Australian Journal of Teacher Education

Volume 23 | Issue 1 Article 2

5-1-1998

An investigation of the decision making strategies of learning disabled (LD) and non disabled (NLD) adult students using information processing theory: Implications for educators.

Alison Fulmer
University of British Columbia

AN INVESTIGATION OF THE DECISION-MAKING STRATEGIES OF LEARNING DISABLED (LD) AND NON-DISABLED (NLD) ADULT STUDENTS USING INFORMATION-PROCESSING THEORY: IMPLICATIONS FOR EDUCATORS

Alison Fulmer

University of British Columbia

ABSTRACT

This study investigated the decision-making strategies of learning disabled (LD) and non-leaming disabled (NLD) adult students using the information-processing model outlined by Kolligian and Stemberg (1987) and process-tracing analysis. As predicted by Kolligian and Sternberg (1987), LD adult students were unable to selectively encode the problem or make selective comparisons and combinations of the dimensions; that is, they did not use "skilled omission". LD adult students searched exhaustively, used more information and demonstrated less variability in their search patterns than their non-disabled peers. These strategies imply the use of compensatory decision models (e.g. additive model in which the dimensions are examined and integrated) which are less cognitively efficient. By contrast, the NLD students employed "skilled omission " and eliminated many aspects of the decision problem. They adopted non-compensatory decision models (e.g. elimination-by-aspects model), which are more cognitively efficient. When task complexity was increased, both groups differentially modified their strategies; however, the NLD students made more adaptations. The results support Kolligian and Sternberg's (1987) information-processing theoretical framework, in particular their componential deficient approach to assessing the cognitive strategies of learning disabled students. Implications for teaching practices and study programs in post-secondary institutions are discussed.

The number of adult students with disabling conditions who attend post-secondary educational institutions has increased dramatically over the past ten to fifteen years. Some of the reasons for the increased interest and enrolment include (a), pressure from self-help and advocacy groups to accept, and accommodate students with special learning needs; (b), awareness of the broadening "social mission' of institutions to provide opportunities for students with disabling conditions: and (c), commitment by government agencies to the integration of disabled adults into the 'mainstream' of society (Wilchesky, 1986). Consequently, many adults with disabling conditions are seeking to further their education and undertake new career directions.

Where as the need to ensure accessibility to further education has been widely recognised, the needs of students with learning disabilities vary considerably, making it difficult for post-secondary institutions to determine and provide a variety of educational programs and instructional strategies to accommodate them (Defur and Taymans, 1995). The purpose of this research is to provide educators with an understanding for the nature of the information-processing strategies used by leaning disabled adult students. It is thought that this knowledge might inform those involved in the teaching-learning process and promote the development of appropriate study skills programs by students counselling services. The research focuses on decision making, a cognitive activity that occurs frequently in everyday life and in the pursuit of academic learning.

Despite a call for research in learning disabilities to focus on decision-making strategies, little is known about how learning disabled (LD) adults make decisions that affect their everyday lives (Palincsar and Brown, 1982). Decision making is a complex cognitive and symbolic activity which "indicates preferences for possible processing activities" (Swanson, 1982, p.320). Swanson has argued that LD students might have difficulty in making decisions because of information-processing problems and use of strategies that "are less than orderly" (Swanson, 1982, p. 313).

Information processing is generally conceptualised as the study of how the individual transforms, reduces or elaborates, organises, stores and retrieves all sensory input (Neisser, 1976; Walisten, 1980). Many researchers have

discussed how LD students process information in ways that are different from their NLD peers (Gerber, 1983; Kolligian and Sternberg, 1987; Swanson, 1982; Willhardt and Sandman, 1988) Some of the differences described include and inability to "actively encode in coming information according to useful classificatory schema" (Rudel, 1980, p. 547); in efficient and ineffective memory strategies; deficiencies in the selection and organisation of information (Seidenberg, 1988); and inflexibility in strategy selection (Pressley, Heisel, McCormick, & Nakamura; 1982; Torgesen and Krail, 1980; Sternberg, 1981; Worden, 1982). Other studies suggest that LD adults scan information less efficiently, continue to search when confronted with contradictory evidence and fail to terminate a thorough and exhaustive search when presented with a negative display (Wilhardt and, Sandman, 1988).

