects, and d) the utility of LOGO and similar computer languages in combination with self-instruction training for reducing cognitive impulsivity.

Appendix F contains a manual for teachers on the use of self-instruction training and the REFLECT program.

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Also, with grateful appreciation to Apple Computer of Canada for their willing assistance in this study.

Donald S. Campbell

INTRODUCTION

The Construct of Impulsivity

Both impulsive behaviour and impulsive thinking styles are accepted and expected in young children who have not gained sufficient maturity with the use of language to effectively mediate cognitive processes. Part of the maturing process of children is to internalize self-regulation and monitoring through the use of speech and language. When this maturing process is hampered in some way, as it would be in the young aphasic or deaf child, impulsivity may continue to be a behavioural and cognitive characteristic with the result that the ability to learn is hindered.

Impulsivity is a term found with increasing frequency in the literature on children who are at risk, including those who are deaf or have a learning disability. It is a cognitive style construct used by researchers to explain a common aspect of the behaviour of these children. The construct provides for certain theoretical assumptions about cognitive processes and the use of language as a mediator of thought.

The construct of impulsivity was given prominence in the 1960s by Kagan and his associates (Kagan, Moss, and Siegal, 1963; Kagan, 1966). In a series of studies with young children, they noted reliable differences in the manner in which their subjects went about solving problems that contained ambiguity and uncertainty. Some children, who made many errors and went about their work quickly, were characterized as impulsive. Others, who made few errors and took more time, were characterized as reflective.

Impulsivity is defined as a cognitive deficit that results in the failure to reflect on the appropriateness or validity of a response to a problem, particularly when the problem contains a high degree of ambiguity or uncertainty. Cognitive impulsivity and associated behaviour is characterized by low response latencies and high error rates and defines one end of a continuum that has reflective behaviour at the opposite end. In more familiar terms, the impulsive child fails to stop and think before acting.

In typical studies involving impulsivity, the variable is often measured by the Matching Familiar Figures Test (MFFT: Kagan et al., 1964). This is a visual, match-to-standard test in which two observations are recorded: the time taken to make the first selection (response latency) and the number of errors made before the correct match is identified (error rate). A pattern of low response latency and high error rate characterizes the impulsive child. This child fails to take the time to look for relevant information and to consider alternatives before responding.

In studies of children's behaviour on the MFFT, including eye movement studies, it has been observed that the reflective child takes a systematic and analytical approach to the task while the impulsive child uses a global and random approach, making fewer eye fixations (Drake, 1970; Craighead, 1978; Thompson, Teare, and Elliot, 1983). Given a random sampling of young subjects, approximately one-third will be identified as impulsive with the MFFT (Margolis, Brannigan, and Poston, 1977). However, this fraction will decrease with increasing age of the general population (Messer, 1976).

The MFFT serves as a metaphor for the many types of ambiguous or uncertain problems and tasks confronted by students every day at home and at school. Decisions and choices are not handled well by impulsive children. They may not attend to directions, may react too quickly to questions before thinking them through, may engage in ineffective and off-task behaviours, and may make more than their share of mistakes without prior consideration of consequences. If the condition is sufficiently severe, the consequences may run the gamut from school failure to delinquency.

A number of recent theories have been offered to explain impulsive behaviour. Although they vary in their focus and degree of reductionism, they have in common the concept of cognitive deficit.

Only marginal evidence for neurological differences as a general contributing factor exists. Ward and Yeudall (1980) report only soft neurological signs in EEG patterns associated with impulsivity. Farley and associates (1972, 1979) propose the self-regulating arousal mechanisms of the cortex (recticular formation) as a source of explanation. They hypothesize that a state of abnormally low arousal of the cortex results in compensation through sensation-seeking behaviour which, in turn, appears as impulsive, hyperactive, and possibly delinquent. Douglas and Peters (1979) suggest that a genetic predisposition to a deficit in cortical arousal and perhaps in other neurological mechanisms may result in a short attention span, an inability to sustain effort and to control inhibitions, and a tendency to seek out stimulation. As a consequence the child's ability to engage in reflective, abstract, and forward thinking is impaired. A spiral of accumulative school failure may result. In order to deflect accepting responsibility for failure, the child may practise avoidance tactics, ranging from hyperactivity during the young years to passive withdrawal in the adolescent years.

Less reductionistic explanations focus on deficits in the child's behaviour and learning and the resulting cognitive processes. A portion of the literature seeks explanation through discussion of moral development (e.g., Hains and Miller, 1980) and temperamental style (e.g., Buss and Plomin, 1975). However, for purposes of the present study, explanations that centre on cognitive and behavioural dimensions of impulsivity are viewed as particularly relevant for the educator because they give rise to instructional strategies for the modification of impulsivity in the classroom.

Lack of self-control and self-regulation are synonymous with the characteristic of impulsivity among a number of researchers. Ainslie (1980) describes lack of control as the selection of immediate, but less desirable, rewards over delayed but more desirable rewards. According to this view, delayed gratification is one self-control mechanism adopted by reflective children. Similarly, Kendall and Finch (1976, 1979) stress a deficit in learned self-control and offer a response inhibitory control hypothesis. Impulsive children fail to inhibit immediately perceived ways of responding to uncertain situations because of a reluctance or inability to engage in effective search and scan activities, to generate response alternatives, and delay action until consequences are evaluated.

Feuerstein (1980) proposes a cognitive deficiency hypothesis in which impulsivity is the result of insufficient or inappropriate mediated learning activity in early childhood. Mediated activity refers to the internal manipulation of knowledge and concepts that facilitates, for example, problem solving, hypothesizing, and prediction of outcomes or consequences. Deficiencies in a child's early learning may produce underdeveloped exploratory skills that include difficulties with problem definition, goal orientation, and the systematic exploration of one's environment for relevant cues. A similar view is expressed in the federally commissioned report, Child at Risk (1980). The authors attribute such cognitive deficiency to poor models in the child's early stages of learning.

Meichenbaum and others (Mahoney and Thoreson, 1974; Donaldson, 1979) approach the problem with a similar view of mediational deficit and the role of language. By extension of various verbal learning hypotheses (e.g., Vygotsky, 1962; Luria, 1961), Meichenbaum (1974, 1977, 1979) and Meichenbaum and Goodman (1971) propose that impulsive ways of behaving stem from a child's failure to use covert or internal speech (verbal mediation) as a means of self-regulation and monitoring.

In a three-stage process, voluntary behaviour eventually comes under the control of covert speech. In the first stage, the overt speech of others (for example, parents and other controlling adults) governs decisions and behaviour in young children; in the second stage, the child's own overt speech is modelled on the adult's and assumes the role of self-regulation; and in the third, speech is internalized and becomes a covert mediator of self-regulation and monitoring. Jensen defines the process as "talking to one's self in relevant ways when confronted with something to be learned, a problem to be solved, or a concept to be attained. In [normally functioning] adults the process becomes quite automatic and implicit..."(in Meichenbaum, 1977, p. 29).

Children who do not develop appropriate mediational skills will have difficulties in learning and problem-solving situations that may result in school underachievement (Weithorn, Kagen, and Marcus, 1984) and antisocial or delinquent behaviour (Campbell and Davis, 1981; Campbell, Andrews, and Fuller, 1983). These difficulties can present themselves in a number of ways; a child may not comprehend a problem sufficiently to be able to recall relevant prior experience, may have experience relevant to the problem but fail to remember it, or may not be in the habit of relying on past experience to guide ongoing behaviour (Meichenbaum, 1977; Meichenbaum and Goodman, 1971). One can imagine a child who has failed to inhibit an impulsive and, in the long run, a dysfunctional response to a situation. Using a mediational deficit theory, one may hypothesize that the child does not comprehend the nature and consequences of the response, would comprehend the nature and consequences had time been given to stop and think, or does not use previous experience or knowledge to generate alternative ways of behaving in the situation.

The Modification of Impulsivity

In overviews of the research literature on impulsivity, authors agree in their conclusions that recent cognitive behavioural approaches to modification are promising but that methodological improvements are needed (Messer, 1976; Kendall and Finch, 1979; Hobbs et al., 1980; Campbell, Andrews, and Fuller, 1983; Thompson, Teare, and Elliot, 1983). These approaches, frequently referred to as cognitive behaviour modification, would have the child develop skills of self-monitoring and regulation through training in attention strategies and overt verbalization. Research suggests that these treatments may be enhanced by the use of modelling and various forms of contingency management.

Self-instruction training, an approach to cognitive behaviour modification (Meichenbaum, 1975, 1979; Meichenbaum and Asarnow, 1979), normally requires the child to overtly verbalize the problem, alternative approaches to resolution, and attentional strategies. Self-instruction training forces the child to employ verbal mediation for which he or she has the capacity but perhaps not the motivation. Camp (1977) hypothesizes that impulsive children rely on "association processing" of information and thereby fail to inhibit first available responses. Self-instruction training allows the child to supplant this dysfunctional approach with more cognitively oriented or reflective processing.

Language becomes a mediator for self-monitoring and regulation and, in so doing, performs a number of important functions; attention is directed toward relevant events, automatic responses to the environment are interrupted, the opportunity to survey and select alternative courses of action arises, and appropriate rules and principles of behaviour may be recalled and focused on the particular event, providing a planned strategy for action (Meichenbaum, 1975, 1979).

Self-instruction training procedures may take many forms. However, common to most are interventions that attempt to provide the subject with a new, modified, or enriched repertoire of cognitive strategies to engage in thinking and problem solving. These strategies may be devised and presented in a three-phase, information-processing model: input, elaboration, and output.

In the input phase, the student is prompted to consider understanding the problem or task at hand and its requirements. In the elaboration phase, the student is prompted to consider needs for additional information, to offer alternative solutions and their predicted outcomes or consequences, and to rehearse and evaluate possible responses. In the output phase, the student is prompted to make a decision, to reply and justify the response, and to evaluate new alternatives in the light of new input or the consequences of the response. These phases are modelled by the teacher and repeatedly practised by the student with a series of different problems and tasks. Overt verbalization in all phases is stressed in the early training because it serves to slow the student's cognitive tempo and opens a window on the student's thinking behaviour to both student and teacher for analysis and discussion.

The use of self-instruction training to modify impulsivity and related behaviours in children has proven successful in a number of laboratory and classroom studies, although there have been few of the latter. Overviews of this body of work are available elsewhere (e.g., Messer, 1976; Meichenbaum, 1979; Meichenbaum and Asarnow, 1979; Hobbs et al., 1980; Campbell, Andrews, and Fuller, 1983; Thompson, Teare, and Elliot, 1983). The majority of these studies has involved pre-adolescent children. As the present study addresses impulsivity in adolescents, a few studies with adolescent children will be reviewed. They have also been selected for particular methodological considerations that will be discussed.

Kendall and Wilcox (1980) assigned 33 subjects (ages 8-12 years) to two variants of self-instruction training. Common to both treatments was instruction in a six-step problem-solving sequence: (a) problem definition, (b) problem approach, (c) focusing attention, (d) problem solution, (e) self-reinforcement, and (f) coping with errors. In a concrete treatment approach, the subjects received self-instruction training that provided specific problem-solving strategies on an MFFT-like task. In a conceptual treatment, the subjects were given self-instruction training that stressed generic and generalizable strategies. On dependent measures, which included the MFFT and ratings of subject self-control, the effects of conceptual treatment were stronger.

Snyder and White (1979) compared contingency awareness, cognitive self-instruction, and placebo treatments using a population of 15 behaviourally disturbed institutionalized adolescents (age range 14 to 17 years). The group had previously shown a resistance to change in an operant program. Subjects met with the investigator for six 45-minute sessions over a four-week period. Assessment immediately after treatment and over a six-week follow-up showed a significant reduction in impulsivity in the self-instruction group as compared with the contingency awareness and placebo groups.

Campbell, Andrews, and Fuller (1983) identified 16 impulsive and high-risk adolescent high school students (mean age 17.3 years) and assigned them to treatment, attention control, and control groups. All groups participated in an average of two, in-class, group problem-solving sessions per week over a period of four months. Students in the treatment group received self-instruction training that included review and discussion of videotaped recordings of the problem-solving sessions. The attention control group also viewed the videotapes but without discussion or training. The control group participated only in the problem-solving sessions. Comparisons within and between group measures on teacher ratings of self-control and judges' ratings of impulsive behaviour from videotapes of the problem-solving sessions gave strong support to the effectiveness of the treatment condition for those students who remained in the study. Subject attrition during the study prevented strong inferences or further generalization from the results.

These works exemplify certain methodological advances that are relevant to the studies to be described later in this report. Mahoney (1974) points out the weakness that treatment duration is not sufficient to be effective in many cognitive-behavioural studies. Treatments of one or a few weeks cannot be expected to significantly or usefully change habituated patterns of behaviour and thought. The successful studies cited above used treatments of one to four months.

In many early studies on the modification of impulsivity, the treatment condition frequently consisted only of training in MFFT-like tasks. Dependent measures were then taken on the MFFT and on other observations of behaviour to assess transfer. Not surprisingly, changes may have occurred on MFFT performance but rarely on other measures. These designs were similar to the concrete treatment described above by Kendall and Wilcox (1980). The inadequacy of these designs lay in their failure to train the subjects for a wider array of responses than offered by the restricted range of the MFFT. For any hope of transfer or generalization, training must be conceptual, as in the Kendall and Wilcox study, and in a context closer to the real world of the subjects, as in Campbell, Andrews, and Fuller (1983).

Feedback has been demonstrated to be an essential aspect of cognitive behaviour modification. It would be a reasonable assumption that the more salient the feedback in self-instruction training, the more effective it is likely to be. Feedback via videotape playback has been used successfully in various clinical therapy programs (Hung and Rosenthal, 1978; Spence and Spence, 1980) and in the impulsivity study by Campbell, Andrews, and Fuller (1983) and Campbell (in press). Videotape playback provides a highly salient form of feedback that aids in recall, cues the subject to particular details of behaviour, and enhances attention control.

Impulsivity and Children with Language Deficiencies

On the basis of the mediation deficit hypothesis described earlier as a contributing factor to impulsivity, it would be a reasonable expectation that children with language deficiencies, such as those who are deaf or have certain learning disabilities, would exhibit characteristics of cognitive impulsivity. The literature tends to bear out this prediction, though with some exceptions.

Impulsivity and hyperactivity are terms used by a number of researchers when describing the behavioural and emotional problems of some deaf children. Freeman (1979) reviews traits commonly ascribed to profoundly deaf children and lists the most consistent as impulsiveness, difficulty with self-monitoring and reflection, and emotional immaturity. Meadow and Trybus (1979) find certain inconsistencies in their review of the literature on behavioural problems among deaf children but find agreement on the characteristics of immaturity, egocentricity, and impulsivity. In a large cross-cultural survey, Althouser et al. (1976) compared profoundly deaf adolescents in the United States with a similar group in Yugoslavia on a language-free measure of impulsivity. They found both groups to be high on impulsivity when compared with hearing adolescents. Similar high incidence is reported by Chess and Fernandez (1980) in a large sample of rubella deaf children and by Eabon (1985) in a sample of prelingually deaf males.

In another descriptive study, Harris (1978) examined impulse control in a large sample of deaf students in relation to parent hearing status, mode of early communication, and academic achievement. On three of four measures, deaf children of deaf parents obtained significantly higher impulse control scores than their deaf peers of hearing parents. A direct relationship was found between the age at which children were exposed to manual communication and impulsivity. In addition, the less impulsive deaf students tended to score higher on academic achievement tests.

Other cognitive and personality constructs similar to impulsivity have been used to address behavioural problems noted among deaf children. Locus of control is a cognitive construct that hypothesizes internally and externally dominated or motivated decision making. Bodner and Johns (1977) studied behavioural correlates of locus of control among a population of deaf subjects. Those demonstrating an internal locus of control were better able to delay gratification than their externally controlled peers. Eabon (1985) examined the relationship between impulsivity and field dependence in a sample of 44 prelingually deaf males (age 6 to 15 years). Field dependence refers to the cognitive style of applying a global as opposed to an analytical (field-independent) approach to problem solving. Field dependence implies a less differentiated mediational structure that is consistent with the effects of language deficit. Eabon reports the best predictors of impulsivity to be age, hearing status, and a third variable incorporating aspects of planning ability and field dependence. Revich and Rothrock (1972) collected behaviour rating scale data completed by residential school teachers of the deaf. They concluded that most disturbed behaviours could be accounted for by three trait groupings: anxious inhibition, preoccupation or immaturity, and hyperactive lack of control or disinhibition.

Although prevalence figures vary, there is a consensus that the incidence of emotional/behavioural problems are higher among deaf than among hearing children (Schlesinger and Meadow, 1972; Freeman et al., 1975; Meadow, 1979). In a review of prevalence studies, Meadow (1979) reports that serious emotional problems are three to six times more common among deaf than among hearing children and that problems of lesser severity are also observed with greater frequency among the deaf.

