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IMPLICIT LEARNING IN THE PSYCHIATRICALLY IMPAIRED

*City University of New York* PH.D. 1987

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# Implicit Learning in The Psychiatrically Impaired

by

Michael Abrams

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1987

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

April 23, 1987

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## Abstract

IMPLICIT LEARNING IN THE PSYCHIATRICALLY IMPAIRED

by

Michael Abrams

Advisor: Professor Arthur S. Reber.

Previous research has demonstrated that people can unconsciously induce complex rules by merely observing exemplars that were produced based on the rules. Implicit learning works just this way. In implicit learning experiments subjects first observed letter string exemplars generated by a complex finite-state grammar and then successfully judged the well-formedness of novel exemplars. That is, they were able to determine if letter strings never before seen were well formed in the sense that they conformed to the rules of the grammar.

In related research, people have been shown to be able to unconsciously acquire fundamental information such as event frequency, or temporal and spatial location of objects, in very much the same way as in implicit learning. In fact, such research has demonstrated that the ability to acquire these kinds of fundamental information is unfailing even in the case of psychiatric or neurological illness.

The fact that the unconscious acquisition of fundamental information was shown to be robust in the face of such illnesses stimulated the question of whether implicit learning is also an unconscious process resistent to such impairments. Four experiments were performed to resolve this issue. Experiments 1-3 studied the learning of a complex grammar, while Experiment 4 studied the learning of a simpler grammar.

The first experiment compared the implicit learning ability of a student group with a group of chronic alcoholics who were patients in a psychiatric facility. The second experiment compared a student group with a group of psychiatric patients suffering from either depression or schizophrenia. The third experiment compared two groups of students: one group was identified as depressed based on an affective inventory; the second group indicated no signs of depression. These three experiments utilized a learning task as a validating measure of impairment.

The results of the first three experiments showed that the psychiatric patients and alcoholics performed much worse in the learning task than both the depressed and non-depressed college students. All groups performed the same in the well-formedness task. The consistency of well-formedness decisions was analyzed by comparing the two judgments each subject made for each letter string used in the tests. This analysis showed that only alcoholics significantly differed from the student groups in that they made more consistent judgments after being informed, during the learning phase of the experiment, that the strings they were observing were constructed based on a grammar. Instructional differences did not have such an effect on any other group.

The fourth experiment compared the ability of a student group with that of a psychiatric group to implicitly learn a simpler rule system. This experiment was based on the premise that if the complex rules in the previous three experiments were induced unconsciously, then simpler rules, which are consciously accessible, should result in impaired populations having relative learning deficits. The results showed this to be the case. The psychiatric group performed below chance and significantly worse than the student group in both the rule judgement task and the learning task.

Therefore, it appears that implicit learning is a robust process that is only minimally mediated by conscious or effortful cognition. Neither minor affective disorders, nor major psychiatric disorders were able to significantly diminish the ability to implicitly learn.

The evidence presented in these experiments also demonstrates that implicit learning is largely an unconscious process. When the rule system that is to be implicitly learned became more apparent, the performance of an impaired population declined relative to an unimpaired population.

## ACKNOWLEDGEMENTS

My most profound thanks to my advisor Professor Arthur Reber for his assistance in every phase of this work, and his tolerance of my intensive approach. In addition, I offer sincere gratitude to: Professor Kietzman for his detailed and laborious review of this dissertation, and his helpful comments; Professor Buckhout for his kind comments and encouragement; Professor Seidenberg for all of his assistance; Professor Erdelyi for reminding me of the importance of incisiveness. I also offer thanks to my wife Marjorie for her help, emotional support, and her laser printer.

I dedicate this dissertation to the memory of my father Ben and my sister Ina.

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# Chapter 1

## Introduction

This dissertation discusses a class of unconscious learning that appears, in part, to be resistant to mental impairment. It also examines what appears to be a related type of unconscious learning to determine if it too is resistant to the impact of various mental disorders. The underlying notion is that some operations that may be referred to as unconscious are actually essential processes that are so fundamental that disruptions of higher cognitive processes have little effect upon them. Specifically, this report examines the issues of whether psychiatrically impaired individuals can implicitly learn complex rules. It is also an extension of the work of Reber (1967, 1976) who demonstrated that the learning of systems as complex as artificial grammars can take place unconsciously, a phenomenon he named implicit learning. This dissertation also investigates some of the related notions of Hasher and Zacks (e.g. 1979, 1984) who studied the automatic induction of fundamental information. Their research provided evidence that automatic processing of fundamental information, such as item and event frequency, are basic and largely immutable processes.

Therefore, two phenomena, which may be psychologically or physiologically related, were studied and compared.

Both involved a kind of non-conscious information induction and both applied a similar underlying principle. However, one major difference in the experimental foundations of the two phenomena is, to date, only the automatic processes described by Hasher and Zacks (1984) have been demonstrated to be so basic as to be resistant to psychiatric and mental impairment. For example, Remien, (1986) reported that depressives were able to perform automatic memory processing. Vakil (1985) and Henderson (1984) found this to be true for both closed head injury patients and elderly adults. Similarly, Ceci (1983) found learning and language disabled children to be able to automatically process auditory information.