THEORETICAL FRAMEWORK: STERNBERG'S INFORMATION- PROCESSING THEORY

The componential sub-theory of Sternberg (1987) is to differentiate specific patterns of processing deficits in LD students. The sub-theory is comprised of metacomponents, performance components and knowledge-acquisition components. These components are used during intelligent problem-solving behaviour and it is argued that they perform different, but often interrelated, functions (Kolligian and Sternberg, 1987, p. 9). Specific components of Stemberg's theory which apply during decision-making behaviour include the ability to select a way to mentally represent the problem: select a strategy or strategies; allocate resources; and, finally, evaluate the effectiveness of one's efforts. Kolligian and Sternberg (1987) hypothesised that LD students would be less able to "selectively encode, compare, and combine information " than their non-disabled peers (p.8). Coincidentally, these abilities are labelled "skilled omission" by decision theorists and are thought to represent efficient and effective decision-making strategies (Ettenson, Shanteau, and Krogstad, 1987).

The purpose of this research is to investigate the claim by Kolligian and Sternberg (1987) that LD students experience difficulty with the selective encoding, comparing and combining of information during decision making. In other words, it is suggested that LD adults students will be less likely than their NLD peers to use "skilled omission" when making decisions. Before this prediction can be tested we need to understand how infonnation-processing strategies are detected and analysed.

METHODS OF INFORMATION ACQUISITION ANALYSIS IN DECISION MAKING

There are two man methods of tracing how people process information. The first, "verbal protocol analysis", consists of record of the continuous verbal reports provided by the participant, who is required to "think aloud" while carrying out decision task. Researchers have expressed concern about this approach. They suggest that the effort required to generate a verbal report constitutes a secondary task which must be performed in concert with the primary decision task and may slow down the decision sequence to such a substantial extent that it may alter the process (Russo, Johnson, and Stephens, 1985). It can also be argued that to provide a verbal report of their processing strategies might impose an additional burden on LD adult students, because of their reported difficulty with expressive language skills (Swanson, 1982).

The second method of tracing how people process information is called "information acquisition analysis". This method analyses how much information the subject seeks, the sequence in which it is appraised, and for how long it is examined. These procedures are easier to obtain and analyse in a formal manner that are the transcripts obtained from verbal protocols (Russo, 1978). A popular technique for obtaining data through information acquisition analysis has been to present the decision task in matrix format on an information board (see Klayman, 1985; Payne 1976). The search processes adopted by the subject are observed by the researcher and the decision strategies can be inferred from the patterns of research selected. The method is non-technical, interesting to subjects, and easy to understand (Klayman, 1985). These attributes make the information board suitable for use with LD adults students, whose social backgrounds, educational levels, and technological knowledge vary widely.

In studies using the information board, a distinction is made between "high-processing" and "reduced-processing" strategies. High-processing strategies are those in which the maximum amount of information is extracted from the task. This implies that the search is exhaustive; that all available alternatives and dimensions are deemed relevant; that evaluations are quantitative, using a continuous scale of utility; and, finally, that these strategies are compensatory because advantages on one dimension are traded off against disadvantages on another, in accordance with the relative importance of the different dimensions to the subject.

Reduced-processing strategies, on the other hand, yield a decision with less cognitive effort. This is accomplished by employing rules which allow an alternative to be accepted or rejected "at the time", resulting in an incomplete search of the dimensions. In addition, evaluation of the information is usually on a "pass/fail," or "pass/neutral/fail" basis. These strategies imply the use of "skilled omission" because the subject selectively encodes, compares and combines the information during the decision-making task (Ettenson, et al., 1987; Johnson, 1988). The reader will recall that Kolligian and Sternberg (1987) suggested that LD adult students would be less likely to use "skilled omission" or reduced-processing strategies because of deficits in componential skills. The method of describing the decision-making strategies as either high-processing or reduced-processing strategies is used throughout this paper.

Research has established that decision makes who are aware of the effort-accuracy trade off present in tasks are more likely to adopt high-processing strategies when the decision task is more complicated or larger (Klayman, 1985; Payne, 1976). Therefore, in an attempt to determine whether LD adult students make this adjustment to strategy selection (that is, from high-processing to reduced-processing strategies), two levels of task complexity are included in the study.

