Implicit and Direct Inference of Artificial Language Rules in Depressed and Non-Depressed Individuals

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Running Head: DEPRESSION AND RULE INFERENCE

Abstract

The hypothesis that depressives are better implicit learners than non-depressives was tested. Forty subjects were assigned to depressed and non-depressed groups using the Beck Depression Inventory. Strings of letters formed by a complex rule system were used to test for the presence of rule learning. Half of each group was given explicit learning instructions on the rule induction task; consequently, the other half was given instructions to memorize stimulus items only, thus inducing implicit learning. Results show an overall main effect of instructions but no significant distinction could be made between depressed and non-depressed groups. The theoretical basis of implicit learning strategies as a possible causal element of depression within the context of Learned Helplessness/Hopelessness theories was discussed.

Inference of Artificial Language Rules in Depressed and Non-depressed Individuals

Depression is a cognitive affective disorder that effects almost twenty percent of North Americans at some time in their lives (Bootzin & Acocella, 1988). However, depression is not always easy to define for different individuals can show different symptomatic manifestations. Also, depression can range in degree, from mild to severe (Beck, 1967).

Depression is often revealed through expressed feelings of sadness, pessimism, failure, and guilt. Also depressives can be irritable, socially withdrawn, indecisive, and lacking in self-esteem. Beck (1967) used these and other factored characteristics to test for the presence of depression in the Beck Depression Inventory. From clinical observations, he diagnosed depressives as having essentially negative and unrealistic beliefs and perceptions of themselves and reality.

From a cognitive perspective, Beck's (1967) Schema theory of depression viewed depression as a negatively biased perception filter that magnified negative experiences and diminished positive experiences. Beck saw depressive schemata as forming out of traumatic negative experiences and subsequently being triggered

by stressful situations. It was the perceptual distortions of depression that seemed to give rise to all behavioral, motivational and affective symptoms.

One particular area of research that led to further theories dealing with the cognitive aspects of depression was the study of learned helplessness. Seligman (1975) formed a new theory of depression based on his previous work on learned helplessness in dogs (Mairer, Seligman & Solomon, 1969). Basically, learned helplessness is a conditioned state stemming from experiences of uncontrollable situations which leads to expectations that future situations will also be uncontrollable. Depression, therefore, was seen as a human cognitive parallel to non-human learned helplessness behavior. That is, when the dogs experienced uncontrollable (vis. non-contingent) aversive events, they were later unable to learn any avoidance responses due to learned helplessness. Humans who experienced non-contingent aversive events were expected to become depressed.

Abramson, Seligman and Teasdale (1978) revised the original learned helplessness theory of depression, taking another established psychological theory, namely attribution theory, into account. According to attribution theory one seeks to identify causes for

events in order to facilitate future prediction and control (Perlman & Cosby, 1983). When one experiences an uncontrollable event the cause can be attributed either to the specific situational variables or to one's own abilities. According to the revised learned helplessness theory, if the lack of control of a given situation is attributed to internal factors then self esteem is lowered as are expectancies that future events will be controllable. If lack of control is attributed to external factors then there is no effect with respect to depression.

Following along the same lines, hopelessness theory (Abramson, Alloy and Metalsky, 1989) was yet a further revision of the revised learned helplessness model. The basic premise that learned helplessness played a causal role in depressive cognition was retained, as well as the constructs from attribution theory. Hopelessness theory, by taking several other factors into account, sought to outline a causal chain of events that could lead to depression via learned helplessness.

Hopelessness depression was outlined as being a subset of the learned helplessness model of depression in which causes for perceived uncontrollable events must be attributed to internal, stable, and global

characteristics. Attributing internal causes to negative life events accounted for low self esteem. Attributing stable internal causes allowed for generalization across situations past and present. Attributing global causes accounted for the distinctiveness of the perceived situation in one's life. Learned helplessness was definitely a component of the new theory but only when the attributional categories of consensus, consistency and distinctiveness were seen as internal, stable and distinctive, respectively, does learned hopelessness develop (Abramson et al., 1989).