Although such research suggests a trend toward a high incidence of impulsivity and related problems among deaf children, it cannot be implied that the deaf are a homogeneous group in this regard. Nor can it be concluded that there is homogeneity in cognitive deficiency. Variance on cognitive processing measures suggests that impulsivity and other debilitating characteristics may be influenced by the age at which communication skills are learned and, likely, by other conditions in the family. Impulsivity does not appear to be a condition necessarily associated with deafness but rather with a variable characteristic more likely to occur among deaf children of hearing parents. Harris (1978) and Freeman (1979) note the greater reflective ability of deaf children who learn to share communication skills with their deaf parent(s) early in life. They argue that the early acquisition of a manual language may be sufficient to create an internalized medium of effective cognition and reflective thought.

Furth (1973) contends that behaviours associated with impulsivity among deaf children may well be learned defence mechanisms in reaction to stress and uncertainty. Such regressive behaviour should not be inferred to be the result of mental disorder or general deficiency but rather a natural and expected consequence of a limited repertoire of responses in the face of stressful situations. Furth suggests that, unlike the hearing child, the deaf child is unable to use a rich verbal medium in expressing emotions. Nor can the deaf child easily engage in dialogue to reduce stress through immediate clarification of meaning.

These arguments support the likely benefits of cognitive behaviour modification with impulsive deaf children. The well-established observation that impulsivity varies with the onset of manual language strongly suggests that cognitive/mediational deficits are the result of the absence of learning opportunity and not of an inherent condition among the deaf that limits the use of language and cognitive potential. Further support for this conclusion is offered by Furth's argument. If impulsive reactions to stress are the result of a limited repertoire of learned responses rather than inherent deficit, then increasing the child's repertoire of responses and strategies for dealing with uncertainty should result in more reflective behaviour -- the goal of cognitive behaviour modification through self-instruction training.

Only one study known to the authors reports using self-instuction training with deaf children. Bender (1980) gave 65 severely impaired elementary school children instruction in an MFFT-like task in 25-minute sessions for four days. Comparison of pre- and post-treament scores on the MFFT showed a reduction in response time but no difference in errors. There were no transfer effects. The profound procedural weaknesses of this study (an all-too-brief and concrete treatment as discussed previously) may have precluded more useful results or insights.

The Child with Learning Disabilities

Impulsivity is a descriptive term frequently used in research to describe children who have been identified as having a learning disability (Loper and Hallahan, 1979; Nagel and Thwaite, 1979). Other terminology closely associated with impulsivity has been discussed by Campbell and Davis (1981) and includes: field dependence (Keough and Donlon, 1972), external locus of control (Hisma, 1976), attention deficit (Harris, 1976; Douglas, 1972), and hyperactive behaviour (Douglas, 1972; Freeman, 1976; Zental and Gohs, 1984).

The choice of terminology is frequently a reflection of the setting of the research or the construct preference of the researcher rather than of unique differences in the behaviours of the children being investigated. In a classroom or other large group setting, hyperactivity may be the term of choice because it is the disruptive aspect of this behaviour that is most salient. In small group or individual instruction settings, attention deficit and impulsivity may be of primary concern because the focus is on the dynamics of individual rather than group learning. The cognitive style constructs of field dependence, field independence, and locus of control reflect, respectively, a focus on perceptual and personality aspects of similar behaviour patterns.

The learning disabled, as a specific classification for children, has frequently been criticized. The extreme heterogeneity of this group, with the accompanying and often contradictory assumptions regarding differences in causes, characteristics, and interventions, has created problems for both identification and research (Cromwell, 1975; Freeman, 1976; MacIntyre, Keeton, and Agard, 1980). The need to provide services for children who enigmatically fail to benefit from standard classroom instruction has influenced the drafting of most classifications, with the result that they often function as loosely descriptive rather than as prescriptive screens. This situation creates problems for research in the selection of subjects and in attempts to generalize from conclusions.

In the second study, to be presented later in this report, student subjects attended a residential school for aphasic children. Unlike deafness, a disability that has relatively identifiable characteristics and causes that lead to reliable interventions, aphasia, as a learning disability classification, fails to meet these conditions. Aphasia does not imply a homogeneous or uniform diagnostic construct.

The study of aphasic children, therefore, was conducted with a paucity of understanding of the disability. Yet assumptions must be made and explored. It was assumed that the general literature regarding the effects of a language deficit on cognition and, more specifically, on cognitive impulsivity would apply to children who had been identified as aphasic. The only area that can be explored is whether an approach to cognitive behaviour modification might be beneficially adapted for a group of highly impulsive students whose varied learning behaviour is assumed to be confounded by language and cognitive difficulties, the nature and origin of which are, to a large extent, unknown.

As in the studies of deaf children, most of those addressing the learning characteristics of children with learning disabilities are descriptive rather than experimental (e.g., Zentall and Gohs, 1984; Margolis et al., 1982), and only a few studies examine the effects of cognitive behaviour modification. A number of these report marginal change only on the MFFT or similar tasks and suffer from the same methodological shortcomings discussed earlier (e.g., Greybill, 1984).

In a more exemplary study, Locher (1985) used a self-instruction training program with an emphasis on haptic training to teach impulse and attention control to 12 children diagnosed as having communication disabilities and a secondary classification of neurological impairment. Two 20-minute sessions per week were given over a 15-week period. The sessions used puzzles and other visual discrimination tasks as vehicles for suppressing impulsive responses while teaching effective encoding strategies. Comparison of pre- and post-treatment measures showed significant improvement in scanning and processing times, attention deployment strategies, and response accuracy. The training program was characterized as effective, durable, and generalizable.

LOGO and Computer Applications in Special Education

The application of computer technology in the area of special education appears promising. As with most new technologies in education, many extremely optimistic claims concerning the efficacy of the new methods have been made. Such claims now need to be tested and modified by research if, as one reviewer has suggested, the new computer age is to become an age of reason rather than an age of romance (Kelly, 1982).

Goldenberg (1979) has suggested three ways in which computers may be used in special education. The first use is as a tutor, facilitating learning by being an information source. Goldenberg suggests that this model may be practical for teaching some academic skills but may also be counter-productive in the area of special education, since it does not build the individual's autonomy or initiative. The second use is referred to as the eyeglasses metaphor. The suggestion here is that computers, like eyeglasses, have the potential of altering or compensating for some effects of the handicapping condition. Goldenberg further suggests that many children with exceptionalities may learn that computers can extend their abilities of self-expression, allowing them to focus outwardly and thus actively influencing their surroundings. The third metaphor Goldenberg suggests is the computer as a mirror, allowing for feedback. Again, this experience can reinforce the fact that the child is an active agent. Several authors have recognized the potential of such an application (Propp, Nugent, and Tidball, 1982; Papert, 1980).

In his review of a symposium on computers for the education of the deaf, Kelly (1982) noted a consensus on the motivational effects of microcomputers. However, the majority of papers presented were qualitative/evaluative descriptions of software developed in specific curriculum areas and many of these were of the drill variety. Few were data based and fewer still had well-developed theoretical underpinnings. Kelly suggests that a need exists for further research to re-examine some of the present practices and to substantiate some of the claims regarding the use of computers with deaf children.

LOGO is a computer language that has a powerful graphic element and has been proven adaptable for hearing impaired and learning disabled children (Goldenberg, 1979; Weir, Russell, and Valente, 1982). LOGO was developed by Papert as a child interactive programming language using a Piagetian model of learning. It was designed to encourage strategies that lead to more reflective, self-conscious thinking. According to Papert (1980), a notable characteristic of children working with LOGO has been a greater facility in engaging in "self-referential discussions of their own thinking". LOGO, therefore, in both theoretical design and in practice, appears to be a highly suitable vehicle for self-instruction training in problem-solving with language-deficient children.

Some of the advantages of computers can also be of great assistance to both teachers and researchers, particularly in the area of data collecting. Time on task, frequency of computer usage, error, and correction counts can all be recorded readily by the computer, thereby freeing the teacher or researcher for other duties, such as closer observation of the child's performance on task.

TWO SELF-INSTRUCTION TRAINING STUDIES

The two studies that follow were designed to enhance the reflective problem-solving ability of samples of impulsive deaf students and students with learning disabilities. The Apple LOGO computing language was used as a vehicle for problem-solving and self-instruction training. The experimental design provided treatment and control group comparisons (within and between groups) on pre- and post-treatment measures. It was predicted that reduction in impulsivity would be observed through a number of dependent measures: the MFFT, teacher ratings of self-control, and independent judges' evaluations. Further, by close observation of selected students in problem-solving and self-instruction activities, patterns of behaviour may be discerned that would augment our understanding of the effects of a language deficit on cognition.

In both studies the MFFT (Kagan et al., 1964) and the Self-Control Rating Scale (SCRS: Kendall and Wilcox, 1979) were used as screening and dependent measures. Both tests were used in modified form.

The MFFT (Appendix A) consists of 12 sets of line-drawn pictures. Each set contains a standard picture and six others, one of which is an exact replication of the standard. The subject's task is to pick the correct one. The test is administered individually and scores are recorded for time to first response (latency) and errors for each set. Test-retest reliability estimates range from r = .39 to .80 for errors, with most estimates at the higher level. The correlation between errors and latencies are typically low, with a median of r = -.49 (Messer, 1976). This finding argues against collapsing the two measures into the frequently (and inappropriately) used "I" statistic.

In the present studies, the first six sets in the MFFT were used for initial screening and pre-testing. The remaining six were used as a post-test measure. This modification was made to lessen the effects of practice and knowledge of results at the time of post-testing.

The SCRS is a teacher-report rating scale designed to measure behaviours associated with impulsivity in the classroom. It contains 33 items, each of which is measured on a 7-point scale, with 7 indicative of maximum impulsivity. It has been observed in previous administrations of the SCRS that a fatigue factor likley influences responses on items toward the end of the test, particularly when a teacher is asked to complete all 33 items on a number of students. Given the reported high reliability of the test, r = .84 to .98 (Kendall and Wilcox, 1979, 1980), a shortened 20-item test was given to teachers with the confidence that reliability would not be seriously jeopardized. The highest obtainable score in the impulsivity direction is 140 (Appendix B).

Other dependent observations were measured by trained judges who were graduate students in education. Ten- to 15-minute videotaped samples of each subject's work (from the beginning, middle, and final weeks of the first study and the beginning and final weeks of the second) were presented to the two judges for independent evaluation. The judges tallied the number of computer programming errors per minute and rated performance on three global impulsivity measures (Appendix C). Programming errors were those miscues or inefficient commands perceived by the judges to be counter-productive or off task. (Over-rotating the LOGO turtle beyond the desired heading or clearing the screen when a simple line erasure was possible constituted two such errors. Others included syntax errors whereby students failed to notice such faults as typing errors or undefined procedures.) A ratio of commands per error was calculated for each student's samples by dividing the total number of commands by the number of errors.

The rating scale prepared for this study was used by the judges to evaluate three global characteristics of impulsivity. At the same time that they were counting errors, they evaluated each videotaped sample on three five-point scales. Anchors for the three scales were: no apparent plan -- closely follows plan, fast -- slow, and haphazard -- careful. The judges paused briefly at five-minute intervals during the video samples to make their independent evaluations. A training session for judges prior to the video evaluations resulted in a high degree of agreement between judges on trial samples.

Study #1: Teaching Reflective Problem Solving to Deaf Students

Method

An initial pool of 30 intermediate level students at Sir James Whitney School (Belleville, Ontario), a residential school for deaf children, was identified by school staff as likely containing impulsive candidates for the study. The MFFT was individually administered to each student in this pool, and both teachers and residence counsellors completed the modified SCRS on each student. Sixteen students who met the following criteria were selected to participate in the study:

1) high impulsivity as measured on both the MFFT and the SCRS,
2) no previous experience with the LOGO computing language,
3) no current activity in other behaviour therapy or drug therapy programs, and
4) student willingness to participate, with parental consent (Appendix D).

The group of 16 was then matched according to sex, age, degree of hearing loss, and scores on the pre-test measures and assigned to either the treatment or the control group. This participating sample had a mean age of 13.8 years (range 11 to 15.9) and included nine females and seven males. Mean errors on the MFFT for the total sample was 1.7 (range 0.5 to 3.5) and mean latency was 33.4 seconds (range 13.2 to 80.5).

All the subjects received two 40-minute instructional periods per week for 12 weeks in the school's computer classroom. They were taught by the research associate (hereafter, instructor) through an interpreter for the deaf. During these sessions, control and treatment subjects were paired and taught how to program in the graphics mode of Apple LOGO. They were to use the language to solve problems in the form of reproducing simple to complex line drawings (e.g., square, house, face, sailboat, person). The same problem tasks were given to both groups on Apple IIe computers. The subjects were introduced to the language with "Instant" LOGO, a version that uses simplified commands for beginners. During later sessions, many of the subjects were programming in full LOGO and were pursuing their own original drawings. The subjects were given a portfolio and encouraged to save printouts of their work. Samples of each student's daily activity at the computer were video recorded directly off the video output.

Each member of the treatment group received three self-instruction training sessions during each three-week period. During these sessions, the subjects viewed videotaped samples of their work and were taught means of monitoring their own work and problem-solving strategies. They were encouraged to plan ahead, to sign to themselves (the equivalent of overt verbalization), to slow down, and to evaluate their work frequently. The instructor sometimes modelled desirable strategies and undesirable problem-solving styles on the computer and discussed their implications with the subjects. When viewing video samples of the previous day's work, aspects of that work were discussed and questions were raised in such a way as to encourage those specific self-instructional training strategies.

Some of these self-instructional training strategies were incorporated in a version of LOGO called REFLECT, which was specially developed for this study. This program provided interventions during the treatment subjects' work at the computer. Interventions, in the form of icons and questions, were designed to teach or reinforce many of the strategies the treatment group received during the individual self-instruction training sessions. These interventions were triggered according to a formula that counted errors and types of errors in relation to moves and time. Some interventions were: a stop sign with "Stop and Think!"; a scroll with a check mark, "Is this a good start to your plan?"; and a map with "Do you have a plan in mind?". The frequency of interventions could be altered by the instructor and were gradually reduced as the study continued. (For a more complete description of the self-instruction training procedure and the LOGO intervention program, REFLECT, see the Teacher's Manual, Appendix F).

At the conclusion of the study the MFFT and SCRS were again administered. Videotaped samples of the subjects' work from the second, sixth, and final weeks were evaluated by the judges for errors and for global characteristics of impulsivity. One subject in the treatment group was not able to provide videotaped samples of work at the conclusion of the study. Judges' measures on errors and global measures of impulsivity, therefore, include seven rather than eight treatment subjects. There was no further attrition of data.

Results

The main variables of interest are changes in:

1) the rate of errors made by the subjects in LOGO programming,

2) the judges' evaluations of global characteristics of impulsivity,

3) MFFT performance, and

4) ratings on the SCRS.

Because the subjects worked at various rates during their sessions, the error variable is reported as a ratio of LOGO commands per error in order to ensure the comparability of the variable across subjects. As shown in Figure 1, the base line error ratio for both control and treatment groups was nearly the same. A between group comparison of means at the conclusion of the study showed a significant difference between the two groups ($t = 1.31$, $p < .10$). (A probability value of 0.10 was set as an acceptable level of significance in this and the following study.) The within treatment group comparison of pre- and post-means also yielded a significant difference ($t = 2.82$, $p < .01$). Although there was a tendency toward improvement in the control subjects, the change was not significant.

These results suggest that the treatment condition had the effect of reducing the error rates of the subjects in that group. Whereas at the beginning of the study they were producing on average approximately 8 legitimate LOGO commands for each error, at the conclusion they had increased their average efficiency to approximately 13 legitimate commands for each error.

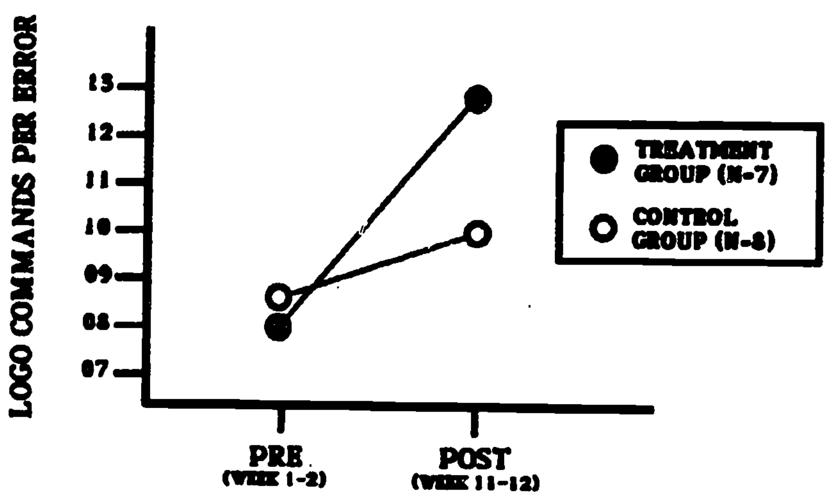


Figure 1: Pre- and post-treatment LOGO commands per error for treatment and control groups

These data may also be viewed in the form of an aptitude x treatment ordinal interaction, as shown in Figure 2. Using MFFT error as the aptitude variable (median split technique), there was no significant performance difference between control and treatment subjects who scored low in MFFT errors. However, there was a strong treatment effect on the subjects who scored high on MFFT errors (t = 3.80, p <.01).