Such phenomena have provoked most of the issues that this dissertation addresses. Within the research discussed is the notion that implicit learning is a more complex incarnation of automatic frequency counting. If both simple and complex frequency counting, as implicit learning may be, are mediated by the same principle, then both should be similarly robust to psychiatric disorders. If implicit learning were not to be resistent to psychiatric impairment, then this would suggest it is a different process -- probably associated with higher brain functioning, and thereby sensitive to the reductions in concentration associated with various disorders.

This research was designed to study further the above question: whether implicit learning of artificial grammar systems is immune to psychiatric impairment as is simple frequency counting. Specifically, the following issues are experimentally examined:

1. Can individuals suffering from various psychiatric disorders perform higher order implicit learning?
2. If they can, do they differ from normal control subjects in any systematic fashion?
3. Are there any correlations between the ability to learn implicitly and divergent psychiatric disorders?
4. Do temporary cognitive impairments (e.g., brief reactive depression) produce results similar to more chronic psychiatric impairments?
5. Do normal and psychiatric populations differ in a implicit learning task utilizing a simpler rule system where the effortful processes could be engaged?

Background: Automatic and Unconscious Processes

The growth of cognitive psychology has brought with it considerable research in the study ofnon-conscious processes. However, this research has been conducted from a very different perspective from the earlier psychoanalytic and related research into the unconscious (e.g., Whyte, 1960; Ellenberger, 1970). The primary concern of the cognitive scientist is the processing of information. Early on (e.g., Neisser, 1967), cognitive researchers noted that we are bombarded with sensory information, yet somehow are able to select, process and record specific and essential aspects. It was also noted that much of this information processing is not mediated with the aid of conscious attention. Somehow, either through practice or inherent mechanisms, we extract and process information without being aware of doing so.

One significant facet of these unconscious processes that has gone largely unexplained is learning of complex relationships. If in fact there is unconscious cognition guiding some portion of human behavior, its ability to learn, induce rules, and develop concepts would have profound influences on the conscious processes. This would imply that many of our conscious processes are guided by an information base acquired without our knowledge, and information that we might, at least initially, deny its existence.

Implicit Learning

Twenty years ago Reber (1967) employed the term implicit learning to characterize the manner in which people develop intuitive knowledge of the underlying structure of a complex stimulus environment. He proposed that implicit learning is characterized by two essential features: it is abstract and it is unconscious.

The classic paradigm to study implicit learning is to have subjects observe exemplars generated by a complex artificial grammar, or more specifically a finite state grammar. This type of grammar consists of a precise number of different internal states, where a transition from one state to another is marked by the emission of a symbol. Symbol (in this case letter) strings would, therefore, be produced by permissable shifts from state to state, depending on the state system of the particular grammar. Thus, the exemplars are arrays or strings of letters.

After subjects are exposed to a number of these strings they are asked to classify novel strings as grammatical or ungrammatical. Despite the inability to articulate adequately any valid understanding of the grammar, subjects are able to classify the novel strings at a level well above chance. They act as though they have learned the rules of the grammar that was implicitly contained in the exemplars to which they been exposed.

Attempts to express verbally their knowledge of the rule system are inevitably incorrect (Reber, 1967, 1976; Reber & Allen, 1978; Reber & Lewis, 1977). This fact suggests that the subjects unconsciously induced the inherent abstract structure in the stimulus set and implicitly developed a perceptual model that reflects to some degree the syntactic structure of the grammar.

The unconscious/conscious distinction was further examined by Reber (1976) when subjects were given explicit instructions prior to the learning phase to search for the implicit rules. Performance worsened when they made conscious effort to find the rules. It was as if the effortful processing only served to reduce the natural efficiency of the automatic processing.

The point that implicit learning is unconscious is crucial. A substantial portion of the research in cognitive psychopathology seeks to uncover the specific cognitive deficits in various forms of pathology. Therefore, the discovery of cognitive processes that are unhampered by forms of psychopathology previously demonstrated to impede most other cognitive processes would be of considerable importance. It would imply two points. The first is that implicit processes occur within the information processing system prior to the point of conscious awareness. The second point is that the neurological foundations of implicit processes and conscious processes may be fundamentally different. That is, implicit learning may be conducted by more primitive brain areas than are associated with consciousness. If this is found to be true it will provide another tool for the better understanding of pathologies that disrupt the conscious processes.

Research into the Cognitive Unconscious

The ascendance of cognitive psychology brought with it a great deal of research in the processes of memory, perception and thought. A review of this research reveals that interactions among these mechanisms are not always conscious. For example, the allocation of percepts to long term memory is not accomplished with direct effort. In fact, even after decades of conscious research into this process it is still not completely understood.