The learned hopelessness theory took diathesis stress into account by postulating that people can be physiologically predetermined towards depressive attributional style, but that the same causal chain of perceptions followed by the outlined attributions is necessary for depression to ensue.

Another factor included in hopelessness theory is that of "specific vulnerability". Psychiatric observations have revealed two subtypes of depression whereby one stems from aversive life achievement events such as getting fired from a job, and the other stems from negative experiences in personal relationships. It is maintained by hopelessness theory that one must

perceive negative events from the context to which one is predisposed, be it negative
events or relationships for depression to follow.

It has been held by original schema based theorists (eg. Beck, 1967) that those suffering from depression are subject to cognitive distortions that do not affect non-depressed people. Such a view was effective in explaining many of the observed qualities of depressed individuals but recent research, typified by Alloy and Abramson (1979, 1981) contests the opinion that negative cognitive distortions are the at the root of the depressive's outlook.

Although Schema and Learned Helplessness theory would have predicted otherwise, research by Abramson and Alloy (1979) indicated that depressed individuals did not show expected biases for a judgement of contingency task. In this task subjects reported the level of contingency between pressing a button and the onset of a light. The light did not always come on when the button was pressed since the actual contingency was computer controlled. When positive feedback, in this case money, was given non-depressed subjects would overestimate the contingency. When feedback was negative (i.e. money taken away) they would underestimate the contingency, thus showing a

self-serving bias.

Depressed subjects were found to report contingencies that were closest to the true values regardless of the feedback condition (Abramson and Alloy 1979). Their findings were in conflict with existing cognitive models of depression such as Beck's schema theory and Abramson, Seligman and Teasdale's revised Learned Helplessness theory. These predicted that depressives, operating with biases that negatively color cognitions, should underestimate contingencies that resulted in positive feedback. They found, however, that depressives made accurate assessments regardless of feedback conditions.

According to Schwartz (1981), the judgement of contingency task for depressed and non-depressed subjects involved confounds related to complex rule induction. In an effort to account for Abramson and Alloy's (1979) findings in terms of learned helplessness theory, Schwartz proposed that depressives are really inducing the contingency rule implicitly. This view would be in accordance with motivational deficits accounted for by Learned Helplessness theory (Seligman, 1975)(Abramson et al., 1978).

It has been shown by Reber (1967) that when people explicitly try to induce a complex rule from a limited

set of instances they are not as successful as those who approach the problem indirectly, as in a memory task for example (as cited in Schwartz, 1981). Schwartz proposed that depressives are not actively involved in trying to identify the contingencies in the experiments by Abramson et al. (1979), and so he does not attribute their accuracy to lack of cognitive bias but to the effect of indirect rule induction.

In fact, Schwartz points out that "in the Reber situation, they (depressives) will be equally good at inducing rules whether or not they know that rule discovery is the point of the task." (Schwartz, 1981, pg. 433). Therefore, Schwartz saw a difference in depressed and non-depressed cognitions not at the point of the attributions following the perception of non-contingency but with contingency perceptions themselves.

Alloy and Abramson (1979) postulated depressive realism as being the lack of cognitive biases otherwise functioning with non-depressives. Schwartz (1981) accounted for the findings by assuming that depressives did not actively process the information given during the judgement of contingency task and so were not susceptible to any cognitive biases that would otherwise develop as a result of forming hypotheses of

rules from a limited set of examples. Given these two interpretations for the findings of the judgement of contingency study by Alloy and Abramson (1979), it may be asked which interpretation is actual. Furthermore, it can be asked which interpretation is more applicable in terms of the necessary perception of non-contingency, which is the first step in the causal chain of depression proposed by learned hopelessness theory.

The assumption made by Schwartz (1981) that depressives will always engage in implicit learning as opposed to active processing regardless of the point of any given task has never been tested explicitly. Using the paradigm for testing implicit learning, as outlined by Reber (1976), depressives could be compared to non-depressives to see if Schwartz's (1981) hypothesis would hold true.