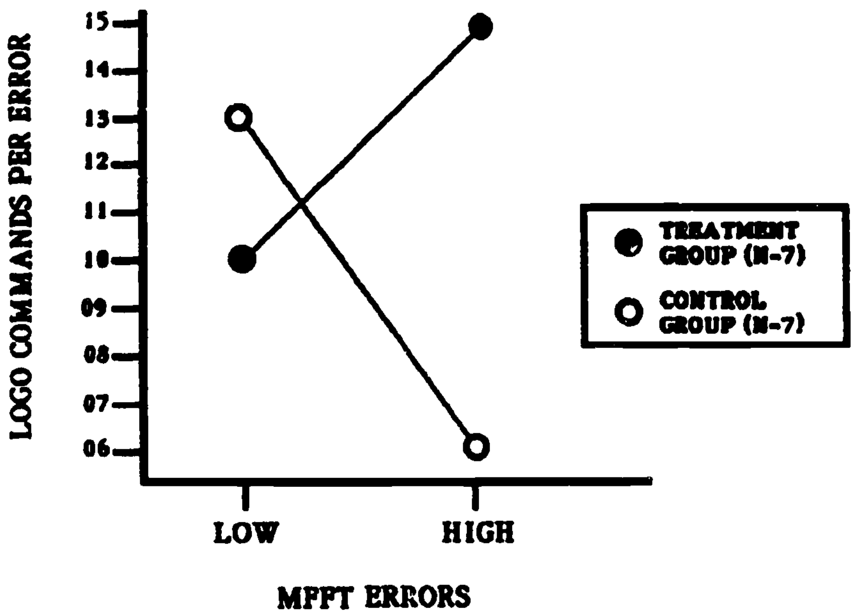


Figure 2: Aptitude (MFFT errors) x treatment interaction on LOGO commands per error

The judges' scale ratings on the three global impulsivity characteristics were collapsed into a single variable. Figure 3 displays the judges' evaluations at five-week intervals. As with the error rate variable, there was little difference between the two groups at the beginning of the study. At the conclusion, the treatment group was judged to have improved and to be more reflective than the control group. Significant differences are obtained when comparing the pre- and post-means of the treatment group ($t = 2.09$, $p < .05$) and when comparing the post-treatment means of the two groups ($t = 2.38$, $p < .05$).

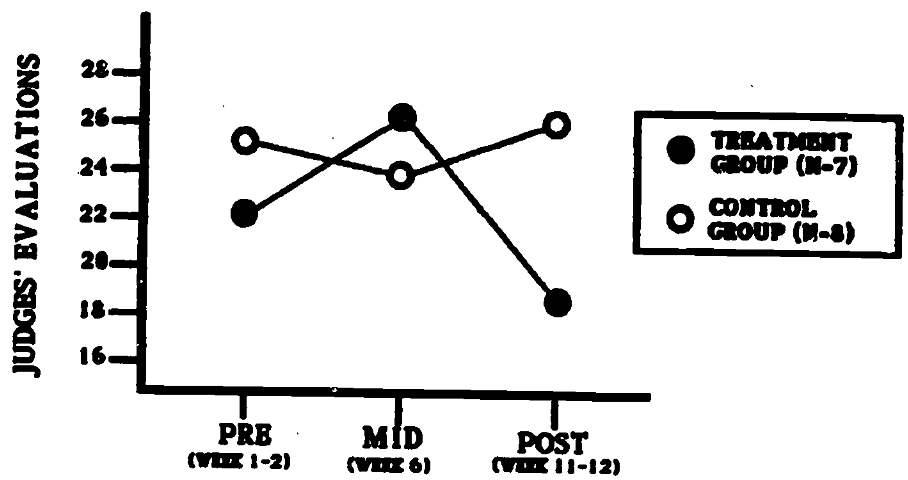


Figure 3: Pre- and post-treatment sum of judges' evaluations of impulsive characteristics

The total number of LOGO commands in the pre- and post-treatment videotaped samples remained relatively constant over the study for both groups. Therefore, while error rate was reduced, the second defining characteristic of impulsivity, latency, did not change.

The MFFT was used as an initial screening and matching measure for subject selection and group assignment. It was also administered at the conclusion of the study as one measure of the transfer effect of the treatment condition. While the error performance of both groups improved, probably due to practice on the MFFT, the treatment group showed significantly improved performance between the beginning and conclusion of the study ($t = 2.51$, $p < .05$) and performed better at the conclusion than the control group ($t = 1.53$, $p < .10$). The data suggest that there may well have been some transfer effect due to treatment on MFFT error rate. The latencies for both groups increased uniformly, producing no differences between the groups.

Like the MFFT, the SCRS was used for initial subject identification, group matching, and as a post-measure for possible transfer effects. The SCRS was again completed by the subjects' classroom teachers and residence counsellors at the conclusion of the study. The data indicate no transfer effects due to treatment alone as measured by the SCRS. There was some improvement in both groups. However, the design of the study does not permit any conclusions regarding the source(s) of the improvement.

A complete listing of the data is contained in Appendix E.

Study #2: Teaching Reflective Problem Solving to Students with Learning Disabilities

In the actual sequence of events, this study was conducted prior to the first. It was conceived as a pilot study for the purpose of gathering some insights into working with language-deficient, but hearing, children in preparation for the study with the deaf. A number of differences between the two studies can be identified. This, second, study was conducted in a more exploratory, less formal manner. There were fewer students in both the treatment and control groups as well as fewer weeks of instruction. The subjects in the treatment group did not use the modified (REFLECT) version of Apple LOGO (its development was taking place at the time of this study and was being guided by experience with the students). In all other respects the studies were similar.

Method

Five teachers of the senior classes at the Sagonaska School for Aphasic Children (Belleville, Ontario) completed the modified SCRS for all students in their homeroom classes. From this group of 25 students, a pool of 16 who scored highest on the rating scale were selected for further testing with the MFFT. School personnel and records were then consulted. Two students currently involved in counselling and drug treatment for behavioural reasons were dropped from the pool. A further screening eliminated four students who showed a pronounced and general developmental lag (indicated by a consistently flat, below-age profile on the school-administered Hiskey-Nebraska Test and by informal teacher assessments). Residential counsellors or parents were then asked to complete the SCRS on the remaining 10 students. Parental consent was obtained for all students tested (Appendix D).

This sample of 10 subjects included 8 males and 2 females with a mean age of 13.0 years (range 10.7 to 15.2) and a mean score of 2.8 errors and 17.5 seconds latency on the MFFT and 88.5 on the SCRS. The subjects were assigned to a control or treatment group, using a procedure that matched for age, sex, and test scores.

The subjects received instruction for six weeks. All sessions were in the school's computer classroom and were administered by the instructor. In the first week all subjects received introductory tutorials on LOGO and in the basic operation of the Apple IIe computer. The LOGO language was introduced using "Instant" LOGO. The subjects were paired and received identical instruction during two 30-minute sessions.

The subjects continued to receive two 30-minute sessions on the computer per week during the five remaining weeks. They were directed to solve problems in the form of reproducing simple to complex line drawings (similar to those used with the deaf students) with the LOGO language. Samples of each student's daily programming activity was videotaped directly from the computer.

The treatment group attended two self-instruction training sessions per week. These were conducted the day following the regular computer session and were administered individually or in pairs by the instructor. During training, the subjects engaged in activities similar to those used with the deaf students: a review of videotaped problem-solving activities, overt verbalization, rehearsal of problem-solving strategies, self-evaluation, and instructor modelling. (For a more complete overview of self-instuction training and uses of LOGO, see the Teacher's Manual, Appendix F.)

At the conclusion of the six weeks, the same post-treatment measures as in the study with the deaf students were obtained: MFFT scores, SCRS scores, and judges' error counts and evaluations on the global measures of impulsivity. Two subjects in the control group could not provide videotaped samples of their work in the final week of the study and, therefore, could not be evaluated by the judges. As a result, only three subjects in the control group provide data for error and global impulsivity measures. There was no further attrition of data.

Results

No significant changes in MFFT errors or latency were observed, although a minor trend toward improvement in latency occurred for the treatment group. Both groups showed a pattern of declining SCRS scores with no differential effect due to treatment.

The ratio of programming moves to errors remained constant in the treatment group and increased slightly, but not significantly, in the control group. Of some interest, however, was the increase in the number of moves in the treatment group. Whereas the mean number of moves in the control group was unchanged, the treatment group increased from a mean of 256 moves per 15-minute sample to 305 moves ($t = 1.53$, $p < .10$).

Although the proportion of errors remained constant over this change in number of moves, perhaps the subjects on average became more efficient with time and more willing to explore with LOGO and to engage in a trial and error approach. On the other hand, one might conclude from these data that they became more impulsive over the period of the study. However, the judges' evaluations do not support this conclusion. The judges' evaluations of global characteristics of impulsivity, in Figure 4, show little change in the control group but significant change in the treatment group toward more reflective problem-solving behaviour ($t = 2.79$, $p < .05$).

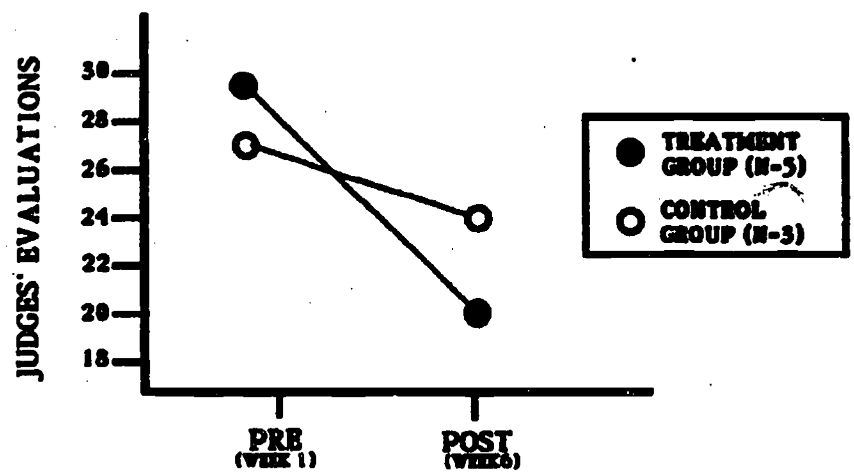


Figure 4: Pre- and post-treatment sum of judges' evaluations of impulsive characteristics

An Anecdotal View

Two subjects from the deaf treatment group and two from the learning disabled treatment group were selected for anecdotal review. (Sources for this review include samples of these students' work with LOGO and journal entries on each student maintained by the instructor. The samples were both printouts of completed projects and videotaped work in progress. In the cases involving learning disabled subjects, audio tapes of conversations between the instructor and subjects were also reviewed.) It is not the intention in this review to generalize beyond the subjects being studied. It will be noted whether the described behaviours and work samples are representative of other subjects or are novel.

The names of the subjects selected have been changed to ensure anonymity. Name initials used in the data appendix (Appendix E) are the same so that readers may compare the following anecdotal commentary with data collected, both prior to and following treatment.

Terri (T.H.) is a profoundly deaf, grade 7-8 student, who was 12 years old at the time of the study. She is the youngest of two deaf children of hearing parents, her brother also attending the school. She seems to be popular with both her peers and her teachers.

There was no transfer of treatment suggested by the pre- and post-treatment SCRS scores. However, what is noteworthy is that the residential counsellor assessed Terri as less impulsive than did her homeroom teacher, which is not surprising, given Terri's outgoing nature. Behaviour that might be appropriate to the playground and the residence might be deemed to be disruptive in the classroom.

On the judges' evaluations, Terri was found to be less impulsive at the conclusion of the study. She was able to improve her commands to error ratio from 9:1 to 15:1. On the global measures of impulsivity she improved her score from 24.5, which was the pre-test median, to 13.5, which was the lowest post-treatment ranking on this measure. Some possible transfer of treatment is also suggested by the MFFT scores. After instruction Terri improved her error rate from 2.0 to 0.7 and slowed her response latency from 39 seconds to 46.5.

Terri was an extremely enthusiastic subject. She frequently came to the computer sessions early and proudly exhibited her work to both peers and teachers. Such enthusiasm was not uncommon among the subjects. Of the 26 subjects involved in the two studies, only two seemed to lose some interest as the project continued. One whose interest waned was Terri's brother; his explanation was that it was "kid's stuff", quite possibly a reaction to his younger sister's success and enthusiasm.

Terri is an extremely expressive and artistic child, seemingly with few inhibitions. As a result she was far more of a risk taker than her peers. She was also more willing to engage in "thinking aloud" and "talking to herself" by signing, even when not engaged in a dialogue with the instructor or interpreter. This quality is a crucial aspect of self-instruction training, which Terri seemed to take to far more quickly and more willingly than many of her peers. Indeed, most of those in the treatment group who showed the least improvement on post-treatment measures were, in the opinion of the instructor, also the least likely to willingly engage in this "thinking aloud" strategy in computer sessions.

Terri was also very quick to personalize her work, freely altering the model when drawing with LOGO. She used her work at the computer as greeting cards and gifts to friends. Again, Terri was not alone in using her work this way, although she did so more frequently and needed little encouragement to do so. Quite often what began as an apparent miscue was, with some improvisation by Terri, turned into a novel design change. Nonetheless, she was willing to erase the screen and begin again if she felt a "quick fix" was not sufficient. Those in the treatment group who seemed least influenced by the instruction were often, in the opinion of the researchers, less willing to go beyond the model drawing and were generally less likely to take risks. Terri, by contrast, would humorously and proudly inform the instructor that her drawings were better than his.

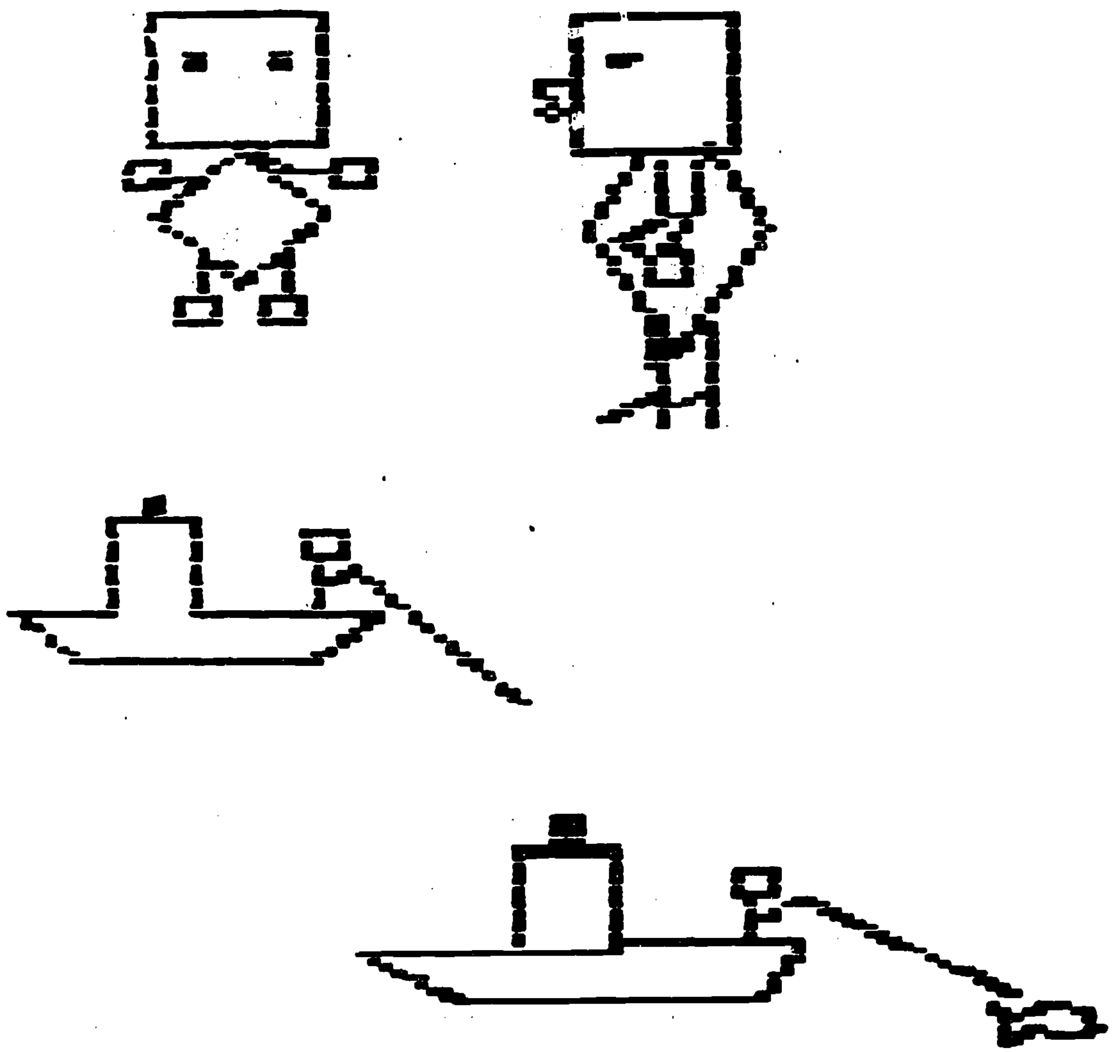


Figure 5: Sample of Terri's elaborations on given models at week five

Len (L.G.) is a profoundly deaf grade 11 student. He is the only child of hearing parents. Len was 15 years old when the study began, which places him among the older subjects. Len is a very conscientious student who seems popular, particularly with his teachers.