The present study investigates the information-processing strategies of two groups of adult students during decision making: learning disabled (LD) and non-learning disabled (NLD). In addition, it aims to determine how their strategies are modified as a function of the complexity of the task. The following hypotheses were tested:

I . The decision-making strategies of LD adult students will differ significantly from that of their non-LD peers: that is, LD adult students will be less likely to use "skilled omission" as predicted by Kolligian and Sternberg.

2. LD adult students will be less likely to modify their decision-making strategies when the complexity of the task is increased.

METHOD

Participants

Two groups of adult students participated in the study-learning disabled (LD) and non-learning disabled MD). The LD group consisted of twenty-four adults diagnosed as LD (14 males and 10 females), with a mean age of 25 years. All had completed at least 12 years of formal education and several students had repeated a grade. The LD adult students were randomly selected from those attending a large community college in British Columbia and all had been identified as being learning disabled through psychological and educational assessments administered by college personnel. The Weschler Adult Intelligence Scale was used to determine IQ and reading and mathematics grade levels were assessed using the Wide Range Achievement Tests. A summary of the characteristics of the LD group is presented in Table 1. TABLE 1

Characteristics of the Learning Disabled Adult Students

	Mean	SD
IQ	97	10.27
Reading grade level	7.65	1.78
Mathematics grade level	7.23	1.37

The NLD group of matched controls was selected from the same college and comprised twenty-four adult students (13 males and I I females) with a mean

age of 24 years. Because of funding restrictions it was not possible to determine the IQ, reading and mathematics levels of the NLD adult students.

However, all the NLD students had completed 12 years of formal education, had never repeated a grade at school or college, had never been designated "special needs" nor received remedial assistance in any subject and all were passing their academic courses. Examination of their academic transcripts revealed that they were making satisfactory (at least C+ grades) or average academic progress.

Task

The decision task met the requirements for assessing the skills of subjects with learning disabilities (Swanson, 1982). Swanson recommends that the task have a history in the field of information processing, a theoretical rationale, assess elementary process mechanisms, contain adaptable language requirements, and, finally, relate to real-life performance.

In this study the decision task was the same as that used by Payne (1976) with adult students: the selection of an apartment. A number of factors relating to the task were arranged in matrix form and presented on two information boards, a 4 x 4 board and an 8 x 8 board (see Payne, 1976); for example, on the 8 x 8 board, eight features of apartments (e.g. rent, parking, size, etc.) represented the dimensions and eight apartments (e. g. Apartment I , Apartments 2, ... to Apartments 8) represented the alternatives. The dimensions of the Matrix were arranged by random allocation so that no alternative contained a "best set" of responses.

Procedures

The study was carried out at a large community college in Vancouver over a period of six months. The researcher read to each participant a short hypothetical situation which explained their need to select an apartment. They were instructed to use as many, or as few, cards as they required to enable them to make a decision and to select them in any order. The cards selected then remained turned face up and were available for student use. The dimensions on the information board were rotated to prevent any order effect, as was the order of presentation of the 4 x 4 and 8 x 8 boards.

The decision-making strategies were analysed using four search measures which formed the dependent variables. The first, amount of information searched (AIS), was determined by simply counting the number of cards searched, in this study a possible 16 (4 dimensions by 4 alternatives) or 64 (8 dimensions by 8 alternatives). The second and third dependent variables, variability of search by alternatives (VSA) and dimensions (VSD), were measured by the variability in the standard deviation of the proportion of available alternative and dimensions of a given set. It has been established (see Klayman, 1985; Payne, 1976) that decision makers using high-processing strategies search exactly the same amount of information on each alternative or dimension, so the variability is zero. Reduced-processing strategies include some method by which various alternatives and dimensions are eliminated after different amounts of search, so by the time a decision is reached, there will have been a variable e amount of information searched per alternative and dimension. Ile fourth dependent variable, direction of search (DS), yields information which is useful in distinguishing among individual search strategies. Some decision strategies are based on an altemative-by-altemative search (e.g. additive model) while others are primarily dimension-by-dimension (e.g. additive-difference). It is possible to distinguish strategies according to their predominant direction. Payne (1976) suggests such a measure: a score of + 1.0 represents a strictly alternatives-wise search and a score of - 1.0 represents a strictly dimension-wise search. The formula for computing the score is (Same A - Same D divided by Same A + Same D). The result distinguishes an over all tendency toward searching in one direction or the other.