If Schwartz' hypothesis were true then the findings of Reber (1976) should be replicated only for the non-depressed subjects. The depressed subjects would be expected show accurate rule induction in both instructional conditions, which would be expected if only implicit learning were occurring. If this were the case then both learned helplessness and learned hopelessness theories would need to be revised in terms

of at the point at which, in their proposed causal chain, there are differences between depressed and non-depressed cognitions.

In order to gain further insight into these differing interpretations, this study tested the assumption made by Schwartz (1981) that depressives will always engage in implicit learning as opposed to active processing regardless of the point of any given task. Using the paradigm for testing implicit learning, as outlined by Reber (1976), depressives were compared to non-depressives to see if Schwartz's (1981) hypothesis would hold true.

Both depressed and non-depressed subjects were asked to reproduce a list of strings (synthetic "words"), presented three at a time, under the guise of a memorization task. One group was told only that there would be an unspecified memory task to follow. The other group was told of the unspecified memory task but was also be told to try to infer the rule which applied to the string formation in order to aid memorization. Later a list of valid and invalid synthetic words were be presented for identification. The findings of Reber (1976) should have been replicated only for the non-depressed subjects. The depressed subjects were expected show accurate rule

induction in both instructional conditions, which would be expected if only implicit learning were occurring.

The paradigm used here demanded mostly short term memory scanning and so depressive memory deficits were not expected to be too great. This would be in accordance to similar findings of Koh and Wolpert (1983) (as cited in Johnson and Magaro, 1987). Also, the absence of severe depression, as would be expected in the subject population defined for this study, should help reduce any memory deficit problems (Johnson and Magaro, 1987).

It is hypothesised that non-depressed subjects given only memorization instructions will perform better on the rule inference task than those given explicit rule induction plus memory instructions. Accordingly, depressed subjects will show high performance in either of the instructional conditions. In other words, depressed subjects will show implicit learning behaviour in either condition but the non-depressives will show such behaviour only when instructed to do so.

The subject variable in this experiment is the presence or absence of depression. The manipulated variable is the instructions given, either to memorize or to memorize and explicitly find the rule of the

synthetic language. The measured variable is the number of correct identifications made of valid synthetic "words" and of invalid synthetic "words".

Method

Subjects

A total of 71 undergraduate students at Algoma University College volunteered to participated in the study. The Beck Depression Inventory (Beck, 1967) was administered to all subjects to measure level of depression in order to assign subjects to depressed and non-depressed groups.

From those tested, 20 of the highest scoring subjects were chosen for the depressed group. None of these subjects scored below 12 on the Beck Depression Inventory. Twenty of the lowest scoring subjects were chosen for the non-depressed group and none of these subjects scored over 7 on the same pretest.

Half of subjects in each of the depressed and non-depressed conditions were randomly assigned to the explicit learning group. The remaining half in each condition were assigned to the implicit learning group

Anonymity was preserved by randomly assigning identification numbers to each subject. A confederate assigned subjects to groups so that the experimenter remained blind to the depression scores of the

subjects. Anonymity was preserved in all further data exchanges by the same procedure.

Following the experiment, subjects were debriefed as to the purpose and findings of the experiment and were asked not to discuss the procedures with anyone until all subjects had been run.

Materials

The Beck Depression Inventory (Beck, 1967) was used to measure level of depression.

A synthetic language was used that was composed of strings of letters that corresponded to the specific rule pattern as outlined by Reber (1976).

Insert Figure 1 here

All synthetic "words" used were derived by following the paths through figure 1, above, choosing the appropriate letter according to the path taken. The minimum number of letters per derived string was 3 and a maximum of 8 letters were allowed. This procedure resulted in 43 possible combinations of letters.

Also 22 strings of letters which resembled but did not correspond to the rule patterned strings were used for testing procedures. Four of these strings were

formed by randomly generating strings of 3 to 8 letters using the same consonants as the actual strings, disallowing any strings which might by chance correspond to the synthetic language. The remaining incorrect strings corresponded to the correct ones except for one letter which was altered at random, being replaced with one of the four remaining consonants.