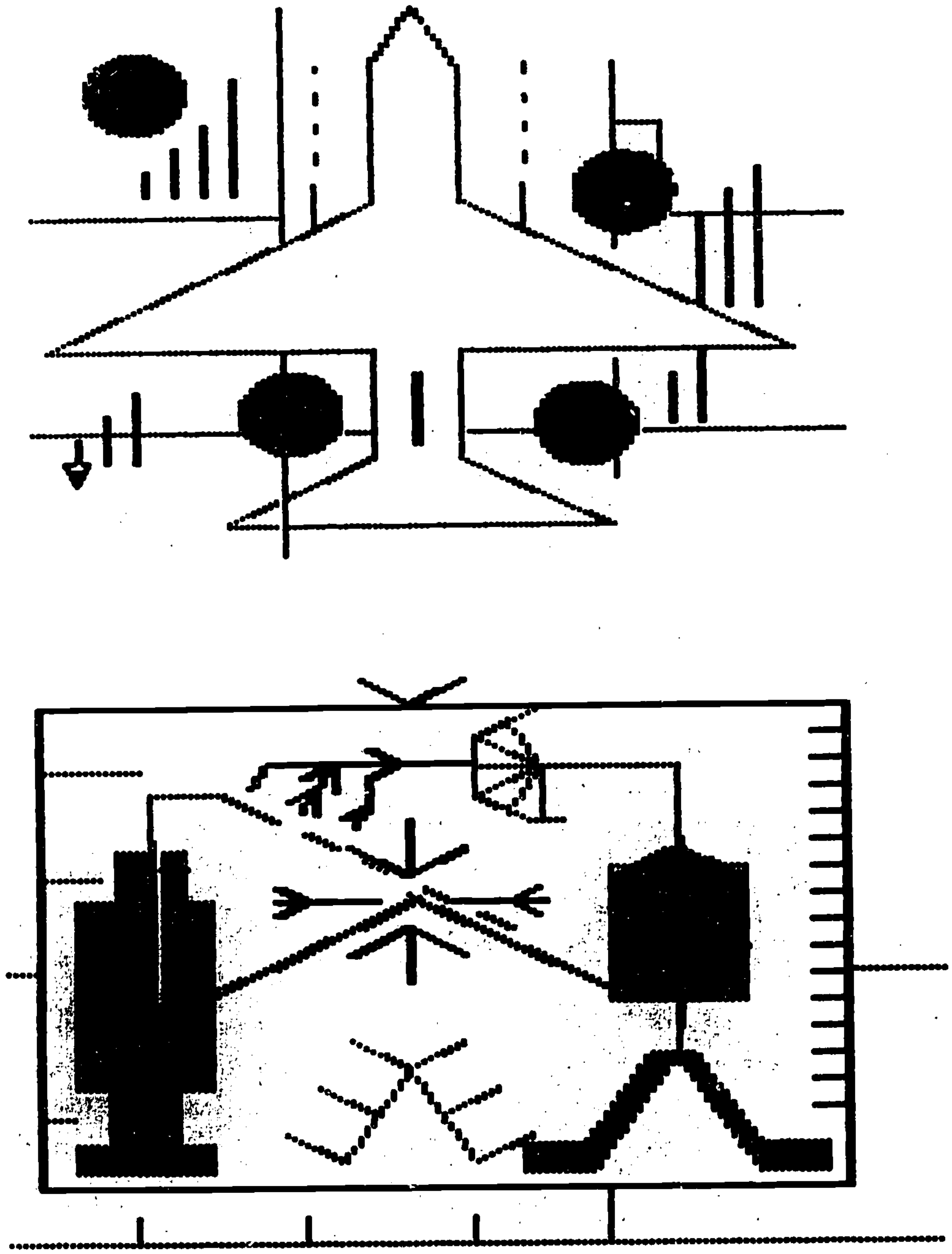
As in the case of Terri, no transfer of treatment was recorded in the post-treatment SCRS. In Len's case, virtually no improvement was recorded by the judges on the ratio scores. However, some improvement was suggested by the judges' global evaluation scores (pre-treatment at 25; post-treatment at 19). Again, some positive treatment results and possible transfer was suggested by the MFFT. Len had an error rate of 1.3 and latency of 59 seconds when the study began; upon completion, Len's error rate was 0.7 while his response times slowed down to 78.2.

Len was also a very enthusiastic participant. He learned LOGO quickly, remembering previous lessons with little or no review. As a result, he was working with confidence, using full LOGO commands sooner than most of his peers. Len was also willing to initiate projects at the computer that were solely his own design. He was very methodic in the planning stages and had a good eye for detail. He did not hesitate to erase and start over and was quite willing to take several classes to complete a drawing. Len showed some frustration with himself when he recognized any design flaw in his work. Unlike some of his peers this frustration did not lead to his abandoning any project, although he would often begin again.

Like Terri, Len was willing to sign to himself and to stop and explain his LOGO designs. He seemed to move beyond this stage more quickly than Terri. He appeared to learn all the self-instructional strategies more quickly and used them independently. This observation could well be due to the age difference of the two subjects but should not imply that the younger subjects were less successful at learning these strategies. Indeed, two of the most improved command to error ratio scores belonged to two of the youngest subjects. However, it did seem to take longer for these younger subjects to internalize these same self-instructional strategies. Although age was not a variable studied in this research, it might be of concern for future research. In the opinion of the instructor it seemed to affect learning rate. If this observation proves to be the case, then future designs of instruction could be improved by increasing the training period for younger students and possibly making instruction more appropriate to the age of the students.

The following subjects were participants in the shorter six-week study, conducted with children with learning disabilities (designated aphasic). The general design of both studies was similar, although the hearing-impaired subjects had the benefit of a longer instruction period and software designed to teach specific self-instructional strategies. These same strategies were taught to the learning-disabled subjects by the instructor but were not reinforced by any instructional software other than LOGO.

Figure 6: Sample of Len's self-initiated drawings at weeks five (Firefox 1) and ten (Robot Warriors)



Tammy (T.P.) is an extremely active student who is easily distracted. She requires considerable teacher attention in order to stay on task. At the time of this study she was just over 15 years old, placing her among the older subjects.

On all pre-treatment measures of impulsivity Tammy scored in the top quartile. On the MFFT, for both errors and latency, she received the highest score of the group on impulsivity. She was rated on the SCRS by both her teacher and residential counsellor as one of the most impulsive students in the school. Tammy also had the lowest computer command to error ratio of all participants on the pre-treatment videotaped samples and, similarly, one of the highest scores on the judges' global evaluations. According to these same judges' evaluations, her work at the computer on post-treatment samples was far less impulsive. She showed some improvement on the MFFT as well, which suggests the possibility of some transfer. The teacher's post-treatment SCRS score was also lower, although scores generally improved among all subjects in both groups on this measure.

Tammy was an enthusiastic subject but was easily distracted by others. Once off topic she had considerable trouble taking up were she had left off. She seemed to enjoy the self-verbalizing strategy but would frequently become side-tracked, again losing sight of her planned project. As a result her work often digressed to a kind of LOGO doodling, with little apparent care or design. Tammy had a tendency to randomly spin the LOGO turtle and when asked what she was doing she would respond with a giggle, "Making the turtle dizzy!".

Tammy had some problems remembering both the LOGO commands and self-instruction strategies from one day to the next. Although they never became totally routine or self-initiated, Tammy did appear to become more adept at using these strategies as instruction continued. In the opinion of the instructor she could have benefited from an extended instructional period.

Unlike Terri and Len, Tammy did not go beyond the model line drawings nor did she attempt to put her own originality into her drawings. Despite this, she seemed to become somewhat more reflective in her work at the computer, even though this work did seem to be more restricted when compared with that of many of her peers.

Paul (P.T.) was just under 14 years of age when the study began. In the opinion of Paul's teacher and his counsellor on the SCRS, Paul appeared to be quite impulsive. Post-treatment evaluations by the judges on error ratio and global characteristics suggest somewhat more reflective behaviour at the computer. The teacher's post-treatment SCRS score showed a 37-point decline. Although dramatic, interpretation of this change is confounded by the fact that the means of both treatment and control groups declined over 20 points. The MFFT error rate remained virtually unchanged; however, the response latency did increase from 14 seconds to nearly 26 seconds.

Paul was highly motivated in the computer classroom. According to his other subject teachers, this motivation was not always evident in other classrooms. Despite a limited vocabulary and some problems with syntax, Paul was very talkative. He seemed to be popular with both his peers and teachers, although his sometimes moody behaviour occasionally strained these relationships. According to both school and residential staff, Paul has matured considerably in the past year.

Paul was one of only three participants in this study who went beyond "Instant" LOGO. By the end of six weeks he was using full LOGO commands, defined procedures, and recursion. Paul often talked of his desire for his own computer and came to the classroom frequently to play computer games.

Paul, like Tammy, also became easily side-tracked and engaged in disconnected conversations but less frequently than Tammy. He developed a better command of LOGO than Tammy and seemed far more able to plan ahead. He often initiated corrective strategies and seemed to enjoy revising the model. Although these revisions were more reserved than Terri's or Len's they were, nonetheless, imaginative. If Paul had had a longer instruction period, it is quite possible that he too might have become more daring in his LOGO drawings. In fact, in the last week of instruction Paul drew his own model of a Christmas tree, complete with decorations and several colours. He spent two full computer sessions drawing and revising this tree.

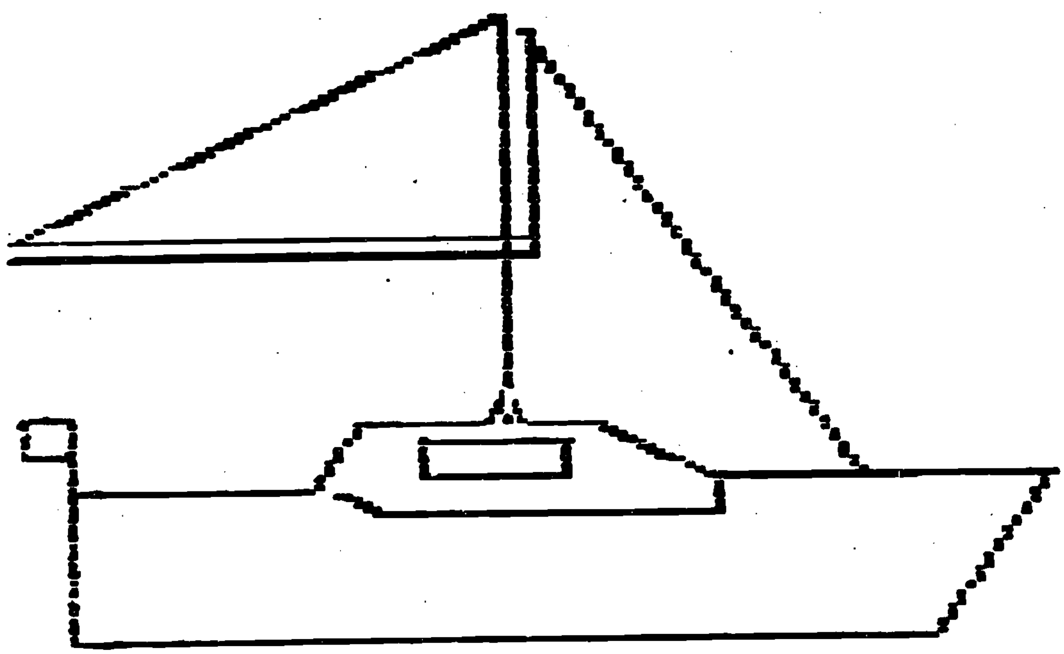


Figure 7: Sample of Paul's copy of given model with some elaboration

Both Paul and Tammy engaged in self-verbalization when working at the computer. Their vocabulary was somewhat more limited than that of many of their peers. Therefore, rather than using more intricate or grammatically structured speech, their's was chopped and more informal: "Up", "What?...ah,no", etc. Much of their speech was of a cheerleading nature: "All right!", "There...great!". Despite this apparent language deficiency, the results on the judges' evaluations were promising.

Although language is obviously important in self-instruction training, the varying levels of success of these four subjects suggest that language deficiencies need not preclude the application of self-instruction training. Longer instructional periods combined with reinforcement of self-instruction training in more varied contexts are likely required to ensure more substantial and generalized effects.

Discussion

These two studies, in particular the study with the deaf sample, give strong support to the utility of self-instruction training as a means of enhancing reflective thought and problem-solving ability in the impulsive and language-deficient child. In the following discussion, five specific aspects of the study are reviewed and interpreted for their relevance to further research and practice.

(1) Differential Effects

In the study with the deaf children, significant change in three of the four dependent measures presents a pattern in which errors and global characteristics of impulsivity declined on the classroom task for the experimental group. The ordinal aptitude x treatment interaction is particularly interesting, suggesting that no differential effect due to treatment with low impulsive students on errors exists. However, those highly impulsive deaf students in the self-instruction training program benefited substantially whereas the error performance of those in the control group was poor by comparison. These findings support an argument for the application of self-instruction training in the classroom and, if resources are scarce, particularly with those students who exhibit characteristics of high impulsivity.

(2) Time

In the learning disability treatment group, only judges' global assessments of impulsivity declined significantly. However, trends on other measures were in the expected direction. Had the study been longer than six weeks, perhaps stronger effects would have been obtained, as in the 12-week study.

Although the differences in the results of the two studies cannot confidently be attributed to length of treatment, it is an appealing explanation. Any therapist, teacher, or parent who has attempted to change ineffective or destuctive behaviour in highly impulsive students will likely admit to the difficulty of the task and the time required to bring about lasting change. As pointed out in the review of cognitive behaviour modification research, time is an important variable and programs must be given time to succeed. It is interesting to note that had the study with the deaf students stopped at six weeks, the judges' evaluations would have shown no improvement. Only at 11 to 12 weeks was significant progress observed.

(3) Transfer

On the one hand, the results suggest that self-instruction training is an effective means for language-deficient children to learn interactive computing skills and a computer language. This finding, in itself, is useful for the teacher who makes use of the computer in the classroom, a situation that will surely be on the increase in coming years. But, on the other hand, the treatment students' newly acquired reflective skills on the computer did not generalize to other aspects of their academic or social lives, as measured by the SCRS. (Although there is some indication of transfer to the MFFT among the deaf students, the band of behaviour required by this test is too narrow to claim that useful transfer occurred.)

It has frequently been pointed out that approaches to cognitive behaviour modification ought not be conducted in isolation of the person's wider environment if the desired goal of transfer is to be attained (Coates and Thoreson, 1979; Kendall and Wilcox, 1980; Ross and Fabiano, 1981). Ideally, these newly acquired cognitive skills should be practised and reinforced in many facets of the student's daily life.

The present studies did not go far enough in making the treatments, in the terms of Kendall and Wilcox, "conceptual" nor were they sufficiently multi-faceted. It is recommended that in future research and practice other supervising adults (teachers and counsellors) be made aware of the intents of self-instruction training and that they be trained in its use so that the student receives continuous instruction, feedback, and opportunities for practice. Further, self-regulation and problem-solving strategies should be built into many (if not all) facets of the child's ongoing academic and social curriculum.

(4) Computing and LOGO in Special Education

These studies help confirm the useful place of the computer and appropriate software in the special education classroom. Most of the students participated with enthusiasm, improved efficiency, and creativity and were surely on their way to learning new and important cognitive skills. The interactive requirements and creative potential of graphic LOGO appears to enhance and sustain student interest and to be ideally suited for self-instruction training.