The search processes used by participants were recorded by the researcher on a grid which matched the information board presented and the decision strategies determined according to the methods outlined.

RESULTS

Throughout the analyses of the data, $p < .05$ was set as the level of statistical significance. To test the first research hypothesis (that the decision strategies of LD and NLD adult students are significantly different-that is, LD students are

less likely to use skilled omission that their ~~D peers), a MANOVA was performed. The amount of information searched (AIS), variability of search by alternatives (VSA), variability of search by dimensions (VSD) and direction of search (DS) were the dependent variables and category of students (LD and NLD) was the independent variable. The result was a statistically significant main effect for category of students in discriminating between participants' decision-making strategies, F(l, 46) = 17.0l,p <.001. Table 2 reports the means and standard deviations of the two groups of participants (LD and NLD) at the two levels of task complexity.

The univariate test for each of the dependent variables, amount of information searched (AIS), variability of search (VSA & VSD) and direction of search, are reported below.

TABLE2
Sample Means and Standard Deviations (SD) by Category and Level of Task Complexity for Each Dependent Variable (N=48).

1. Amount of Information Searched (AIS)		
Category	*Task 1(4x4)*	*Task 2 (8x8)*
Mean LD	15.00 (1.76)	56.37 (11.05)
Non-LD	12.96 (2.94)	42.87 (12.94)
2. Variability by Alternatives (VSA)		
Mean LD	0.06(0.10)	0.13(0.17)
Non-LD	0.17(0.15)	0.27(0.14)
3. Variability by Dimensions (VSA)		
Mean LD	0.06(0.10)	0.13(0.14)
Non-LD	0.15(0.13)	0.24(0.12)
4. Direction of Search (DS)		
Mean LD	0.30(0.94)	-0.04 (0.99)
Non-LD	-0.48 (0.63)	-0.61 (0.64)

DEPENDENT VARIABLES

1. Amount of Information Searched (AIS)

The result of the univariate tests of the amount of information searched and category of students at the two levels of task complexity were statistically significant for AIS Task 1 *(4 x 4), F(l, 46) = 8.49,* p <. 01 and for AIS Task 2 *(8 x 8), F(1, 46) = 15.10, p <, 001).* Figure I shows that the LD students used more information than did their NLD peers. A similar result was obtained for Task 2. LD adult students made an exhaustive search of the decision problem, a pattern typical of compensatory decision models such as the additive model, and less cognitively efficient.

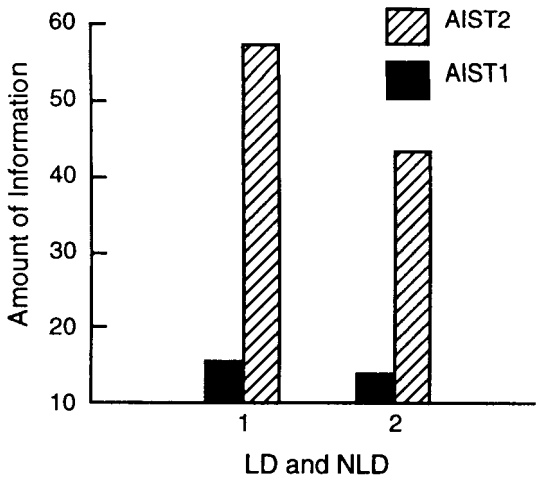

Fig. 1: Amount of Information Searched

2. Variability of Search by Alternatives (VSA)

The results of the univariate tests for VSA Task 1*(4 x 4)* were statistically significant, F(l, *46) = 8.97, p <. 01.* LD students demonstrated less variability in their search of the

alternatives than did the NLD participants (see Fig. 2). A similar result was obtained for Task 2.