Procedure

All subjects completed the Beck Depression Inventory. The inventory was read to subjects who then recorded their responses anonymously on an answer sheet.

Subjects assigned to the memorization only group were given the following instructions:

> This is a simple memory experiment. You will see items made up of the letters P S T V X. They will run from three to eight letters in length and will be shown to you in groups of three. After seeing each set of three items I will give you a card and your task will be to try to reproduce all three items. After you have reproduced all three correctly two times in a row we will go on to a new set of three items. (Reber, 1976)

The instructions for the explicit rule induction group were the same as above with the addition of the following:

> The order of letters in each item is determined by a rather complex set of rules. The rules only allow certain letters to follow other letters. Since the task involves memorization of a large number of these complex strings of letters, it will be to your advantage if you can figure out what the rules are, which letters may follow other letters and which may not. Such knowledge will certainly help you to learn and memorize the items. (Reber, 1976)

All subjects were given a list of 15 strings which followed the rules of the synthetic language. The strings were presented in sets of three for a period of five seconds per string. Subjects were required to recall each set of strings on a piece of paper and were given as much time as needed to do so. String sets were presented as many times as needed for the subjects to reproduce each set correctly two times in a row. The order of presentation of each of the sets was randomized for each subject.

The number of exposures to each of the string sets was recorded to check for possible learning deficits

for depressives as well as the possible effect of increased exposures to the stimuli on identification.

Twenty-two of the remaining "grammatically" correct items were selected as well as 22 items that were "grammatically" incorrect. All subjects were tested by showing all of the items twice. Subjects in the memorization only group were informed of the rule structure of the strings and all subjects reported which strings were grammatically correct and which are incorrect. No time limit was imposed during this phase.

Results

An analysis of variance (ANOVA) was performed on the data of the four different groups. The groups did not differ significantly from each other, $F = .99$ $p = 0.4086$. That is to say there were no differences between instructional groups regardless of depressed or non-depressed conditions. The means of each group are plotted in figure 2.

Insert Figure 2 here

It must be noted that by pooling the data for the depressed and non-depressed groups the effect of instructions on rule identification became evident. A

studentized t-test comparing the means of each instructional group to expected chance means showed that those given implicit learning instructions (memorization only) did perform better than chance $x = 48.25$, $sd = 8.7$, $t = 2.19$ $p < 0.025$. The explicit instruction group did not perform significantly better than chance $x = 52.25$, $sd = 10.5$ $p > .10$.

Learning curves showed that depressives took more trials to criterion than non-depressives, $t = 22.04$ $p < .01$. This apparently had no effect on rule identification. The means for the learning curves for the depressed and non-depressed groups are plotted in figure 3.

Insert Figure 3 here

Discussion

In order to draw conclusions according to the hypothesis of this paper, there would have to have been significant differences between the depressed and non-depressed groups with respect to rule learning. If results had turned out as hypothesised by Schwartz (1981), depressives would have always scored better than chance and non-depressives would have scored better than chance only in the implicit learning

condition as seen in figure 4.

Insert Figure 4 here

Experimental results showed that depressed and non-depressed subjects in both instructional conditions scored only according to chance. Assuming that the non-depressed subjects were of the same general population as in Reber's (1976) study, then the effects of instructions should have been evident. It was only when the results for depressed and non-depressed subjects were pooled that the instructional effect was seen. These findings suggest that the effects of the manipulation and testing were too weak to prove or disprove the hypothesis of this paper.

The fact that the four experimental groups centered around the expected level due to chance may suggest that the testing procedure used was too difficult, so the discriminability necessary to distinguish between the instructional groups may have been reduced. Even though there were differences in learning curves for depressed and non-depressed subjects, there was no difference in performance. It may well be that there are no differences between depressed and non-depressed individuals with respect to

implicit or explicit rule learning, but the data from this experiment failed to confirm or disconfirm this proposition.