The cognitive processes that appear non-conscious have been described with varying terminologies. Neisser, in his classic text, coined the expression preattentive processes (Neisser, 1967, 1976). He referred to those cognitive processes that do not require conscious attention or effort. Some have referred to essentially the same operations as automatic mechanisms (e.g., Posner & Snyder, 1975). Reber (1967) used the term implicit to describe a class of unconscious learning studied in this paper.

In general, cognitive psychologists have favored variations of the term automatic over the term unconscious (Anderson, 1980; Lachman, Lachman & Butterfield, 1979; Klatsky, 1980). This stems, at least in part, from Broadbent's (1958) representation of the conscious mind as a system with limited capacity. He suggested that the role of consciousness is to filter out the irrelevant stimuli from the vast medley that are always present. However, his original representation did not allow for any processing of the unattended or filtered stimuli.

A classic experiment by Moray (1959) established that the role of attention is not merely to filter out unattended sensations. He employed a shadowing task in which subjects had to monitor a message in one ear. While monitoring, the subjects name would be occasionally sounded to the unattended ear. Rather then be filtered out, many of the subjects reported being aware of their names. Moray concluded that some subjects were able to rapidly shift attention from the attended ear to the unattended one. However, Deutsch and Deutsch (1963) and Norman (1968) concluded that there was sufficient evidence to believe that all sensory input was unconsciously monitored prior to reaching attentional or conscious levels.

This prompted several researchers to investigate further consciousness as a limited capacity system that encompasses both the attended as well as the unattended channels. Posner and Boies (1971) demonstrated that a task requiring little or no attention can be performed at the same time as a attention-demanding one. They also found that performance on the non-attentional task, measured by reaction time, diminishes when increasing amounts of attention are required for the attentional one. Their research led them to conclude that attention has three components: alertness, selectivity and processing capacity. In addition, they concluded that while these three components of attention are related to conscious awareness, many tasks do not require all three components and therefore remain unconscious. They proposed that "conscious awareness is rather late in sequence of mental processing" (p. 407), and operations such as relating sensory input to long-term memory can occur outside of consciousness.

In a related vein, Posner and Snyder (1975) performed a classic experiment to demonstrate the functional dichotomy between automatic and attentional processes. Subjects were given priming letters that would either correctly or incorrectly cue the first letter of a letter pair. Their task was to determine as rapidly as possible if both letters in the pair were the same or different. The primes were, depending on the letter, predictors at varying likelihoods. If the prime was presented rapidly before the letter pair, the subjects' ability to determine sameness or difference was facilitated if the prime was an accurate predictor. If the predictor was incorrect the subjects were not inhibited in their reaction time. However, if the cue was presented with a long interval, reaction times tended to lengthen. This demonstrates that the process operates on two levels, one requiring attention or consciousness, the other unconscious or preattentional. It also demonstrated a bridge between the two in which conscious expectations can impair the automatic processes.

Schiffrin and Schneider (1977) demonstrated that conscious effort can indeed affect the automatic processes. In fact their research indicated that automaticity is acquired through conscious practice. Practiced subjects in their experiments were able to monitor a large number of simultaneous sources of signals for a single target. Thus, a task that originally required conscious mediation required less and less attention with practice, until it became entirely unconscious, with virtually no central limitations. However, they still viewed the process as being consciously controlled. It just is processed so rapidly in short term memory that cognizance is not attained. An important subsidiary aspect of their theory is that controlled processes are required for long term storage. In effect, they say that completely automatic cognition is illusory or artifactual.

Learning to operate a manual transmission is a typical illustration of the phenomenon of acquired automaticity. When one first begins to learn to shift gears, each step of the process is completely conscious and frequently preclusive of other complex tasks. The practiced gear shifter, however, is capable of carrying on a conversation, reading street signs or planning future activities. Such a driver may even complete a trip with little or no memory of ever shifting gears, or even of driving at all. Yet, at any time the driver can apply focused attention and the process will become fully conscious. This exemplifies the notion that the unconscious is acquired through learning. This point of view contrasts with the idea that the unconscious contains fundamental and intrinsic processes.

Posner in a review (1982) of the research on automatic processes agreed that automaticity is a function of reduced demands on attentional resources. He suggested that people can monitor two channels simultaneously because no interference occurs over the sensory channels employed, but conscious awareness of any of the information coming across the channels imposes a drastic limit.

A slightly different conclusion was recorded by Kellogg (1985) who explored long term storage of attended as opposed to unattended information. His findings indicated that attention improves retention, as measured by recognition memory for attended items, but attention was not required for long term storage.

In summary, the essential finding of the plurality of experiments on attentional vs. unconscious processing of information, is that there are very few higher mental operations that are completely automatic and entirely outside conscious or attentional control. Yet it appears evident that there are in fact processes that are unconscious and automatic.

Some have tendered formal models to explain this divorce of attentional and automatic cognition. Kahneman (1973) proposed that while attention is indeed limited, it can be applied quite flexibly. He suggested that we acquire an allocation policy that determines how attention will be deployed at any given time. However, the freedom to allocate our attentional resources has some constraints. He points out that we have built in limitations that neither learning nor environmental demands can alter.