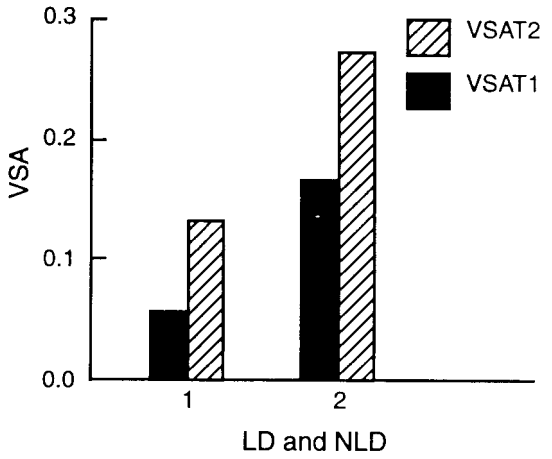

Fig. 2: Variability of Search by Alternatives

3. Variability of Search by Dimensions (VSD)

The results of the univariate tests for VSD Task 1. and 2 were statistically significant, *F(l, 46)* = 7.52, p <. 01, respectively. LD students demonstrated less variability than did their NLD counterparts (see Fig. 3).

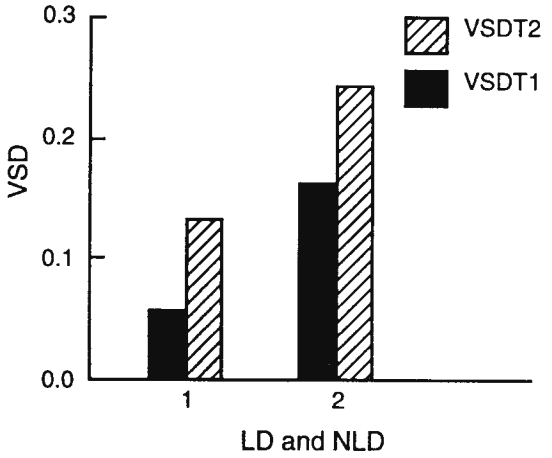

Fig. 3: Variability of Search by Dimensions

4. Direction of search (DS)

The results of the univariate tests of DS Task I and 2 were statistically significant, *F (1, 46) = 10.89, p*<. 01 and *F (1, 46)* = 5.57, p <. 05, respectively. In Task 1, the LD students were more likely to direct their search through the alternatives of the decision problem (Mean = + 0.30), whereas the NLD students searched via the dimensions (Mean = - 0.48). It will be recalled that a positive sign indicates an alternative- wise search and a negative sign a dimension-wise search (see Fig. 4).

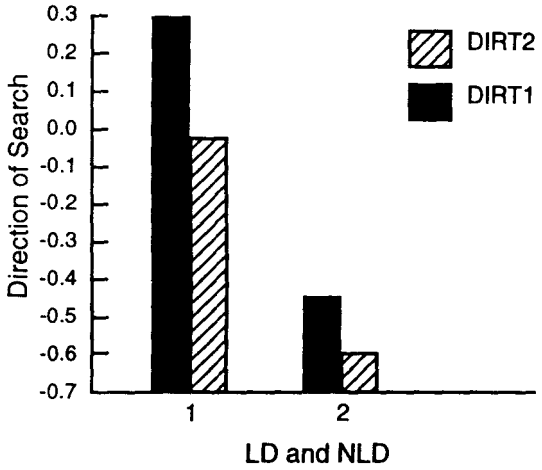

Fig. 4: Direction of Search

LD adult students did not use skilled omission: that is, as a group they did not selectively encode, compare and combine the information. They used more information and demonstrated less variability in their patterns of search than did their NLD peers.

To test the second research hypothesis-that LD adult students are less able to modify their decision-making strategies when task complexity is increased, a MANOVA was performed. T-he results were statistically significant, *F* (3, 44) = 6. 10, p <.001 for the 4 x 4 task and *F* (3, 44) = 12.83, p <.001 for the 8 x 8 task. In addition, a statistically significant interaction effect was obtained for category and task complexity *F* (3, 44) = 4.43, p <. 01 (see Table 3).

TABLE 3 Effect of Category of Students (LD and Non -LD) of Decision-making Strategies at Two Levels of Task Complexity (4 x 4 and 8 x 8) (N = 48).