It is interesting to note that Papert's claim that LOGO alone increases reflective thought cannot be supported by the findings reported here, at least not among a language-handicapped population. The performance of students who received only LOGO (the control group) did not improve whereas those who received LOGO with self-instruction training (the experimental group) did. Practice with LOGO alone does not appear to be sufficient for this population. Clearly, sustained teacher intervention in the form of self-instruction training or a similar approach is required to ensure that these students internalize reflective strategies.

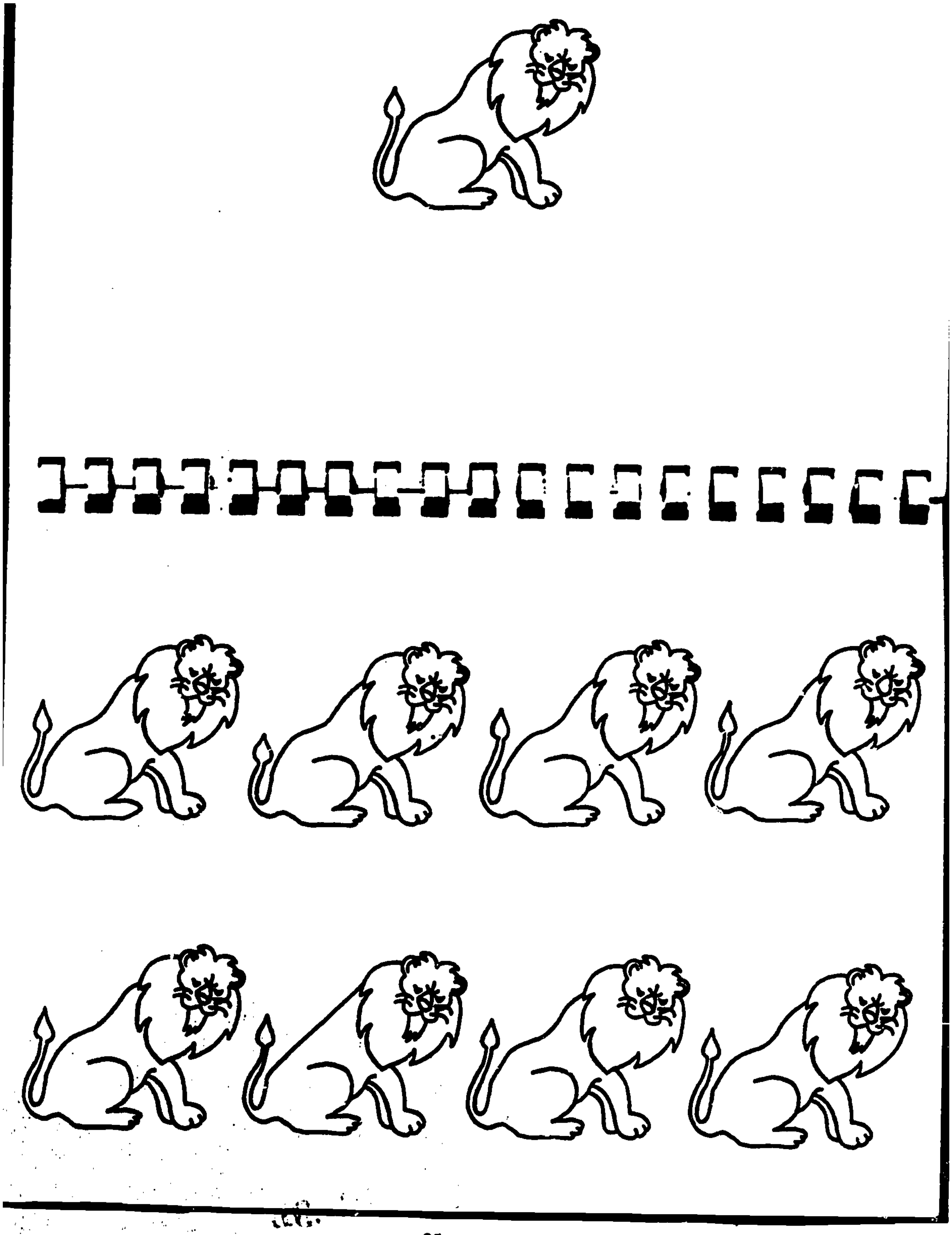
(5) Anecdotal Support

The brief anecdotal review of the progress of four students gives qualitative support to the conclusions reached through quantitative analysis. More importantly, however, the anecdotal review goes beyond the quantitative data and provides insights into features of the students' behaviour and ground for future research. Particularly noteworthy are the descriptions of the nature and variety of overt verbalization by the students. Many of the deaf students began signing to themselves and the aphasic students used available speech without prompting. Such behaviour is regarded as a necessary feature of successful self-monitoring and regulation and is a goal of self-instruction training. It was unknown, and a matter of some concern, at the outset of the studies the extent to which these students could or would engage in this behaviour. A recommendation for future research is to examine the nature and extent of overt verbalization among children with language deficiencies.

This study has attempted to show that deficient or maladaptive learning is very likely a contributing factor to the types of thinking and behaviour that may lower the quality of life among impulsive and language-deficient children or, at the extreme, place these children at risk. The study has also provided evidence that such thinking and behaviour is modifiable through an inferred intervention in cognitive processes. We think it important that this approach to children with special needs not be considered particularly esoteric or removed from classroom practice. In a very real sense the central mission of education for these students is the development of adaptive cognitive processes, in which the traditional content of a curriculum is the vehicle rather than the goal of learning.

Appendix A

Sample from the Matching Familiar Figures Test



Appendix B

The Modified Self-Control Rating Scale

BEHAVIOUR RATING SCALE

Name of Student ______________________

Teacher/Supervisor ______________________ Date ______________

Please rate this student according to the descriptions below by circling the appropriate number. The underlined 4 in the centre of each row represents where the average child would fall on this item. Please do not hesitate to use the entire range of possible ratings.

1. When the student promises to do something, can you count on him or her to do it?

   1 2 3 4 5 6 7
   always — never

2. Can the student deliberately calm down when he or she is excited or all wound up?

   1 2 3 4 5 6 7
   always — never

3. Is the quality of the student's work about the same or dces it vary a lot?

   1 2 3 4 5 6 7
   same — varies

4. Does the student work for long-range goals?

   1 2 3 4 5 6 7
   frequently — never

5. When the student asks a question does he or she wait for an answer, or jump to something else (e.g., a new question) before waiting for an answer?

   1 2 3 4 5 6 7
   waits — jumps

6. Does the student interrupt inappropriately in conversations?

   1 2 3 4 5 6 7
   waits — interrupts

7. Does the student stick to what he or she is doing until he or she is finished with it?

   1 2 3 4 5 6 7
   always — never

8. Does the student follow the instructions of teacher or counsellor?

   1 2 3 4 5 6 7
   always — never

9. Does the student have to have everything right away?

   1 2 3 4 5 6 7
   always — never

10. When the student has to wait (e.g., in line) does he or she do so patiently?

   1 2 3 4 5 6 7
   always — never

11. Does the student sit still?	1 often	2	3	4	5	6 never	7
12. Can the student follow suggestions of others in group work or play, or does he or she insist on imposing his or her own ideas?	1 able to follow	2	3	4	5	6 imposes	7
13. Does the student have to be reminded several times to do something before he or she does it?	1 never	2	3	4	5	6 always	7
14. When reprimanded, does the student answer back inappropriately?	1 never	2	3	4	5	6 always	7
15. Would you describe the child more as careful or careless?	1 careful	2	3	4	5	6 careless	7
16. Are there days when the student seems incapable of settling down to work?	1 never	2	3	4	5	6 often	7
17. Is the child easily distracted from his or her work?	1 never	2	3	4	5	6 often	7
18. Does the child play well with peers (i.e., follow rules, waits turn, co-operates)?	1 always	2	3	4	5	6 never	7
19. If a task is at first too difficult for the child will he or she get frustrated and quit, or first seek help with the problem?	1 seek help	2	3	4	5	6 quit	7
20. Does the student do too many things at once, or does he or she concentrate on one thing at a time?	1 one thing	2	3	4	5	6 too many	7

Appendix C

Judges' Error Count and Impulsivity Evaluation Instrument

Error Category	Time Incidence Counts (1 Min. Intervals.)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15.
(Check off.)															
1) ON TASK ERRORS. Student seems to be following a plan, but uses inappropriate and inefficient commands.															
2) REPETITIVE ERRORS. Student fails to recognize errors or frequently makes similar errors.															
3) OFF TASK ERRORS. Student appears to have no plan. Commands may seem random or unrelated to overall goal.															

a) First 5 Minutes:

(No apparent plan.) (Closely follows plan.)

(Fast.) (Slow.)

(Haphazard.) (Purposeful.)

b) Second 5 Minutes:

(No apparent plan.) (Closely follows plan.)

(Fast.) (Slow.)

(Haphazard.) (Purposeful.)

c) Final 5 Minutes.

(No apparent plan.) (Closely follows plan.)

(Fast.) (Slow.)

(Haphazard.) (Purposeful.)

Appendix D

Consent Forms

FACULTY OF EDUCATION
DUNCAN MCARTHUR HALL

Queen's University
Kingston, Canada
K7L 3N6

January 30, 1985

PARENTAL/GUARDIAN CONSENT FORM

I, the undersigned, as parent or guardian of______________________ consent to his/her voluntary participation in a research program at Sir James Whitney School which is designed to enhance decision-making and learning skills. The reserach program has been funded by the Ontario Ministry of Education, approved by the administration of Sir James Whitney School, and has passed an ethics review required by Queen's University at Kingston. The program will be conducted by members of the Faculty of Education, Queen's University and the staff of the school during the period of February through mid-May, 1985, and will require no more than three hours per week of the student's time. The program will involve instruction in problem solving and will include the use of micro computers.

I understand that information gathered through the participation of the student named above will remain confidential and that he or she may withdraw from the program at any time.

I also understand that, due to limitations in the size of the study group, this consent form does not insure the participation of the student named.

Please feel free to call should you have any questions.

Thank you.

Dr. D.S. Campbell
Associate Professor
Faculty of Education

Principle Investigator
613-547-6188 or
613-547-5832

Student name____________________

Parent/guardian name____________________

Date____________________

Signed____________________

FACULTY OF EDUCATION
DUNCAN McARTHUR HALL

Queen's University
Kingston, Canada
K7L 3N6

October 15, 1985

PARENTAL/GUARDIAN FORM

I, the undersigned, as parent or guardian of ____________________ consent to his/her voluntary participation in a research program at Sagonaska School which is designed to enhance decision-making and learning skills. The research program has been funded by the Ontario Ministry of Education, approved by the administration of Sagonaska School, and has passed an ethics review required by Queen's University at Kingston. The program will be conducted by members of the Faculty of Educatión, Queen's University and the staff of the school during the period of February through Mid-May, 1985, and will require no more than three hours per week of the students' time. The program will involve instruction in problem solving and will include the use of micro computers.

I understand that information gathered through the participation of the student named above will remain confidential and that he or she may withdraw from the program at any time.

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Please feel free to call should you have any questions.

Thank you.

Dr. D.S. Campbell
Associate Professor
Faculty of Education

Principle Investigator
613-547-6188 or
613-547-5832

Student name____________________

Parent/guardian
name____________________

Date____________________

Signed____________________

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Appendix E

Data Summary

Table 1

STUDY 1: Subject characteristics and pre- and post-treatment scores on MFFT and SCRS

				MFFT				SCRS			
				Pre		Post		Pre		Post	
Subject	Age	Sex	Group	Err.	Lat.	Err.	Lat.	Teach.	Coun.	Teach.	Coun.
T.H.	12.0	F	T	2.0	39	0.7	47	86	70	84	72
S.D.	12.2	M	T	1.0	32	0.7	25	102	63	95	47
M.A.	12.2	F	T	3.2	13	2.0	14	87	77	84	68
C.T.	15.9	M	T	1.7	27	0.7	46	89	81	96	87
W.G.	15.0	M	T	1.3	59	0.7	78	98*	79*	86	70
D.J.	14.3	F	T	0.5	45	0.7	51	102	136	104	95
W.L.	15.1	F	T	0.7	31	0.2	58	95	72	43	49
M.S.	14.4	F	T	3.5	22	1.6	21	67	57*	47	53
mean:	13.9			1.7	34	0.9	43	90	79	80	68
s.d.:	1.5			1.1	14	0.6	21	12	24	23	17
T.K.	13.0	F	C	0.5	81	1.2	64	64	54	70	44
S.E.	11.0	F	C	1.5	20	1.8	20	94	63	85	46
D.D.	12.2	M	C	0.5	25	1.8	47	91	90	81	59
A.M.	15.0	F	C	2.2	27	0.7	73	81	57	44*	33
L.Y.	15.4	F	C	5.0	16	2.3	9	82	125	79	93
H.T.	14.6	M	C	1.5	18	1.0	31	109	91	91	81
D.K.	15.3	M	C	0.7	41	1.0	43	121	99	108	106
K.T.	13.4	M	C	0.7	31	2.0	34	74	76	50*	88
mean:	13.7			1.6	32	1.4	40	90	82	76	69
s.d.:	1.6			1.5	21	0.6	21	18	24	21	26

* Due to items omitted (judged not applicable by raters), these scores were pro-rated.

Table 2

STUDY 1: Judges' error count and global evaluations

Subject	Group	Pre-Treatment E/Mn	E	M	Mo/E	Glb	Post-Treatment E/Mn	E	M	Mo/E	Glb
T.H.	T	1.8	48	434	9.0	24.5	1.4	29	434	15.0	13.5
S.D.	T	1.7	40	370	9.5	24.0	1.6	34	416	12.2	22.5
M.A.	T	1.8*	40	188	4.7	17.0	0.4	11	215	19.5	17.0
C.T.	T	1.9*	38	272	7.2	17.5	0.4	9	128	14.2	16.5
G.W.	T	1.3	22	288	13.1	25.0	1.8	36	420	11.7	19.0
W.L.	T	2.9	45	86	1.9	22.5	2.8	45	316	7.0	24.0
M.S.	T	1.8	33	312	9.5	28.0	1.0	24	254	10.6	16.5
mean:		1.9	38	280	7.8	22.6	1.3	27	312	12.9	18.4
s.d.:		0.5	8.5	108	3.7	4.0	0.8	13	118	3.9	3.7
T.K.	C	1.2	34	375	11.0	26.0	0.9	9	110	12.2	39.0
S.E.	C	1.2	16	132	8.3	17.5	1.5	22	149	6.8	17.0
D.D.	C	1.6	33	294	8.9	24.5	1.5*	14	272	19.4	22.0
A.M.	C	1.7	34	312	9.2	27.5	1.5	43	214	5.0	33.5
L.Y.	C	1.5	15	93	6.2	30.0	2.2	43	296	6.9	27.0
H.T.	C	1.2	41	306	7.5	23.0	0.8	16	110	6.9	21.5
D.K.	C	1.9	40	294	7.4	26.5	0.9	20	200	10.0	25.0
K.T.	C	2.6	68	624	9.2	23.0	2.7	69	854	12.4	21.0
mean:		1.6	35	304	8.5	24.8	1.5	30	276	10.0	25.8
s.d:		0.5	17	161	1.5	3.8	0.7	20	243	4.7	7.3

E/Mn - errors per minute, E - errors, Mo/E - moves per error, Glb - global characteristics.
* Videotaped samples were less than 15 min. E/Mn was pro- rated. E/Mo was calculated as total moves divided by the raw error count.

Table 3

STUDY 2: Subject characteristics and pre- and post-treatment scores on MFFT and SCRS

				MFFT				SCRS			
				Pre		Post		Pre		Post	
Subject	Age	Sex	Group	Err.	Lat.	Err.	Lat.	Teach.	Coun.	Teach.	Coun.
M.R.	14.1	M	T	2.1	18	2.6	17	92	88	56	71
P.T.	13.8	M	T	2.3	14	2.5	26	118*	98	81	92
T.P.	15.2	F	T	3.8	7	2.3	13	109	95	82	95
B.A.	12.3	M	T	3.5	10	4.8	12	55	83	64	65
L.M.	10.8	M	T	3.7	4	2.8	4.5	96	97	91	92
mean:	13.2			3.1	10.6	3.0	14.5	94	92	75	83
s.d.:	1.7			0.8	5.5	1.0	7.9	24	7	14	14
D.R.	12.1	M	C	2.2	21	2.8	23	126*	74	89*	81
P.J.	10.7	F	C	3.3	38	2.3	31	59	122	48	109
J.J.	13.2	M	C	3.5	25	2.3	20	76	46	41	40
W.S.	13.2	M	C	1.8	11	2.8	16	77	94	77	77
R.M.	15	M	C	1.5	25	1.0	36	92	75	38*	53
mean:	12.8			2.5	24.0	2.3	25	86	82	59	72
s.d.:	1.6			0.9	9.7	0.8	8.1	25	28	23	27

* Due to items omitted (judged not applicable by raters), these scores were pro-rated.