Kahneman does not allow for unconscious processes per se. Rather he suggests that the shifting of attention from task to task, and existence of certain tasks that do not require attention would account for processes that appear unconscious. His model of attention also encompasses the notion that the level of arousal may elevate or decrement attentional capacity.

This last idea was extended by Pribram and McGuiness (1975) who added the processes of activation and effort to arousal as requisites for consciousness and attention. According to this system the various states of consciousness, and therefore unconsciousness, are a function of differing mixes of activation, arousal and effort. Pribram and McGuiness differ from Kahneman in that in they propose that all aspects of attention can operate outside of consciousness.

In addition, Pribram and McGuiness associate activation, arousal and effort with specific brain structures, most of which are part of the limbic system. This explains why an important part of this system is associated with emotional states, which are intimately involved with attentional capacity.

The preceding research review illustrated that there is a good deal of literature concerning attentional versus automatic processes. In general the evidence denotes that consciousness is associated with attention. A process may become unconscious if is practiced to the extent that attention is no longer needed. Or, alternatively, a process may seem unconscious when through practice or for some other reason it requires very little attention. However, there is also a body of research that indicates that there are cognitive processes that are intrinsically unconscious, and do not require effort. Such processes do not come about because practice makes them so rapid that they appear to be out of the realm of volition. Instead they are so cognitively and, perhaps, neurologically primitive that the conscious mind cannot access their processes. Several of these are discussed below.

Marcel (1983a, 1983b) demonstrated that semantic decisions can be guided by tachistoscopic exposure to words yielding no accessible memories. His results suggest a combined innate automaticity and an acquired automaticity. The unconscious process that permit the subject to respond to aspects of the tachistoscopic display are dependent upon the subjects automatizing the written English language. In contrast, the ability to process abstractly the semantic properties of the stimuli that are not consciously perceived is less likely a result of learning or practice. How can we learn to work with information we are not aware of having?

Marcel's work is similar to the results of MacKay (1973) who found that even if subjects involved in a shadowing task were unaware of words in an unattended channel, these words frequently influenced the interpretation of what was being shadowed. Similarly, Marcel's subjects denied an awareness of the priming word that was tachistoscopically presented. Yet the results indicated that the priming word was perceived and utilized to guide a lexical choice. Thus, the words were somehow used unconsciously to graphically and semantically guide conscious decisions. When the interval between the word and mask was decreased there were diminutions in graphic and semantic processing, respectively. This led Marcel to conclude:

> Perceptual processing itself is unconscious and automatically proceeds to all levels of analysis and redescription available to the perceiver. The general importance of these findings is to cast doubt on the paradigm assumption that representations yielded by perceptual analysis are identical to and directly

reflected by phenomenal percepts (p. 197)

Thus, according to Marcel what you see is not necessarily what you cognitively get.

Results obtained by Corteen and Wood (1972) are, in some ways, more striking than those obtained by Marcel, who required his subjects to attend to the stimulus source. Corteen and Wood presented the relevant stimuli through the non-attended channel during a shadowing task, after they had previously utilized a classical conditioning paradigm, by pairing city names with electric shocks. They then measured galvanic skin response while subjects were presented with the city names embedded in other materials in the non-attended channel during the shadowing task. They found that subjects produced unconscious autonomic responses to the unattended presentation of words previously paired with the shocks. This result led them to conclude that selective attention does not filter out unattended stimuli, and that there are cognitive processes that are automatic or preconscious.

Emotional judgments have also been shown to have foundations in unconscious learning. Zajonc and his co-workers (Kunst-Wilson & Zajonc 1980; Zajonc, 1984) reported that people favored objects that they had been previously exposed to, even if they were not able to consciously recognize these items. This has also found to be true for novel exemplars of an artificial grammar. Gordon and Holyoak (1983), replicated both Zajonc's and Reber's results by first exposing subjects to letter strings generated by an artificial grammar similar to the ones used by Reber (1980). They then had subjects make affective judgments on letter strings conforming to, or violating the grammar rules. They found that the subjects favored the strings that conformed to the rules.

Erdelyi (1974, 1985) in his analysis of perceptual defense noted that information can be sufficiently processed without conscious mediation to preclude awareness of emotionally charged terms. Nisbett and Wilson (1977) extended this notion by providing evidence that most, or perhaps all higher cognitive processes take place outside of conscious accessibility. They suggest that cognitive control is illusory, and introspective reports on decision making range from confabulation to a priori casual theories. They theorize that subjects may apply Kahneman and Tversky's (cf. Kahneman, Slovic & Tversky, 1982) decision heuristics to understand their own unconscious processing. Higher cognitive processing takes place outside of consciousness and the comprehension that one's conscious mind has of this processing is not necessarily in harmony with reality.