Source of Variation	df	f	p
Between Subjects LD/Non-LD	1	17.01	0.000**
Within subjects	3	6.10	0.001
4x4 Task			
8x8 Task	3	12.83	0.001

Category x Task Interaction	3	4.43	0.01

**p=<.001

*p=<.01

Participants in both groups differentially modified their decision strategies; however, the LD students made fewer modifications than their NLD peers. When confronted with the more complex task, a small number of LD students changed the direction of their search to a dimension-wise pattern. NLD students continued to select a dimension-wise pattern, searched even less information and demonstrated more variability in their patterns of search.

DISCUSSION

This study investigated the information-processing strategies used by learning-disabled adult during a decision-making task and compared them with those of their non-disabled peers. The findings permit a categorical conclusion: The decision-making strategies of LD and NLD adult students are different. As predicted by Kolligian and Sternberg (1987), the LD adult students were less likely to selectively encode the problem and make selective comparisons and combinations of the information: that is, they did not use "skilled omission" (Ettenson et al., 1987; Johnson, 1988). They failed to terminate their exhaustive search patterns, even when presented with unsatisfactory or negative information, a result which supports the findings of Wilhardt and, Sandman (1988). In addition, their search strategies could be described as limited and inflexible (Pressley et al., 1982).

As a group, the LD students selected compensatory decision strategies in which all the dimensions and alternatives of the problem are searched exhaustively (e.g., additive decision model). Compensatory decision strategies are less cognitively efficient and place the decision maker in a difficult position at the conclusion of the search because all the information has to be combined to make a decision. Many of the LD students were overwhelmed by the amount of information they had accumulated and some expressed frustration.

By contrast, the NLD students searched less information, demonstrated more variability in their patterns of search and adopted non-compensatory decision models; that is, they used "skilled omission". Non-compensatory decision models (e.g., elimination- by-aspects) require the participant to selectively encode the information prior to commencement of the task, to prioritise the dimensions of the problem, and to eliminate those features which do not meet requirements. These strategies are more cognitively efficient.

Differences in the decision-making strategies of the two groups of adult students were also found to result from an increase in the complexity of the task, a finding which supports earlier studies (Fulmer, 1997; Klayman, 1985; Payne, 1976). Both groups differentially modified their decision strategies as the task became more complex; however, the LD group made fewer adaptations, used more information and demonstrated less variability in search patterns. When confronted with the more complex task, some of the LD students modified the direction of their search.

However, as a group, the LD students were less able to construct strategy at the point of application, n when task complexity was increased. This finding supports Bettman (1979), who argued that LD students often found it difficult to construct a more effective strategy when confronted with a more complex problem to solve.

IMPLICATIONS FOR EDUCATORS

The findings from this research support the prediction by Kolligian and Sternberg (1987) that componential deficits are present in many LD students. LD students appears to lack some of the skills described as performance components (Kolligian and Sternberg, 1987). They are less able to use information to infer relationships and to vary their strategies. In short, they find it difficult to "actively encode incoming information according to any classificatory scheme "(Rudel, 1980, p. 547). LD students also experience problems when required to plan and monitor their performance during decision making and appear unable to

"coordinate, direct and organise search strategies" (Swanson, 1982, p.320).

These findings have implications for teaching practice and the development of appropriate study skills programs. LD students will need help to use more cognitively efficient and effective information-processing strategies: that is, to develop cognitive competence. In education, the field of instructional psychology (Glaser, 1982) actively promotes cognitive competence, usually conceptualised as engineering the transition between learners' current skill states and that desired by educators. This emphasis on teaching thinking skills has focused on low people think rather than on what they know. Focal topics have included the intuitive understanding of physical concepts, such as movement (e.g., McCloskey, Caramazza, and Green, 1980), energy (Solomone, 1983); of statistical concepts, such as mathematical average (Strauss and Bichler, 1988); of biological concepts, such as natural selection (Brumby, 1988); and of deductive reasoning (e.g. Evans, 1983). In each case, the goal has been to identify cognitive deficiencies that might be corrected through instruction. This concern for intuitive thought processes reflects a belief that education must consider where the learner is coming from cognitively, as well as where it wants them to be.