Therefore, the hypothesis put forth by Schwartz (1981), that depressives are capable only of implicit learning was neither confirmed nor denied. In order to avoid this problem in the future, any further research will have to ensure proper discriminability in any test used to measure rule learning.

Had the results shown that there were no differences at all between depressed and non-depressed subjects with respect to complex rule learning, that is if both groups paralleled Reber's (1976) findings, then learned helplessness/hopelessness theories would not be called into question. The theories would then be justified in assuming that attributional differences play a causal role in the onset of depression.

Had the results shown that depressives were always implicit learners, regardless of instructional condition, and non-depressives paralleled Reber's (1976) findings then Schwartz' view would have been supported. This would mean that depressed and non-depressed people differ in respect to how they perceive contingencies. Therefore, following with the logic of learned hopelessness theory, the attributional process

in the causal chain leading to depression would be applicable to depressives only. Non-depressed people would never make it to that point in the chain.

This reasoning would suggest that non-depressives would be resistant to depression, for they could not perceive aversive non-contingencies, a point made by Schwartz (1981). Abramson and Alloy (1984) also agreed that non-depressives may be relatively resistant to depression, but they believe that this is due to cognitive self-serving biases.

References

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Figure Captions

Figure 1: Schematic diagram of the finite-state grammar used to generate the stimuli. (So = initial state; So' = terminal state. The language is all possible paths through the system with maximum 8 letters.)

Figure 2: Rule identification scores for implicit and explicit conditions in depressed and non-depressed subjects.

Figure 3: Number of trials to memorization criterion in depressed and non-depressed subjects.

Figure 4: Expected rule identification scores for implicit and explicit conditions in depressed and non-depressed subjects.