Jacoby and Witherspoon (1982) observed that the schism between conscious and unconscious semantic processing can become very striking with amnesiacs. They asked Korsakoff patients to spell homophones that they had heard earlier in a specific context (e.g. they had been asked what instrument employs a reed?). The patients, despite having forgotten the orienting questions, would tend to spell the word according to the context of the question. This demonstrated that unconscious operations can be the basis of what appears to be conscious decisions.

Broadbent (Broadbent, Fitzgerald & Broadbent 1986) expressly studied the major dichotomies between knowledge that can be verbally expressed, and that which can be acted upon. His experiments show that people can learn to perform adequately in complex situations without being able to express correctly how they were able to do so. For example, people controlling a model of a city transportation system made more correct decisions after practice than without. Yet after practice they did not give more overt correct explanations as to what they were doing, or how they were doing it.

Social judgments have also been demonstrated to have a basis in non-conscious induction. Lewicki (1985,1986) performed a series of experiments establishing the same principles for social interaction, in which he found (Lewicki, 1985) that even a single pairing of physical traits and personality interactions can be the unconscious basis for later social judgments. Lewicki argues that virtually all information is induced in the form of covariations of events. The collection of these covariations is not conscious, nor do we have direct access to our data base of covariation information. Nevertheless, our judgments are influenced by this database.

In one such experiment (Lewicki, 1986) subjects were presented photos of three women. They were told that this was for the purpose of psychological training. Each photo was accompanied by a description of the personality and background of the photographed person. Within each description it was mentioned that the person was very capable within a specific domain.

One woman was described as capable in foreign languages, another in math, and the third in biology. There were two experimental groups, in one group, the person capable in math had her hair pegged back, while the other two had their hair down. In the second group, the math capable person had her hair down, and the other two had it up. The subjects were later asked to rate new photos of young women on six 6-point trait dimensions: warmth, persistence, frankness, extroversion, math capability, and ear for music. The stated purpose for this rating was to test psychological intuition. As was expected, the groups rated photos with hair up as math capable if they were first exposed to a photo presented this way; conversely, if they first saw a photo with hair down as math capable, they tended to rate new photos shown with hair down as math capable.

These and similar experiments were the basis of Lewicki's conclusion that we unconsciously acquire covariation data and use the data for social and other judgments. He proposes mechanisms he calls Internal Processing Algorithms (IPA) that automatically apply covariation information to relevant situations, and are the basis of both procedural and declarative knowledge. These IPA's perform like compiled computer programs; the specific operations they perform have become merged into one large process, and therefore are inaccessible to consciousness. In comparison, Lewicki proposes that conscious processing is akin to interpreted computer programs in which each cognition is performed separately and is fully accessible to introspection.

There are still others who imply that the unconscious is intrinsic to the structure of the human brain. Chomsky (1980) proposes that the brain has neurological systems that are specific to arithmetic, language and many other specific functions. Since these functions are in effect hard-wired and not a result of learning, either conscious or unconscious, it is probable that people would not have access to cognitions arising from these brain centers. He states to this effect:

> It appears that a great deal of procedural knowledge is unconscious, in the strict sense that we have no awareness of or control over it. Procedures are instantiated by appropriate inputs run themselves off, and deliver appropriate outputs automatically.

This position is also reflected the modular unconscious of Fodor (1983) who suggests that the workings of the relatively low level specialized brain systems are unavailable to higher level cognitive processes. Kosslyn (Kosslyn, Holtzman, Farah & Gazzaniga, 1985) proposes that visual imagery is a process mediated by several brain modules, each designated to evaluate independently one aspect of the imagery process. Piaget (Rychlak, 1981) implies a genetic unconscious. That is, the brain has evolved the ability to process information, and these abilities express themselves with the maturation of the brain. This concept melds well with implicit learning, in that the process may be tapping some very basic associational cognitive facilities.

Gazzaniga (1985) takes a similarly strong position by hypothesizing that virtually all attributions of volition are illusory. He argues that the basis of most of our actions is the result of cognitive processing that is inaccessible to consciousness, but that is attributed to conscious intent only after the fact. He further suggests that the conscious mind is the verbal mind which has the ability to express itself to the outside world. This verbal consciousness does not have access to most of the cognitions of the independent modules. Implicit learners who exhibit knowledge of the rules of a complete system but cannot verbally express them may not have access to the specific module that does this type of processing.

Gazzaniga based this conclusion on many years of working with patients who had surgery severing the corpus callosum. He found that these patients would claim that actions that were mediated by their non-verbal brain hemisphere were volitional. This was paradoxical, because the claim itself was mediated by the verbal hemisphere which had no access to the cognitive basis of the action. His experiments with individuals with intact brains led him to conclude that the tendency to claim and believe in volition was a faulty propensity of consciousness itself.