Table 4

STUDY 2: Judges' error count and global evaluations

		Pre-Treatment					Post-Treatment				
Subject	Group	E/Mn	E	M	Mo/E	Glb	E/Mn	E	M	Mo/E	Glb
M.R.	T	1.5	22	371	16.9	26.5	3.1	47	312	6.6	20.0
P.T.	T	2.4	37	343	9.3	25.0	2.1*	31	438	14.0	20.0
T.P.	T	2.9*	37	154	4.2	26.0	1.4	20	232	11.5	14.0
B.A.	T	1.7*	23	196	8.5	31.0	2.6	40	313	7.9	28.0
L.M.	T	2.[illegible]*	27	214	7.9	39.5	1.0*	24	228	9.5	17.0
	mean:	2.1	29.2	256	9.4	29.6	2.0	32.4	305	9.9	19.8
	s.d.:	0.6	7.4	96	4.6	6.0	0.9	11.0	85	2.9	5.1
D.R.	C	1.9*	33	289	8.8	23.0	2.2	36	306	8.6	23.5
P.J.	C	2.4*	27	236	8.6	35.0	1.6*	22	311	14.0	28.0
W.S.	C	3.4*	36	212	6.4	22.5	1.5	23	118	5.1	20.0
	mean:	2.6	32.0	246	7.9	26.9	1.8	27.0	245	9.2	23.8
	s.d.:	0.8	4.6	39	1.3	7.3	0.4	7.8	110	4.5	4.0

E/Mn - errors per minute, E - errors, Mo/E - moves per errror, Glb - global characteristics.

* Videotaped samples were less than 15 min. E/Mn was pro- rated. E/Mo was calculated as total moves divided by the raw error count.

Appendix F

REFLECT: A Program to Promote Reflective Thinking (Teacher's Manual)

REFLECT

A PROGRAM TO PROMOTE REFLECTIVE THINKING

REFLECT is a program designed to promote reflective styles of thinking and to enhance problem-solving abilities. We anticipate that its most useful applications will be with children and adolescents who have learning difficulties, however, it may be found a useful resource for other students as well. For the student with learning difficulties, we believe the teacher is an essential part of this program and should be available to the student for a number of roles which will be described later in this manual.

To use the program you will require the following:

-- an Apple IIe computer with extended memory (128 K)

-- a single or dual disk drive

-- a video monitor or television set (colour preferred but not required)

-- a printer (not required but desirable)

-- an Apple LOGO II program disk

-- a REFLECT program disk

-- two blank disks for saving copies of student work and cumulative logs of student commands (optional)

-- THUNDERCLOCK board (optional) for date/time stamping of log files

TABLE OF CONTENTS

1.0 AN OVERVIEW OF THE PROGRAM

This page will give you a brief overview of the steps and procedures which should give the best results with REFLECT.

The TEACHER explains to the STUDENT the purpose of the exercises about to begin. The student will be learning a new computer language called LOGO which invites the student to figure out ways of drawing pictures on the screen.

↓

The STUDENT uses the TUTORIAL portion of the REFLECT program with LOGO to learn the basic LOGO commands. The student uses these commands to copy simple drawings which appear on the screen.

↓

The REFLECT program monitors the STUDENT'S moves and at various intervals STOPS the student, INTRODUCES REFLECTIVE PROBLEM-SOLVING IDEAS and directs the student to PRACTICE them.

↓

At intervals considered appropriate by the TEACHER, the STUDENT'S work is reviewed with the student. The student's progress and errors and the reflective problem-solving ideas are discussed. The student is encouraged to always think about these ideas and to use them frequently. (This procedure will be referred to as SELF-INSTRUCTION TRAINING.)

↓

The STUDENT continues to explore LOGO and to create new drawings while practicing the newly acquired skills for reflective thinking. As the skills are learned, the interventions by the REFLECT program can be REDUCED or ELIMINATED by the TEACHER.

2.0 INTRODUCTION: WHY REFLECT?

> What they should learn first is not the subjects ordinarily taught, however important they may be; they should be given lessons of will, of attention, of discipline; before exercises in grammar, they need to be exercised in mental orthopedics; in a word they must learn to learn.
>
> Alfred Binet, 1908

2.1 The Impulsive and Distractable Student

We expect young children to be somewhat scattered in their thinking and to be actively, even frantically, engaged in exploring their surroundings. These characteristics are a part of early childhood and, though at times frustrating for the adult, we might worry if they were absent. But when these characteristics persist into later stages of childhood and adolescence, we describe them as signs of immaturity. That is, we come to expect that as children grow, they will become more reflective and purposeful in their thoughts and actions.

Children who do not meet these expectations can be described in many ways. One way is with the word "impulsivity", a term seen with increasing frequency in recent research on children with learning difficulties. The impulsive child is described as one who often does not think before acting or making a decision, who is easily distracted and perhaps hyperactive, and who is unwilling or unable to attend to a task for more than brief periods. The impulsive child tends to be a poor problem solver and is likely to make excessive errors even though measured intelligence may be average or above.

Impulsivity is therefore a term which refers to a particular style of thinking. If excessive, it may be a significant handicap to effective learning. Impulsivity has been linked in particular to the problems of learning in disabled and deaf children.

This characteristic of children's learning was noted in the early 1960s by educational psychologist Jerome Kagan and his associates (Kagan, 1965). They observed that when children are confronted with ambiguous problems, there are consistent individual differences in the time taken to solve the problem and in the number of errors made. One group of children would not take time to think, would jump at a solution, and have high error rates. These children were described as being impulsive. Other children who consistently took time to think through their answers and made few errors were described as being reflective.

Most teachers will recognize the impulsive child in the classroom. The young student may shoot up a hand in reply to a question but have either a wrong or no answer at all, can become easily frustrated with instructions, has difficulty finishing work, is easily distracted by classmates, can read for the main point but has difficulty recounting specific detail, finds making choices difficult but wants everything now. Impulsivity in the adolescent student may lead to passivity and avoidance in school and, in fewer instances, to delinquent behaviour. The examples can go on and each would reflect the student's inability or unwillingness to stop and think.

There are a number of theories which attempt to explain the causes of impulsive styles of thinking (or cognitive impulsivity). They should be of interest to the educator because they give insights into various teaching methods which may help the student become a more reflective thinker.

A common feature of many of the theories is the concept of deficit. At the most physiological level, one theory suggests deficient functioning of the brain's arousal system which, in turn, results in excessive seeking for stimulation (Farley et al., 1979). Douglas and Peters (1979) hypothesize a genetic predisposition toward impulsive behaviour which results in attention disorders and lack of inhibition controls. These problems contribute to an accumulating pattern of school failure.

Other theories stress a more cognitive view. Feuerstein (1980), Kendall and Finch (1979), and Meichenbaum (1977) share the view that a deficit in internal language used to mediate thought and actions contributes to poor self-control and problem-solving abilities. The child does not stop and think because there is not a sufficient repertoire of experience and relevant concepts readily available in memory.

As a result of such deficiencies, impulsive children and adolescents (and adults) will likely exhibit a pattern of characteristics in their behaviour. Certainly, not all persons will exhibit identical characteristics, but the following review may help with identification. Our view of the impulsive child includes:

-- a tendency to work quickly and to make errors.

-- an inability to attend to and to sort out relevant features or information given a problem situation.

-- an inability to carefully analyze a problem, choosing instead a global or holistic approach.

-- being easily distracted by others or by one's own thoughts, difficulty with concentration.

-- seeking stimulation and sensation, taking the form of irrelevant and off-task talk and movement.

-- seeking cues on what to do from others and depending on others for direction.

-- an inability to deal with large amounts of information or instructions at one time.

-- an inability to think through alternate courses of action and their consequences or alternate solutions to a problem and to evaluate their correctness.

-- a reluctance to delay gratification.

-- a poor self-concept as a student resulting from repeated frustration and failure.

2.2 Improving Reflective Thought

The theories on impulsivity are relativley recent. Therefore, research with methods to reduce cognitive impulsivity based on these theories are not extensive. However, the work that has been done is promising. It suggests that impulsivity is modifiable and that children can be trained to think more reflectively. Descriptions and reviews of many of these studies are avaliable elsewhere and are listed in the bibliography.

There are a number of common features of these studies which contribute to their success and which have been incorporated into the REFLECT program.

PROBLEM-SOLVING ACTIVITIES

Students are engaged in a series of problem-solving activities which are the vehicles for learning and practicing reflective ways of thinking. The content of the problems should, of course, be of interest to the students and sufficiently difficult to be challenging but not cause excessive frustration. The problems may be wide ranging -- from word problems in mathematics, to problems in a social context, to drawing pictures on a computer (as in the REFLECT program).

MODELLING

It is essential that the teacher be a model of reflective problem-solving for the students. The teacher works through sample problems or tasks and demonstrates out loud the various approaches and strategies the students are to learn.

SELF-VERBALIZATION

Just as the teacher models approaches to reflective thought out loud, students are encouraged to do the same. They are told to think out loud, to talk to themselves in relevant ways when doing their work. This procedure has a number of important advantages. It ensures that fast and random thinking is slowed down. It offers both the student and the teacher a "window" on the student's thinking so that both can see the sources of errors.

SELF-INSTRUCTION TRAINING

This procedure attempts to put the student in control, to regulate and monitor one's own thinking and activity. During problem-solving activities, the teacher listens to and observes the student. The teacher has the student practice with new ideas and strategies for solving the problem. Over time, the teacher's interventions are reduced as the student continues to learn, rehearse, and practice these new ways of thinking. In the REFLECT program, these strategies and ideas are introduced and reinforced via the computer as a supplement to the teacher. The REFLECT program encourages the student to PLAN IN ADVANCE, to STOP AND THINK, and to EVALUATE work in progress. In time, it is the student's own self-instruction rather than outside intervention that directs thought and action. More detail on the role of the teacher is given in Section 5.0 of this manual.

TIME TO SUCCEED

One message rings clear from studies which attempt to modify complex human behaviour. Interventions must be given time to succeed. There is little point in using the REFLECT program, or any other approach, if they are seen as a quick fix. Our own experience and that of others indicate that a program should be planned for at least two or three months with the student engaged in specific self-instruction activities for two or three sessions per week. Further, the transfer effects of such programs will be enhanced if its features are reinforced in many aspects of the student's daily life -- in and out of the classroom.

3.0 OVERVIEW OF THE REFLECT PROGRAM

The REFLECT program is intended to be used as part of a self-instruction training program. The computer provides the student with a problem-solving environment in which the student learns and practices with various strategies. There are a numbe f options which can be used depending on the student's ability and readiness. These options are:

-- Tutorial mode

-- Prompting mode

-- Instant LOGO

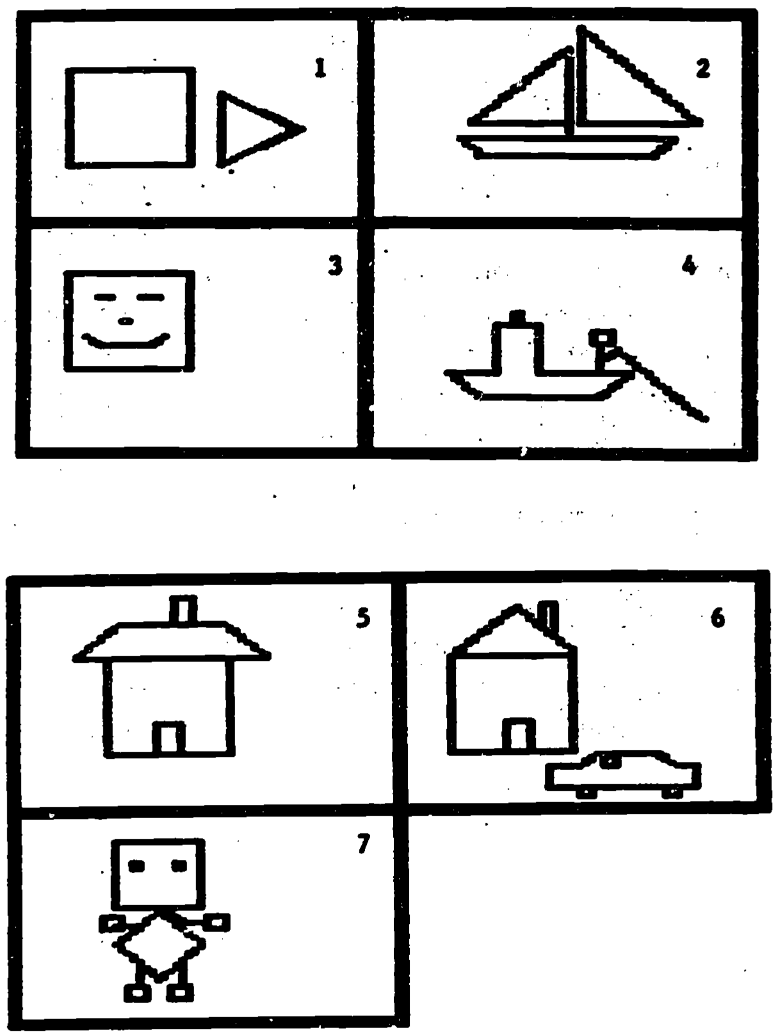
-- Apple LOGO II only

-- Log file

The TUTORIAL MODE provides the student with a list of increasingly difficult pictures from which to choose. The student is directed to replicate chosen pictures using LOGO commands. The pictures, in order of difficulty, are shown in Figure M1.

Also while in the TUTORIAL MODE, interventions appear at various times while the student is working on the drawings. The interventions introduce the student to reflective problem-solving strategies and are reminders to think of them. Each intervention appears, to the student, as an icon temporarily superimposed over the student's LOGO work on the TV screen. Each icon has an associated written label that always appears below it. This is followed by a question that is intended to remind the student of the problem-solving strategies being learned

Figure M1: Sample model pictures to be reconstructed by students in REFLECT program



or prompted. The student is required to acknowledge the question with an appropriate reply before proceeding with more LOGO work. Different forms of the questions are used to avoid habitual response patterns.

The interventions are introduced gradually. In the "easiest" pictures to replicate, only three icons are used. As the pictures increase in difficulty, the remaining icons are introduced one at a time with each new picture attempted. Thus, in order to become acquainted with each of the problem-solving strategies, it is recommended that the student should complete at least three of the drawings listed in the menu. A sample session is shown in Section 9.0.

In the PROMPTING MODE, the students are free to work with any picture of their own design. Interventions will again occur to remind the student of strategies. Default rules govern the timing of these interventions. These rules may be changed by the teacher, for each student, in order to meet each student's needs. For example, the teacher may choose to reduce their frequency once the student has begun to show mastery of the strategies or when the student is experiencing frustration with their frequency. Procedures for altering the intervention rules are given in Section 8.0.

Another feature of the REFLECT program is that it offers the student a choice of LOGO commands. The beginning student may wish to become familiar with LOGO using the "INSTANT" LOGO commands. These are abbreviated or "shorthand" commands and are easier to learn. Once comfortable with the language, most students would profit from moving into full APPLE LOGO II.

Finally, the REFLECT program has been designed to allow the teacher to keep a cumulative log file of each student's responses on the computer, accompanied by the date and time intervals between responses. If this option is of interest, it requires the addition of a "Thunderclock" board to the Apple IIe, and a second disk drive is advised (but not mandatory).

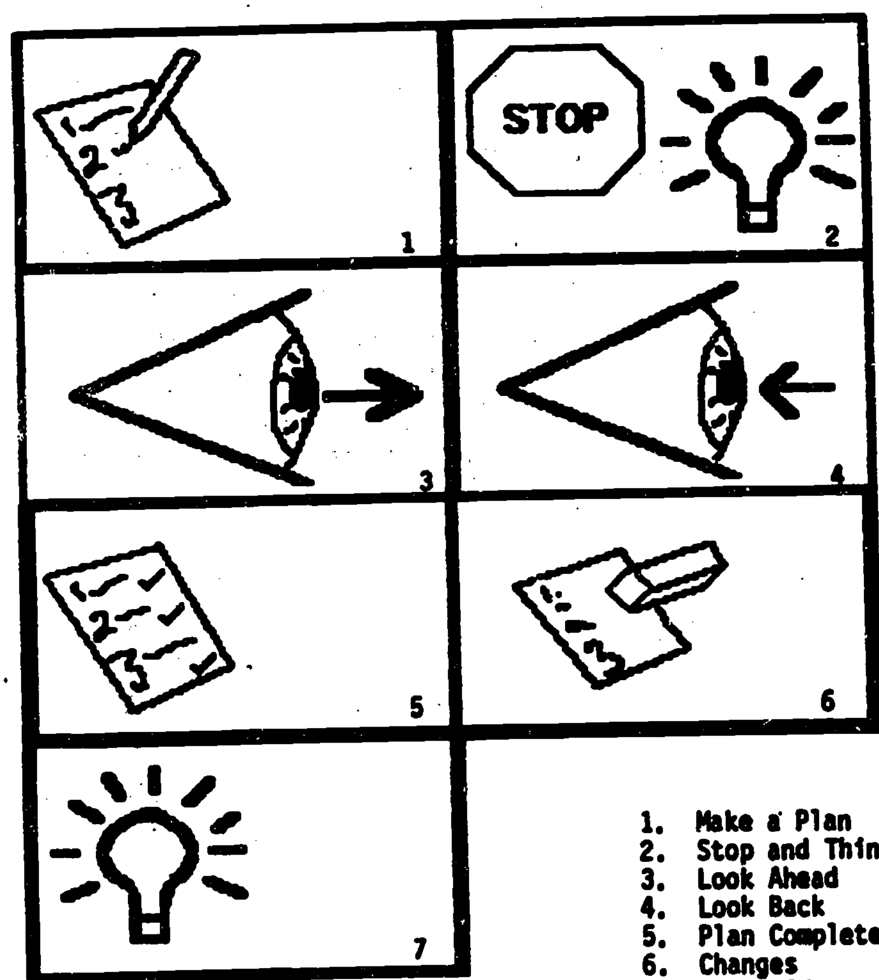
To start up the REFLECT program with a choice of options, see Section 6.0, "Using the REFLECT Program".