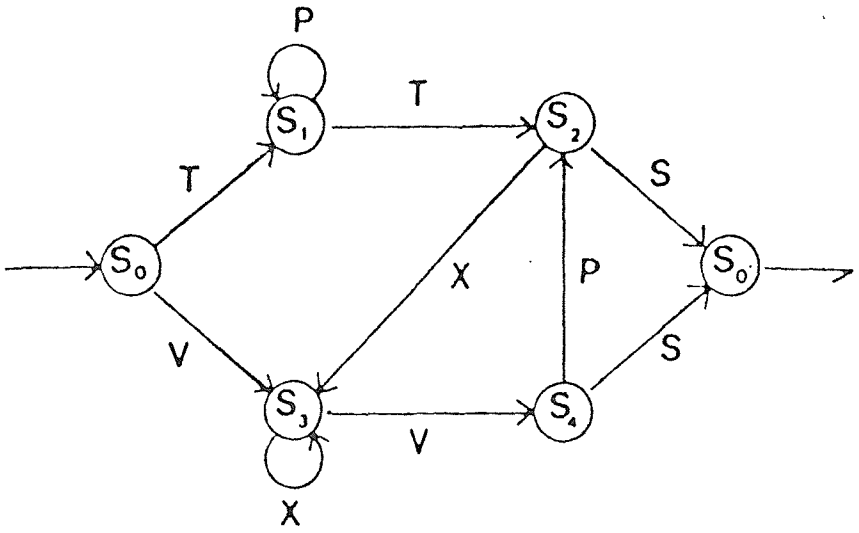
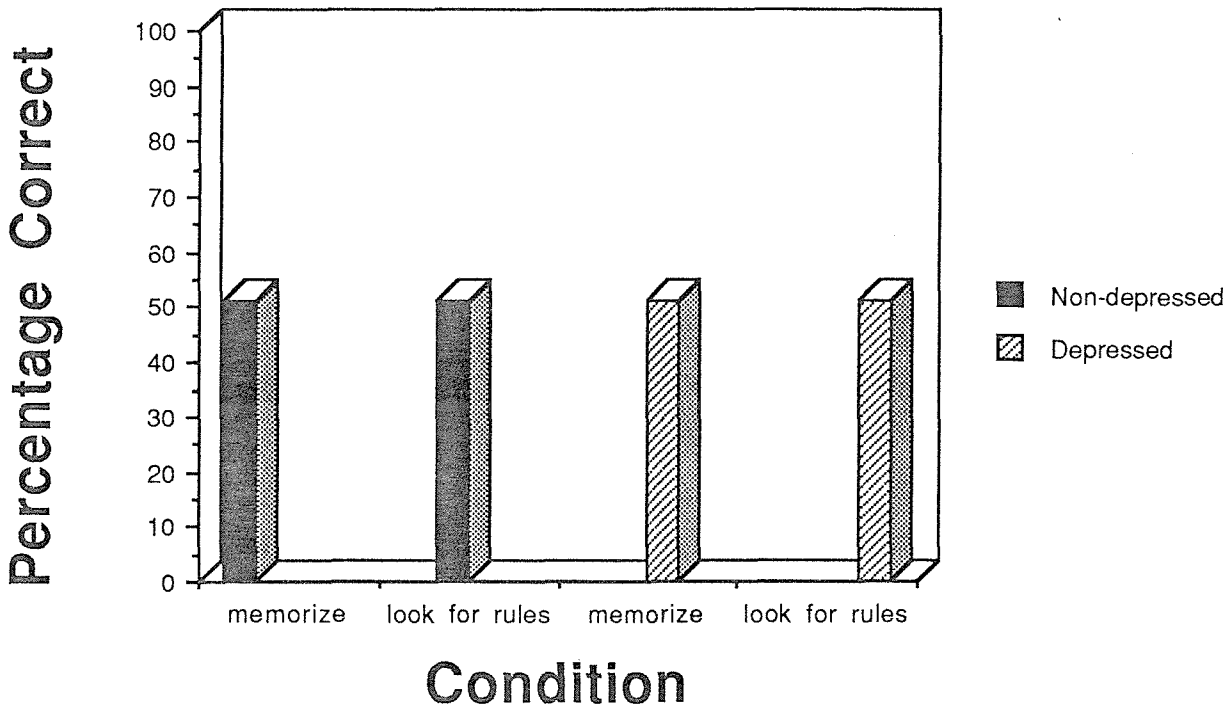
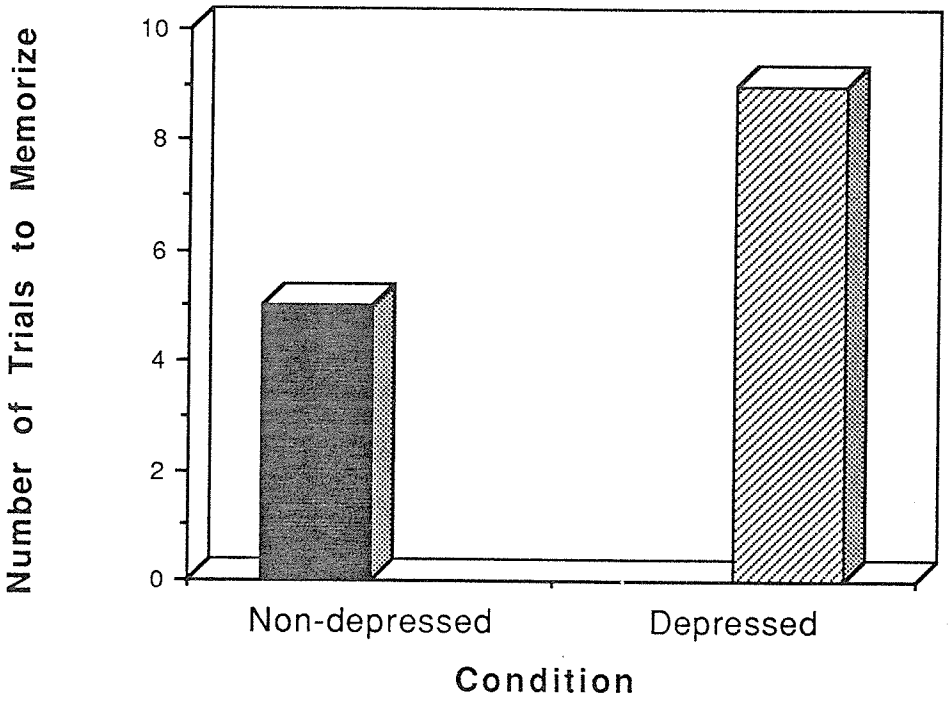