Related theories by brain researchers (Weingartner, Burns, Diebal, & Lewitt, 1984; Newman, Weingartner, Smallberg, & Culne, 1984) have hypothesized specific neurotransmitter systems which may mediate certain unconscious processes. Weingartner and his associates have also studied the effect of Parkinson's disease (Weingartner, Burns, Diebal, & Lewitt, 1984) and associated neurotransmitters (Newman, Weingartner, Smallberg, & Culne, 1984) on automatic versus effortful processes. They concluded that automatic processes are resistent to many neurochemical changes. Hirst and Volpe (1984) propose that neurological systems develop in childhood as a partial function of environmental stimulation. Once developed these systems are automatic and unconscious, becoming conscious only when impaired.

Others (e.g. Winson, 1986; MacLean, 1948; 1958; 1962) postulate that the human brain consists of laminar structures each representing an incarnate recapitulation of a phylogentically older stage of human development. The general theme of these theorists is that when a brain evolves it does so accretionally; that is, a mutation that involves a complete replacement is a much more risky venture than one that adds a new structure to the currently existing one. Thus, our brain consists of new structures added one by one to those that analogically existed in our most early ancestors. Further, they argue the evolution of the brain was too rapid to allow for adequate neurological wiring between the evolutionarily old and new systems, connections within each system, however, are much more adequately mapped out. Thus, unconscious processing is hypothesized to occur because the earlier brain structures are not capable of expressing the nature of their cognitions to the verbal neo-cortex.

The preceding review and discussion makes clear that there are cognitive processes that are carried on outside of conscious awareness. Some of these processes may start out as conscious and then, through practice, become unconscious. Some processes may have never been part of consciousness. Implicit learning seems to be such a process.

# Chapter 2

## Implicit and Fundamental Processes

### Fundamental Processes

Directly in line with the concept of implicit learning are the fundamental automatic processes proposed by Hasher and Zacks (1979, 1984; Alba, Chromiak, Hasher & Attig, 1980; Zacks, Hasher & Sanft, 1982). Although they agree with Schneider and Schiffrin (1977) that long term declarative memory requires conscious mediation, they submit that certain classes of environmental information are induced without any cognitive or attentional effort. Specifically, information about frequency, or temporal and spatial location of events is acquired without any effort.

Hasher and Chromiak (1977) performed a prototypical automatic processing experiment, which tested subjects' ability to automatically acquire frequency knowledge. Students, ranging from second grade to college were assigned to two groups. The first group was informed that a word list they were given to learn would be followed by a test on word frequency. The second group was not told about the forthcoming test. Words on the list occurred from 0 to 4 times, and the subjects were asked to rate them accordingly.

Their results indicated that there was no developmental trend in the ability to induce frequency. They also found that the explicit instructions produced a slight increase in accuracy in judgments for the high frequency words, but they did not result in any accuracy increments in the low frequency words. Attig and Hasher (1980) performed a similar experiment in which college age students, middle-age adults, and elderly adults were compared in their ability to judge frequency. All subjects heard 30 words which were repeated zero to seven times forming a 90-slot presentation list. They were then given a two-alternative, forced-choice recognition task designed to measure their sensitivity to frequency of occurrence. As in the experiment described above, half of the subjects were given explicit instructions about the frequency test prior to the list presentation, and the other subjects were informed after the presentation of the list. There were no instructional effects and no differences among the three groups in the ability to induce frequency.

Hasher and Zacks, (1984) propose that neither effort nor cognitive impairment will diminish nor aid automatic processes. For the purposes of this dissertation the most salient point they make is that these processes continue at times when controlled processes are severely impeded, specifically in the presence of psychiatric or cognitive disorders.

Hasher and her coworkers observed that people seem to automatically acquire fundamental information while doing no more than attending to stimuli. The most relevant aspect of this notion is the fact that the information is acquired outside of conscious experience, without any effort, and can be used as a basis for conscious decision making. This, too, is a classic feature of implicit learning. In fact, subjects in implicit learning experiments frequently deny any knowledge of rules or principles that could be used to classify test strings (Reber, 1977, 1985). In addition, when subjects are informed of the existence of a grammar and told to try to acquire an understanding of it, their performance in classifying novel stings tends to degrade (Reber, 1976; 1980).

Links between Implicit Learning and Fundamental Processes

What is especially interesting is the apparent link between Reber's implicit learning and Hasher & Zacks automatic processing. According to Reber (1986, p. 2):

> ..the connection between these disparate lines of research should become more clear: if subjects keep a running count of frequency information about the occurrence of single events perhaps they keep a running count of frequency information about covariational events. Or, phrased another way, perhaps the essential process that underlies implicit learning is the 'logging', as it were, of bigram covariations of a relational form. This, it should be appreciated, is

more than just an idle speculation. In the early paper by Reber & Lewis (1977) it was shown that the underlying abstract representation of a synthetic grammar that subjects had acquired was virtually completely accounted for by just a bigram invariance system.