To develop appropriate curricula in the area of study skills programs, counsellors might include information and activities from the "Personal Decision Making" program developed by Ross (198 1). He conceives of the decision process as involving six steps: (a), encoding the problem; (b), identifying a set of alternative courses of action; (c), evaluating alternatives by these criteria; (d), identifying appropriate criteria; (e), summarizing information about alternatives and (f) self-evaluation. The program is based on an explicit descriptive history of how untrained individuals learn to approximate the skills used by sophisticated decision makers. His course of study offers a sequence of exercise for traversing these steps. Two examples illustrate the application of these skills to post- secondary education. In the area of English literature, students might study the decision made by characters in fiction or essays in which the steps in the program can be applied and alternative courses of action fairly considered. In educational psychology, the study skills program could aim to develop in students the ability to identify appropriate criteria with which to evaluate alternative models of teaching or compare theories of development and learning. Other examples of programs developed for children and adolescents are provided by Baron and Brown (1991) and Bergmann and Rudman (1985). Authors Bergmann and Rudman (1985) offer a curriculum which stresses eight steps in the process of making decisions. The eight steps include: (a), problem finding; (b), problem defining; (c), information gathering; (d), information prioritising; (e), values assessment; (f), alternatives and consequences; (g), action; and (h), evaluation. A complete description of the skills involved in the accomplishment of each step is outlined in the text and examples for practice are included. Indeed, in a review of the approaches and programs that teach students how to think and make decisions, Nickerson, Perkins, and Smith (1985) held that focus on basic cognitive skills, including problem-solving strategies, systematic approaches to organisation and time-management, procedures for completing assignments and examinations was essential to promote intellectual competence. To summarise, without specific help in "learning how to learn", many students with learning disabilities may find it difficult to achieve in post-secondary courses of study.

LIMITATIONS OF THE STUDY AND IMPLICATIONS FOR FUTURE RESEARCH

This study has a number of limitations. The sample of LD adult students was small, making it difficult to generalise the results. Research using larger sample sizes and a wider variety of decision problems is needed to confirm the findings of this study. In addition, it was not possible to match participants in the two groups according to IQ.

Whereas the decision task used in this research met the requirements outlined by Swanson (1982) for assessing the abilities of learning-disabled students, it was, nevertheless, hypothetical, in that students were not actually selecting an apartment in which they would live. However, the results provide support for the application of Kolligian and Stemberg's componential deficit model (1987) to study of

why and how the information processing strategies of learning-disabled students differ from their non-learning disabled peers. The results of this study raise several important issues which have implications for research, teaching practices and policy development, including the need for further information about the information-processing strategies of LD students; the teaching-learning process; the development of appropriate study skills program; and the initiation of policy to support students with special needs. The progress we make in accommodating persons with learning disabilities in post-secondary institutions will be dependent in part, on our ability to address these issues.

REFERENCES

Baron, J. and Brown, R. (199 1). *Teaching Decision Making to adolescents.* Hillsdale NJ; Lawrence Eribaum Associates.

Bergmann, S. and Rudman, G. (1985). *Decision*

Making Skills for Middle School Students. National Education Association of the United States. Washington, DC; NEA Professional Library.

Bettman, J.R. (1979). *An information–processing theory of consumer choice.* Reading, MA; Addison-Wesley.

Brumby, M.N. (1984). Misconceptions about the concepts of natural selection by medical biology students. *Science Education 68* (4(, 493-503.

Einhorn, H.J. and Hogarth, R.M. (1981). Behavioural decision theory; Process of judgement and choice. *Annual Review of Psychology. 32,* 5388.

Ettenson, R., Shanteau, J. and Krogstad, J. (1987). Expert judgement: Is more information better? *Psychological Reports, 60, 227-238.*

Evans, J. St. B.T. (1983). *The Pyschology of Deductive Thinking.* London: Routledge and Kegan Paul.

Fulmer, K.A. (1997). Use of a developmental theory of parental cognition to construct a model of parental decision-making strategies. *Child and Youth Care Forum,* 26,6,391-409.

Gerber, M.M. (1983). Learning disabilities and cognitive strategies: A case for training or constraining problem solving? *Journal of Learning Disabilities, 16, 255-260.*

Glaser, R. (1982). Instructional psychology: Past, present and future. *American Psychologist,* 37, 292-305.