FIGURE 1. Schematic diagram of the finite-state grammar used to generate the stimuli. (S_0 = initial state; $S_{0'}$ = terminal state. The language is all possible paths through the system.)


Percentage Correct
100
90
80
70
60
50
40
30
20
10
0
memorize
look for rules
memorize
look for rules
Condition
Non-depressed
Depressed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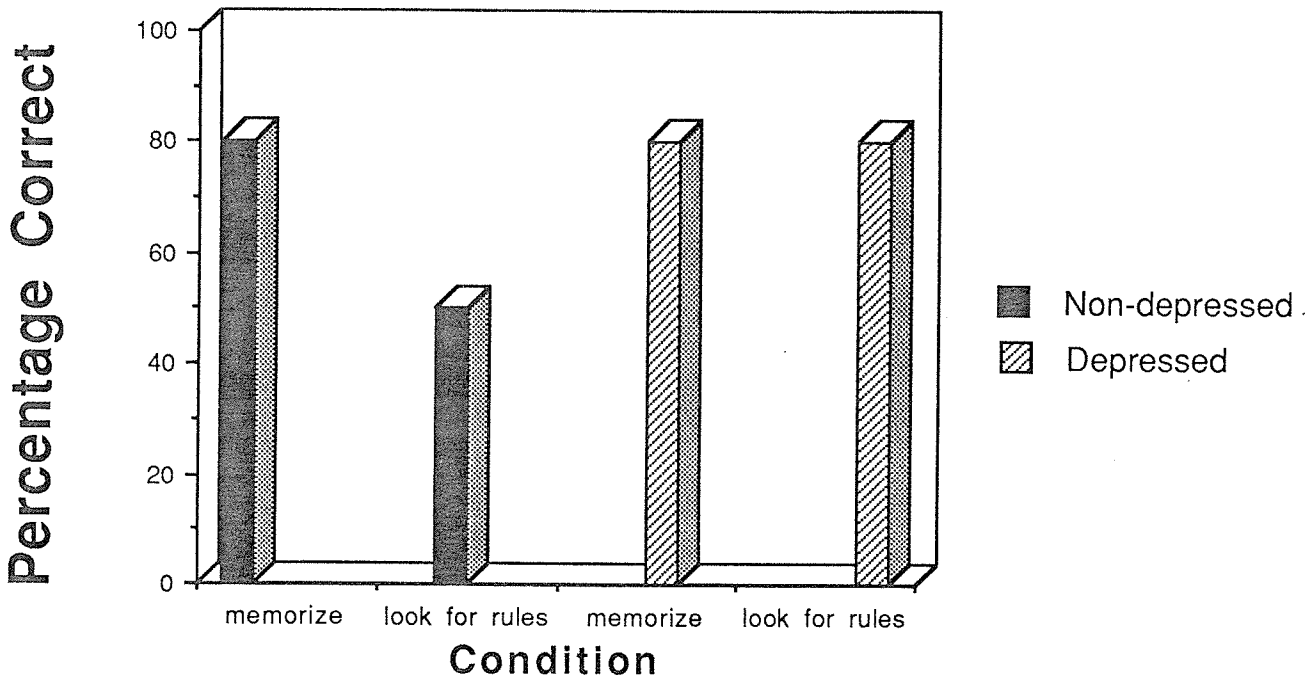
6
4
2
0
Non-depressed
Depressed
Condition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100
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memorize
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memorize
look for rules
Condition
Non-depressed
Depressed