Lewicki (1986, p. 28) independently came to a similar conclusion about the importance of the induction of covariations of events. In his recent review of non-conscious social processes, he states:

> The most basic category involved in processing information such as concrete episodes and general concepts or procedures, is a notion of co-occurrence or, more generally, covariation. To encode any kind of information, a cognitive system has to process data in terms of covariations. For example, there is no other way to acquire a concept than to discover co-occurrences between some of its features; the only way to interpret any stimulus is to check whether features co-occur in a stimulus. Processing information about covariations is a basic aspect of any act of cognition.

If, in fact, implicit learning is a also fundamental mechanism like the automatic processes studied by Hasher and Zacks, one could also infer that implicit learning is also insensitive to psychopathology. In addition, Reber (1985) sets forth a cogent implication that implicit learning is a phylogenetically simple process. This concept underlies a great portion of later discussion in this dissertation.

Implicit and Fundamental Research

Hasher and Zacks (1984) were among the first to point out explicitly that there are cognitive operations that are resistent to mental impairment. They proposed six criteria that are readily applicable as a definitive standard for any process proposed to be outside of conscious control. That is, they suggest that if any cognitive process can meet these criteria it should readily be accepted as unconscious or automatic.

Note that it does not follow that if a process does not meet all of Hasher and Zacks' criteria it is not an automatic process. Rather it may fall somewhere else on a continuum between the automatic processes and the controlled processes. There is a substantial body of research that has sought to test the relevance of these six criteria. The theme derived from this research is that most cognitive operations that appear unconscious or automatic have conscious components as well.

The six criteria are relevant to the research in implicit learning because if the argument is correct that implicit learning is predicated on counting covariations we should find that it meets the standards as well as the other fundamental processes. The six criteria are:

1. People are sensitive to automatically acquired information without intending to be.
2. Automatically encoded information is in no way different from the same information encoded intentionally.
3. Training at processing automatically encoded information does not improve encoding or retrieval.
4. People vary very little in their ability to acquire information using the "fundamental processes."
5. The ability to encode information will not vary by age.
6. Arousal, stress, other cognitive demands will have no impact on automatic processing.

The following represents a short review of some of the research that has dealt with issues closely related to those raised by the preceding six criteria. The review also serves to compare the research into implicit learning with that exploring fundamental processes.

Reber, Kassin, Lewis and Cantor (1980) presented several groups of subjects with the actual schematic structure of an artificial grammar and with specific exemplars from the grammar presented in several different ways. In one group, every subject was given the schematic of the grammar, and shown how it could be used to generate grammatical strings. Each subject in this group was then given an observation session in which they viewed 63 exemplars from the grammar. A second group was given the same detailed explanation of the nature and rules of the grammar, but not until midway through the presentation of the exemplars. A third group received the explanation at the end of the observation session. In addition there were two control groups each receiving only one of the two training procedures.

The results revealed that all groups were able to perform substantially above chance on a well-formedness task, in which subjects must judge if letter strings are well formed in the sense that they conform to a pre-determined rule system. In addition, the groups who received both implicit training, and explicit instructions into the nature of the grammar generating scheme performed better than the two single-training controls. (There were differences between the three experimental groups that are not relevant here.) The most parsimonious interpretation of this result is that implicit learning has both automatic and attentional components. If the attentional component is carefully directed to key aspects of the process then there will be improvements in the learning of that process.

In contrast, there has been a series of studies (Medin, Dewey & Murphy, 1983; Dulaney, Carlson & Dewey, 1984;

Carlson & Dulaney, 1985) which expressly reject the notion of implicit and unconscious learning of grammars in favor of conscious and controlled strategies. Dulaney, Carlson and Dewey (1984) set forth the strongest dissension by showing that subjects in grammar learning study can, under some conditions, specify what segments of a letter string rendered it ungrammatical. This suggests that the process was conscious and a result of training conscious skills. Reber, Allen, and Regan (1985) rebutted this interpretation by proposing that the demand characteristics of Dulaney, Carlson and Dewey were responsible for the subjects apparent overt knowledge of the grammar rules. For example, simply because someone can tell you that the words "each other" in their particular location in the sentence "Tom each other and they like" renders the sentence ungrammatical it should not be taken as evidence that he or she "knows" the rules governing the proper placement of phrases like "each other" in any conscious sense. This type of grammar knowledge is what Reber, Allen, and Regan said Dulaney, Carlson and Dewey were finding in their subjects. An ability to point to the approximate location of a ungrammatical sequence in a letter string was interpreted as conscious knowledge of the grammar.

Thus, Reber, Allen and Regan (1985) proposed that an individual may be able to correctly attribute a decision to a rule that is not explicitly or consciously known. This contention is abstractly corroborated by the work of Gazzaniga (1985) who examined how persons who underwent neurosurgery severing the corpus callosum attributed purpose to their own behavior. He found that in almost every case such individuals will attribute an action or decision -- that they could not possibly have access to -- to a conscious volitional purpose. Thus, even if Dulaney et al.'s subjects attributed their classification of grammaticality to overt knowledge of the grammar, it does not eliminate the possibility of an unconscious basis of the decision.