Johnson, E.J. (1988). Expertise and decision under uncertainty: Performance and process. In M.TH. Chi, R. Glasser, and M. Farr (eds), *The Nature of Expertise.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Klayman, J. (1985). Children's decision strategies and their adaptation to task characteristics. Organizational Behaviour and Human Decision *Processes.* 35, 179-201.

Kolligian, J. Jr. and Sternberg, R. (1987). Intelligence, information processing and specific learning disabilities: A triarchic synthesis. *Journal of Learning Disabilities,* 20, 1, 8-17.

Lockhead, J. and Clement, J. (Eds.). (1979). *Cognitive process instruction.* Philadelphia: Franklin Institute Press.

McCloskey, M., Carramazza, A. and Green, B. (1980). Curvilinear motion in the absence of external forces: Naive beliefs about the motion of objects. *Science,* 210, 1139-1141.

Neiser, C. (1976). *Cognition and reality.* San Francisco: Freeman.

Nickerson, R.S., Perkins, D. N. and Smith, E.E. (1985). *The teaching of thinking.* Hillsdale, NJ: Lawerence Eribaum Associates.

Palincsar, A. and Brown, A.L. (1987). Enhancing instructional time through attention to metacognition. *Journal of Learning Disabilities,* 20, 2, 66-75.

Payne, J.W. (1976). Task complexity and contingent processing in decision making: An information search and protocol analysis. Organizational Behaviour and *Human Performance,* 16, 366-387.

Payne, J.W. (1982). Contingent decision behaviour. *Psychological Bulletin,* 92, 2, 382-402.

Pressley, M., Heise], B. E., McCormick, C.B. and Nakamura, G.V. (1982). Memory strategy instruction. In C.J. Brainerd and M. Pressley (eds), Verbal processes in children: *Progress in cognitive development research. (Vol.* 2, pp. 125-159). New York: Springer-Veriag.

Ross, J.A. (1981 a). Improving adolescent decision-making skills. *Curriculum Inquiry* 11(3),279-295.

Rudel, R.G. (19 80). Learning disability: Diagnosis by exclusion. *Journal of the American Academy of Child Psychiatry,* 19, 547-549.

Russo, J.E., Johnson, E.J. and Stephens, D.L. (1985). *When are Verbal Protocols Valid ?* Unpublished working paper. Cornell University.

Seidenberg, P.L. (1988). Cognitive and academic instructional intervention for learning disable adolescents. Topics *in Language Disorders,* 8, 5671.

Shaklee, H. and Fischoff, B. (1982). Strategies of information search in casual analysis. *Memory and Cognition, 10,* 529-530.

Sternberg, R.J. (1991). Testing and cognitive psychology. *American Psychologist,* 36, 11811189.

Strauss, S. and Bichler, E. (1988). The development of concepts of arithmetic average. Journal of Research in Mathematics Education, 19,64-80.

Swanson, H.L. (1982). A multidirectional model for assessing learning students' intelligence: An information-processing framework. *Learning Disability Quarterly,* 5, 312-326.

Swanson, 1. (1987). Information processing theory and learning disabilities: A commentary and future perspective. *Journal of Learning Disabilities,* 20, 3, 155-166.

Taylor, R.N. (1984). *Behavioural decision making.* Glenview, III: Scott, Foresman.

Torgeson, J.K. and Kahil, R.J., Jr. (1980). Memory processes in exceptional children. In B.K. Keogh (ed.), *Advances in special education: Basic constructs and theoretical orientations (Vol. 1, pp.* 16-19). Greenwich, CT: JAI Press.

Walisten, T.S. (Ed.). (1980). *Cognitive process in choice and decision behaviour* Hillsdale, NJ: Lawrence Erlbaum Associates,

Willhardt, L. and Sandman, C.A. (1988). Performance of nondisabled adults and adults with learning disabilities on a computerized multiphasic cognitive memory battery. *Journal of Learning Disabilities,* 21, 3, 179-185.

Worden, P.E. (1983). Memory strategy instruction with the learning disabled. In M. Pressley and J.R. Levin (eds), *Cognitive strategy research: Psychological foundations (pp.* 129-153). New York: Springer-Verlag.