4.0 GETTING THE STUDENT STARTED

If the student is a beginner, it is recommended that basic familiarity with the LOGO language be acquired in the INSTANT LOGO mode for a few sessions before the TUTORIAL mode is used.

Before launching the student into the TUTORIAL MODE, introduce the nature of the program. It is suggested that you tell the student (in language meaningful to the student, of course) that the exercises are intended to help with learning and thinking through problems. Although the problems on the computer are not like those in school work, there are similarities in the way one needs to think to be successful in school. Tell the student that while working

Figure M2: REFLECT program intervention icons



1. Make a Plan
2. Stop and Think
3. Look Ahead
4. Look Back
5. Plan Completed
6. Changes
7. Great Idea

on the pictures, reminders of ways to think will appear on the TV screen accompanied by questions. You might prepare the student by showing the intervention icons in Figure M2. Emphasize that the reminders are there to help the student slow down and to work with purpose or, in other words, to stop and think.

While the student is working, or just after completion of a drawing, we believe it is important that the teacher monitor progress and prepare the student for self-instruction training. Suggested procedures for the teacher's role in self-instruction training appear in the next section.

After the student has completed at least three pictures in the TUTORIAL MODE (after three or four more sessions) you may think it time to move on to the PROMPTING MODE. In this mode students are free to be creative with their own drawings and designs. It is important that the student have a plan before starting. Encourage the student to prepare a sketch on paper of his or her next drawing. In this mode, the reminders will again appear on the screen. Their appearance is regulated by the program, however, as mentioned earlier, and the teacher may modify their frequency in order to accommodate student differences. Again, it is important that the teacher monitor student activity and encourage self-instruction training.

We have found it highly motivating for students to be able to print out copies of their work.

5.0 THE TEACHER'S ROLE IN REFLECT

The intent of REFLECT is to have students slowly begin to acquire new strategies for learning and thinking. In order to achieve this goal, students need to learn and practice these strategies until they become second nature and part of the students' repertoire of skills. The teacher's role is critical, particularly in the beginning stages.

As stated earlier in the section on "Improving Reflective Thought", there are four basic features to using this program. They are: problem-solving activities, modelling, self-verbalization, and self-instruction training. The REFLECT computer program provides the problem-solving activities with LOGO, it introduces reflective learning strategies to the student, and it encourages practice. The other features are up to the teacher and student.

Modelling is a powerful stimulator of successful learning. As the student becomes acquainted with LOGO and what it can do, the teacher should MODEL reflective thinking for the student and do so out loud so the student can have a picture of how the strategies are used. The teacher might work through a LOGO problem and think out loud for the student, giving stress to strategies by saying things like:

-- "Do I understand what I am to do? I'll describe it in my own words."

-- "What is my plan going to be? I'll trace the drawing first or draw a picture of it."

-- "Do I know all the computer commands I will need to make this drawing? Maybe I need to review them or try some new ones out."

-- "I have just made a mistake. What did I do wrong? Maybe I was going too fast and hit the wrong key. No, I think I must have overestimated the length of the line needed here."

-- "Is there another way I can do this move? I should think about the possibilities. How about if I move the turtle to the other side with 'pen up' and then start my line?"

-- "Does my drawing look like the one on the screen or the one I drew on paper? Where or how is it different?"

-- "I have to remember to go slowly and think about what I am doing so I don't make too many mistakes. A few are OK but too many are frustrating."

-- "Do I want to change my plan or how I am going about it? It would be interesting to include a circle here. How do I make a circle with the turtle? I need to refer again to the command directions."

-- "Am I satisfied with what I have done? I think so. It is close to what I had in mind...maybe even better!"

In this way, both the idea of using reflective thought and thinking out loud (self-verbalization) are demonstrated to the student who is encouraged to now do the same. Once the student adopts this way of thinking out loud, self-instruction training has begun. Students, alone or in pairs, can emulate your reflective behaviour while working with REFLECT at the computer. If alone, they should be encouraged and feel free to speak aloud (or in a good whisper) and, if in pairs, they should verbalize their thinking to each other. This thinking aloud is one means of getting the student to slow down and to avoid random thinking behaviour. And when thinking patterns become overt in this way, the listening teacher has a means of understanding students' thinking behaviour and sources of difficulty.

Once or twice a week, the teacher should have a session with the student during which work is reviewed and the student is asked to talk about work in progress or completed. In this way the teacher monitors the students' use of the strategies and reinforces their use. Once good progress is shown, the need for teacher intervention and thinking out loud diminishes.

The teacher thus becomes a guide and facilitator of the student's own self-instruction in thinking more reflectively. The more the student practices and has opportunities to practice, the greater the likelihood these strategies will become automatic and generalized. Therefore, the teacher should begin to consider methods of encouraging transfer to other facets of the student's life. Certainly transfer would be enhanced if the strategies used in REFLECT were to become a highly visible part in the daily academic curriculum and in attempts to control social behaviour.

6.0 USING THE REFLECT PROGRAM

6.1 Starting Up the REFLECT Program

(Please note that this program is a prototype only, and its design was constrained by the limited computer resources available. This version does not necessarily reflect the format in which a final version may eventually appear.)

Getting the REFLECT program started involves following the simple steps outlined below. First, check that you have all the required computer equipment and floppy disks.

You will need an Apple IIe (or IIc) computer with at least one disk drive. A colour monitor is desirable as is a printer. You may also need a "Thunderclock" if you wish to date/time stamp the log of student commands.

You will need four disks to get started:

Apple Logo II Language disk
Master Program disk (/SMASTER/)
Student Work disk (/SLOGO/)
Student Log disk (/LOG/) -- Optional

-- Apple Logo II is the Logo program for the Apple IIe and IIc. (It is available for purchase from Apple dealers.)

-- /SMASTER/ contains the REFLECT programs.

-- /SLOGO/ and /LOG/ are the repositories of student work. The /SLOGO/ disk also contains copies of the icons that are used throughout the program. You may make as many copies of the /SLOGO/ disk as you like, usually one for each student. Do not use the one that comes with the REFLECT program, save it as a backup copy in case you need to make more later. If you do not have the /LOG/ disk already, you may create one. It is just a blank disk that has been formatted using PRODOS, with the pathname /LOG/. You will ideally use one /SLOGO/ and one /LOG/ disk for each student, but the disks may be shared if students are not using them concurrently. These disks are used mainly to store student work and the log of student commands. The disk /SLOGO/ may also contain information on the frequency of interventions desired, see the section "Intervention Criteria". The disk /LOG/ is NOT required if no logging is to take place. If only one disk drive is available, log files will be placed on the /SLOGO/ disk, and the /LOG/ disk is not required.

Once you have all the necessary equipment, you may start the REFLECT program. Here's how to do it.

1) STARTING UP "APPLE LOGO II":

a) Put the "Apple LOGO II" disk in the disk drive.

b) Turn the computer ON.

c) Press <RETURN> when requested.

d) Remove the "Apple LOGO II" disk when the "Welcome to Logo" message appears on the screen.

2) LOAD THE REFLECT MENU PROGRAM:

a) Insert the MASTER PROGRAM DISK, labelled /SMASTER/. Then type:

SETPREFIX "/SMASTER/

b) Load the Menu program: Type

LOAD "START

(The menu program will automatically start running as soon as the procedures finish loading.)

c) Select the mode you wish to use: The menu will appear on the screen and will look like this:

REFLECT MENU
############

0. End this program

1. Tutorial Mode

2. Prompting Mode

Select the number of the option that you wish, then press the key marked <Return>.

d) Answer the questions presented:

You will be asked if you have a Thunderclock installed and wish to use the timing routines, and, if you choose the prompting mode, whether or not you want logging to occur.

The appropriate software will then be loaded for you...it will take some time! (The tutorial takes about 4 minutes to load; the prompting program takes about 6 minutes.)

3) USING "INSTANT" LOGO, "SHORTHAND" LOGO COMMANDS
(Skip to step 4 if you don't wish to use "INSTANT".)

Type:
LOAD "MINSTANT1.LOGO

4) SOME IMPORTANT HOUSEKEEPING:

a) Remove the MASTER program disk and insert the STUDENT work disk, /SLOGO/. Type:

SETPREFIX "/SLOGO/

b) If using LOG files (prompting mode only):

i) If you have a two-disk-drive system, insert the /LOG/ disk in the second disk drive.

ii) If you have a one-disk-drive system, edit the START procedure so log files can be placed on the student disk instead of a separate log disk. (See section on Apple Logo II for help with editing procedures.)

Change MAKE "PRELOG "/LOG/
to MAKE "PRELOG "/SLOGO/

5) FINALLY, GETTING GOING

Type:
START

You are now in the Logo environment and ready to proceed with the REFLECT tutorial or prompting mode as you have selected.

6.2 Finishing

When the student has completed a picture, or the session is ending, you must tell the REFLECT program in order to get the final interventions and to properly close off any log files that are being kept.

Follow these steps:

1. TO FINISH:

   a) At any time in tutorial or prompting mode, type QUIT to finish.

   or

   b) For tutorial mode, at almost any time, OPEN-APPLE + ESC will get you back to the start of the program or to the menu. From the menu, ESC will terminate the program, as will selecting menu option 0.

2. AFTER "QUIT"ING A SESSION:

   After you have typed in QUIT, there will be a few final questions and concluding interventions.

3. REMOVE DISKS:

   Remove the Student Work Disk (/SLOGO/) and the log disk (/LOG/), if it was used.

6.3 Starting Again with Another Student

For another student to use the SAME mode on the same computer, you may insert a new student disk, type ERALL to erase student work from the work space, and start at step 5 of "Starting Up the REFLECT Program", Section 6.1.

For another student using a DIFFERENT mode, you must turn the computer off and start at step 1, Section 6.1, again.

(N.B. Do not use the control-open-apple-reset keys to restart. YOU MUST TURN THE COMPUTER OFF and on again in order to properly free up all the work space required by these programs!)

6.4 Controlling Interventions

There are several ways to modify the intervention criteria, which allows the teacher a fair amount of control over when interventions may occur. Full details and descriptions are provided in Section 8. For convenience, the next two sections present brief summary information on how to change the major controlling variables.

6.4.1 Changing intervention frequencies BEFORE a session

TUTORIAL MODE	PROMPTING MODE
Type: EDITFILE "INTER and change the student's record. (For help see later section on editing.)	No changes can be made before a session, although you may permanently change the default values. (See later section.)

6.4.2 Changing intervention frequencies DURING a session

TUTORIAL MODE	PROMPTING MODE
At the > prompt, type: EXP x y z where x,y,z are intervention frequencies. (Default EXP 6 8 8)	At the > prompt, type: STLVL number where number is a number from 1 to 5. (Default STLVL 1)

6.5 Controlling Logging Activity

During REFLECT sessions with/without logging you may replace the current "log" procedure with another one, effectively stopping logging or starting up (changing what was requested via the menu).

From the > prompt, insert the Master Program disk (/SMASTER/) in the drive that has the Student Work disk (/SLOGO/) currently in it, and type:

LOAD "/SMASTER/FREEEXP.LOG	for logging
LOAD "/SMASTER/FREEEXP.NOLOG	for NO logging

Then re-insert the Student Work disk (/SLOGO/).

N.B. The log file will not be closed until you type QUIT, even if you turn logging off in the middle of a session!

7.0 USING LOGO -- A SUMMARY OF COMMANDS

The following sections contain a summary of the most useful commands that you may wish to use during the REFLECT program. For more details on Logo, see "Apple Logo II Reference Manual" (Apple Computer Inc., 1984), which accompanies the Apple Logo II disk.

7.1 Using "Instant" Logo by Itself:

1. Boot Apple Logo II and remove disk.
2. Insert /SMASTER/ disk.
   Type LOAD "/SMASTER/MINSTANT1.LOGO
   Insert any student disk (marked /SLOGO/).
   Type SETPREFIX "/SLOGO/
3. You are now ready to go. (Please note: these procedures are "buried" and will therefore not show when you print out procedure titles nor will they be saved to disk if you do a "SAVE". They will, however, cause difficulty if you try to EDIT something with the same name as one of the INSTANT procedures, therefore, DON'T USE procedure names that are the same as the INSTANT one-character commands!)

7.2 "Instant" Logo Command Summary

The following one-character commands are available when "MINSTANT1.LOGO" has been loaded.

Commands	Meaning
F	FORWARD 10
B	BACK 10
R	RIGHT 30
L	LEFT 30
M	(Mini step) FORWARD 1
S	Square
T	Triangle
A	Arc

NOTE: The <Return> key must be pressed following each command, or commands may be strung out on a line, separated by spaces.

7.3 Frequently Used Apple Logo II Commands

All regular Logo commands may be used in conjunction with "INSTANT" Logo, but the following may be especially useful.

Commands	Meaning
PE	PENERASE
PD	PENDOWN
PU	PENUP
CS	CLEARSCREEN

ST	SHOWTURTLE
HT	HIDETURTLE
HOME	Move turtle to centre screen
SETBG	Set BackGround colour
SETPC	Set Pen Colour
FILL	Fill in the shape outlined by the current pen colour with the current pen colour. N.B. Works only if the turtle's pen is DOWN.
TOOT	frequency duration (If you dare!)

7.4 Apple Logo II "Utility" Commands

Commands		Meaning
OPEN-APPLE + ?	--	See help screen (use open apple + ESC to get out)
OPEN-APPLE + ESC	--	Stop a procedure that is executing
CTRL-S		See Split screen
CTRL-T		See Text screen
CTRL-L		See Lower part of graphics screen
SAVEPIC "picture.PICT	--	Save a picture to disk
LOADPIC "picture.PICT	--	Load a picture from disk
PRINTPIC "picture.PICT	--	Print a picture on the printer
SAVE "procedures.LOGO	--	Save procedures to disk
LOAD "procedures.LOGO	--	Load procedures from disk
ERASEFILE "filename	--	Erase a file from the disk
POFILE "filename	--	Print out "filename to the screen
DRIBBLE 1) POFILE "filename) DRIBBLE 0)	--	Print out filename to printer in slot 1

7.5 Apple Logo II Editor Commands

Commands		Meaning
EDITFILE "filename	--	Allows you to edit "filename and restore it to disk without disturbing current workspace.
EDIT "procedure	--	Edit a procedure.
EDIT ("procedure1 "procedure2 "procedure3...)	--	Edit the named procedures (handy just for looking at several procedures at the same time).

EDIT controls:
Arrow keys move cursor in appropriate direction

-- CTRL - O	. open a line
-- CTRL - K	. kill line
-- CTRL - R	. get back last "killed" text
-- CTRL - Y	. kill line to right of cursor
-- CTRL - D	. delete character to LEFT of cursor
-- CTRL - F	. delete character UNDER cursor

OPEN-APPLE + ESC	--	Quit procedure execution or leave editor without making any changes.
OPEN-APPLE + A	--	Accept editor changes and exit.

8.0 INTERVENTION CRITERIA

Deciding when to intervene in a student's session is based upon a few rules that are built into the REFLECT program. The tutorial mode has interventions spaced at fairly regular intervals throughout, so that the student has a chance to become familiar with them. In contrast, the prompting mode attempts to present interventions only when a student is likely to need the reminders. Accordingly, the criteria, and the teacher controls over interventions, are different for each mode. Procedures for modifying the frequency and timing of these interventions are given below.

8.1 Tutorial Mode

Interventions in this mode occur on a regular basis in order to help the student become familiar with them. Interventions occur after prescribed numbers of Logo commands have been entered by the student. The numbers of commands required before another intervention may be set either before OR during a REFLECT session. How to control these prescribed numbers and their functions are described here.

8.1.1 To change intervention frequencies BEFORE a session

Each student disk should contain a file named INTER. This file contains the default numbers that are used for determining when interventions will occur. Each student should have a "named" record in this file, and a copy of this file should be made on each student disk. This file should be set up on the Student Work disk (/SLOGO/), by the teacher, if the default values are not suitable. The names to be used are the names the students will type in when first starting up the REFLECT program. (Note: Only one-word names are allowed.)

A sample INTER file might look like this:

```
PAT 2 5 7
JIM 4 6 8
DON 6 8 8
SCOTT 10 10 10
KEVIN 8 10 8
```

The numbers beside each name correspond to the number of Logo command lines allowed between the three "places" where interventions may occur. If you wish to change the values in the file PRIOR to starting a session, type:

```
EDITFILE "INTER
```

Use the standard editing commands (see Section 7.5 for further information on editing) to change any of the numbers in the student record (OR to create a new record):

e.g., STUDENTNAME x y z where

x = # Logo command lines after "Plan" icon
y = # Logo command lines after "Stop and Think" icon
z = # Logo command lines after "Looking Back" icon

Please note that when a student types "QUIT", the program goes to the "Plan Complete" icon and the program is terminated or restarted at the student's request.

If no student record is found in the INTER file on the /SLOGO/ disk currently in use, DEFAULT VALUES: x = 6, y = 8, z = 8 are used.

When you are finished editing, type: OPEN-APPLE + A to accept the changes (or OPEN-APPLE + ESC to abort).

8.1.2 To change intervention frequencies DURING a session

At any time during Logo use (i.e., at the > prompt) type:

EXP x y z

where x, y, and z are the same three numbers as explained above.

8.2 Prompting Mode

Interventions in this mode are governed by one "global" variable which controls all the rules that determine when an intervention will take place. In general, interventions may take place frequently, infrequently, or somewhere in between. Interventions generally occur if many errors in Logo syntax or execution are made in a short time. Also, if the student goes a long time without a prompt, the teacher is given an audible warning. The teacher may then decide to "force" a prompt for the student which will occur several commands later. The teacher may also request a "pat-on-the-back" prompt for times when all is going well.

A default value for the "global" variable is built into the REFLECT program but may be easily changed during a session to provide more or less frequent interventions than the standard. In order to meet the needs of a particular student, a teacher may also change individual components of the "global" variable. The individual components, and how to change them, are discussed below.

8.2.1 To change intervention frequencies BEFORE a session

It is not possible at this time to easily change the intervention frequencies before a prompting session starts. (Of course, "permanent" changes to the default values can be easily made in the program itself.)

8.2.2 To change intervention frequencies DURING a session

STLVL is the "global" value that controls the maximum time between interventions, the maximum number of errors (in syntax or Logo execution) allowed between interventions, and the time before an intervention will occur after a teacher requests it.

At any time during Logo work (i.e., at the > prompt) type:

STLVL :level

where :level is an intervention "number" from 1 through 5. Generally, lower intervention numbers set more frequent interventions and higher numbers set less frequent interventions. A special case is :level = 99 which effectively turns off all further interventions until QUIT is entered.

The following describes, in some detail, the intervention variables and how they may be individually changed. This section will likely be of interest to the teacher who is already familiar with the REFLECT prompting mode and wants to "fine tune" the intervention timing to more closely match a particular student's needs. Anyone not interested in such modifications may safely skip the remainder of this section.

The default STLVL value is (:level = 1). Other intervention variable defaults are based on :level as described below.

(The current value of all individual variables described here may be changed at will by using the MAKE command at the > prompt.

e.g., MAKE "MAXC 40

Use the variable name from the list below, but replace the : with ".)

The following two variables control the maximum time without an intervention:

:MAXC	:level * 30	-- max. number of commands allowed without an intervention
:INTT	:level * 7 minutes	-- max. time (minutes) without an intervention

Syntax error intervention frequency is controlled by the following two variables:

:SNCM	:level * 8	-- max. number of commands in which prescribed number of syntax errors must occur before an intervention

:SNSY	:level * 3	-- number of syntax errors that will trigger an intervention

(To change both syntax intervention frequency variables at the same time during Logo exploration, type :SETSYN :SNSY :SNCM.)

Execution error intervention frequency is controlled by the following:

:ENCM	:level * 8	-- max. number of commands in which prescribed number of execution errors must occur before an intervention
:ENEX	:level * 3	-- number of execution errors that will trigger an intervention

(To change both execution intervention frequency variables at once, type :SETEXEC :ENEX :ENCM.)

The teacher intervention delay is controlled by:

:TNUM	3 + random (2)	-- number of commands to delay before teacher-requested intervention will occur.

8.2.3 Detailed rules for intervention timing

The REFLECT program has built-in rules about when to intervene. These rules are based on the value of SETLVL and ultimately on the individual variables discussed in the previous section.

The program will intervene if:

1. :SNSY syntax errors occur in :SNCM commands. (A list of possible syntax errors that are recognized is given in Section 8.3.)

2. :ENEX execution errors occur in :ENCM commands. (A list of possible execution errors is given in Section 8.3.)

3. If NO other intervention occurs in :INTT minutes or :MAXC commands, then beep three times to alert teacher. No further action is prescribed, but the teacher may wish to request intervention later (see #4 below).

4. Teacher requests intervention.
   Intervention will occur :TNUM (plus or minus 2) moves after the teacher intervention is requested.

   Type:

   TON
   * (enter password and <RETURN> -- Password = JFN)
   # (enter icon number 1-5, see list below)

(Please note: If the password is incorrect, the icon number will not be requested and NO intervention will be flagged.)

Choose the intervention that you desire by typing in one of the following "icon numbers":

Icon 1 = "Stop and think"
Icon 2 = "Look back"
Icon 3 = "Look ahead"
Icon 4 = "Great ideas" (light bulb)
Icon 5 = "Good plan" (Partially checked-off plan)

==> Any intervention reset counters for all other interventions and gives a "fresh start" for determining when next to intervene.

8.3 Apple Logo II Error List

The following are the errors that are "counted" by the REFLECT program when determining if an intervention needs to take place.

SYNTAX ERRORS:

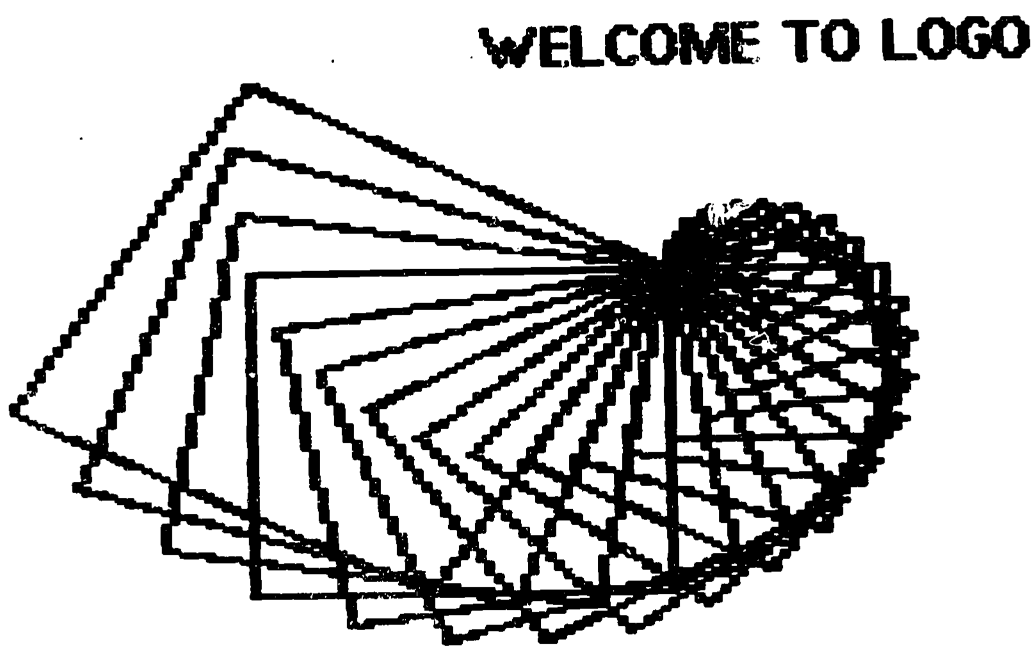
29 NOT ENOUGH INPUTS TO name
30 TOO MANY INPUTS TO name
31 TOO MUCH INSIDE ()'s
33 CAN ONLY DO THAT IN A PROCEDURE
34 TURTLE OUT OF BOUNDS
35 I DON'T KNOW HOW TO name
36 name HAS NO VALUE
37 UNEXPECTED ')'
38 YOU DON'T SAY WHAT TO DO WITH name

EXECUTION ERRORS:

1 name IS ALREADY DEFINED
2 NUMBER IS TOO BIG
6 name IS A PRIMITIVE
9 name IS UNDEFINED
10 name DIDN'T OUTPUT TO name
13 CAN'T DIVIDE BY ZERO
19 TOO FEW ITEMS IN name
24 name CAN'T BE USED
25 name IS NOT TRUE OR FALSE
26 PAUSING...
27 YOU'RE AT TOPLEVEL
41 name DOESN'T LIKE name as INPUT

(FROM: Apple Logo II Reference Manual, Apple Computer Inc., 1982, 1984, p. 251-252.)

9.0 SAMPLE TUTORIAL SESSION




```
?START
Hi, what's your name? PAT
Hi, PAT.
Just a moment please...
```

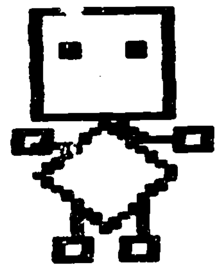
MENU

What shape would you like to make?

0 End this program

1 Square and Triangle
2 Sailboat
3 Happy face
4 Fishing boat
5 House
6 House and car
7 Ert

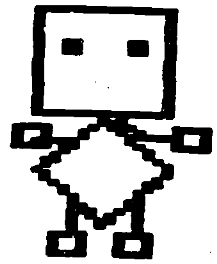
Choose a number?



Press RETURN to select this model, OR
press any other key to choose another.

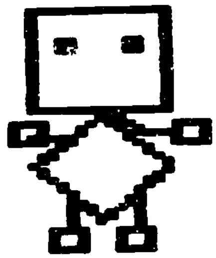
Just a moment please.

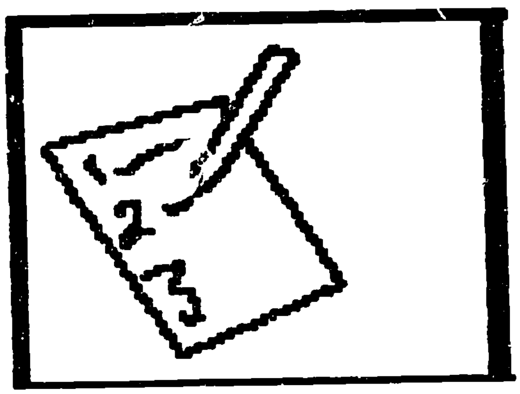
80



This is the drawing you wanted to make.
Think about a picture you may have made
before which might help you now.
(Press RETURN)

Just a moment please...

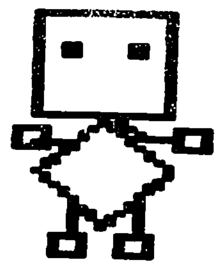


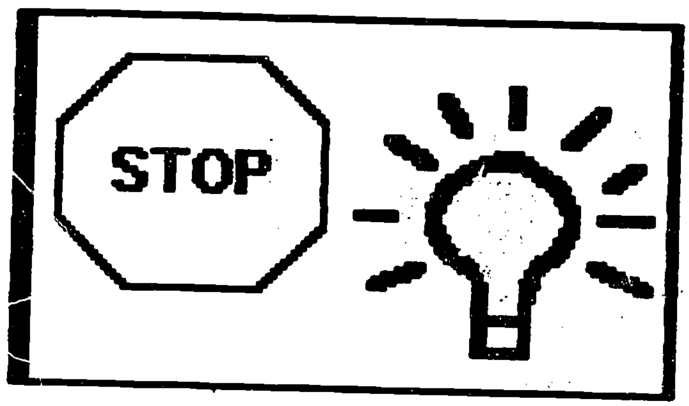


Plan(Press RETURN)

Have you got a plan in mind...
(Yes or No) ? YES

Okay, try out your plan.
(Press RETURN)





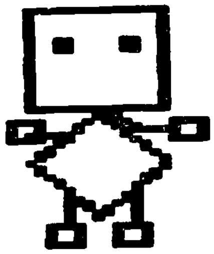
Stop and Think (Press RETURN)

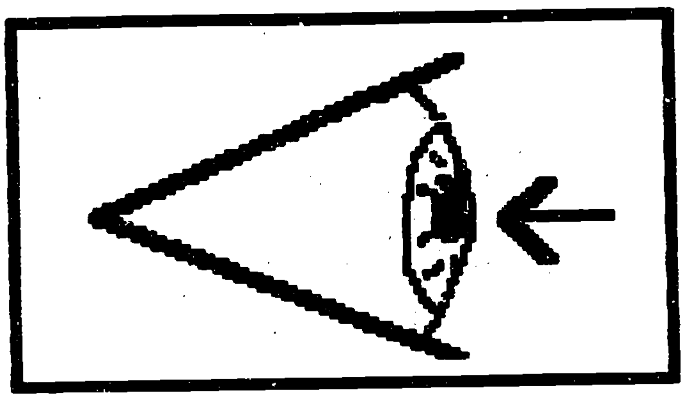
So far, is this what you had in mind?
(Yes or No) ? YES

Good...please carry on, PAT!
(Press RETURN)

You may now try out some Logo commands.

```
>LT 90
>FD 5
>LT 90
>FD 2
>RT 90
>FD 8
>RT 90
```





Look Back (Press RETURN)

Does this follow your plan so far? ...
(Yes or No) ? YES

Great, keep on going!
(Press RETURN)

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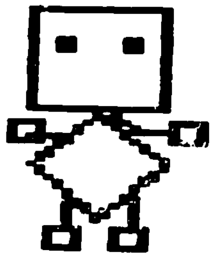
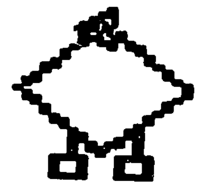
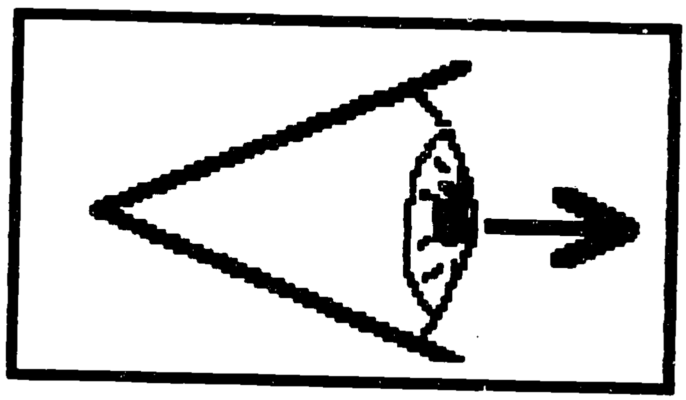
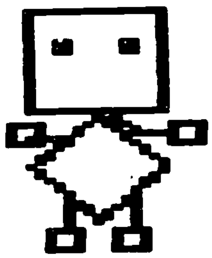


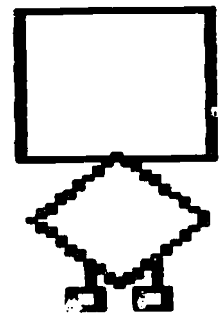


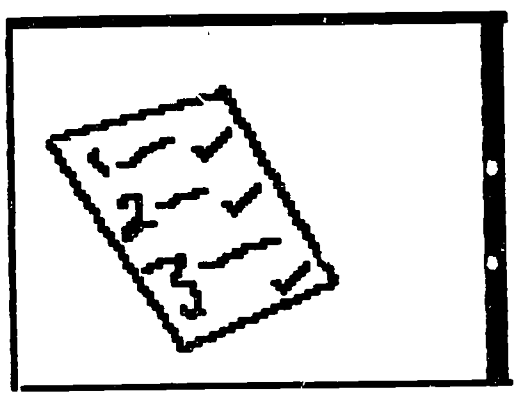


Look Ahead (Press RETURN)

Now think about where you would like
the turtle to be 5 moves from now...
(Press RETURN)







Plan completed (Press RETURN)

Is your plan complete? ...
(Yes or No) ? YES

Congratulations PAT! (Press RETURN)

Would you like to try something else
(Yes or No) ? NO

That's all!

Appendix G

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