Danks and Gans (1975) performed an experiment which examined the role of overt knowledge in the learning of a miniature linguistic system. Their stimuli consisted of combinations of four shapes and four colors, paired with a two digit number. Their rule system was based on the first digit representing the color of the stimulus item, and the second number representing the shape. For example, the number 6 stood for red and 1 for circle; thus, if a subject was shown a red circle it would be paired with 61.

The subjects were tested as though they were participating in a paired associates learning task, except that the subjects were operating with one of four instructional sets. The first group of subjects were given no information about any rule system. The second was only informed that there were rules associating the paired associates. The third was informed of the structure of the rules, i.e. the first digit of the correct response corresponds to the color of the figure and the second digit corresponds to the shape of the digit. The fourth group was explicitly trained in the rules. Their results were partially compatible with those achieved by Reber and his co-workers (Reber, Kassin, Lewis & Cantor, 1980).

Danks and Gans (1975) found, as did Reber, that merely informing subjects of the existence of the rules either impaired or failed to aid performance. However, Danks and Gans found that the group informed of the nature of the rules did significantly better than the first two groups, with the forth group performing the best of all. In contrast, Reber (Reber, Kassin, Lewis & Cantor, 1980) found that informing subjects of the rule system by displaying a schematic diagram of the artificial grammar and giving a short lesson in how it worked did not aid their performance. They did find that if such instructions were given prior to exposure to a series of exemplars the sugbjects perform better than those shown only the exemplars.

This difference is very likely due to the difference in complexity of the respective artificial languages. What this suggests is, as a rule system becomes more apparent the greater is the role of conscious mediation. As will be discussed later, this concept may allow for the defining of differential deficits in impaired populations.

Kellogg (1985) proposed that not only can information be unconsciously acquired, but that such information may yield permanent memories. At least as consequential as longevity is quantity--are memories acquired implicitly or automatically as complete as those acquired consciously or with effort? Greene (1984, 1986) says no, at least for frequency information. His experiments led him to conclude (Greene, 1986 p.493) that:

> ..intentionality of learning does affect memory for frequency. Therefore, frequency information does not meet one of the criteria of Hasher and Zacks (1984) for automatic encoding ... a study strategy involving semantic processing leads to more accurate frequency estimation than strategies involving counting or rote repetition.

However, he did find in all cases that automatic learning of frequency did take place; it simply was not entirely independent of intention. Allen and Reber (1980) have shown that implicitly learned grammars are retained in long term memory, demonstrating that, like intentionally encoded information, implicitly learned material is stored in long term memory.

Brooks (1978) took issue with a basic premise of implicit learning as it relates to the issue of encoding. Reber contends that individuals who can classify novel strings generated by a finite state grammar can do so because they have formed an abstract memorial representation of the structural principles of the grammar.

In direct contrast, Brooks (1978) claims that while the subjects are viewing the exemplars of the grammar they do not form abstractions but establish memory sets that consist of representations of individual exemplars. Classification of new strings will, therefore, be based on a similarity or analogy strategy. The more similar the new string is to an item in the memory set the more likely it will be classified as grammatical. Note that Reber and Brooks agree that the process is unconscious, but the method of coding is a matter of polemic.

The issue seems, at least in part, to have been resolved by McAndrews and Moscovitch (1985). They performed an implicit learning experiment with the express intention of exposing the method of encoding. They presented subjects with exemplars with a bogus set of instructions. The subjects were told that they were participating in a market research survey with the goal of selecting attractive names for a new personal computer. They needed only to classify the exemplars (brand names for computers) as good or bad, by copying each name onto one of two lists. After the learning phase of the experiment all participants were informed of the true nature of names, that they were exemplar letter strings generated according to a set of rules.

The crucial task for the subjects was to classify new names as conforming to or violating the rules. This was done using a forced choice procedure. The unique aspect of the experiment was that the novel strings in the testing phase of the experiment could be simultaneously evaluated on two dimensions; the first, as in most implicit learning studies was grammaticality (G) vs. non-grammaticality (NG), the second is similarity distance. This dimension is defined by the degree a test string differed from a corresponding exemplar string. Thus, if a string differed by only one character it would have a close (CL) similarity distance, and if a string differed by three or more characters it would have a far (FAR) similarity distance. Any test string could then be categorized as : CL-G, CL-NG, FAR-G, FAR-NG.

According to Brooks' similarity hypothesis, CL strings should be classified as grammatical more often then FAR strings since they will have the greatest similarity to memorized items independent of grammatical status. In contrast, Reber would predict that grammaticality (G) should be the most potent guide for subjects decisions since they have not memorized salient portions of the strings but relational aspects of the structure of the strings. Strings sharing the common structure, but not necessarily their appearance, would be selected as grammatical.

The results of the experiment indicated that to some degree both Brooks and Reber are correct. That is, both similarity distance and grammaticality had roughly equal effects on subjects' decisions. Perhaps just as significant was the finding that subjects could be partitioned into two behaviorally discrete groups, a grammaticality group and a similarity group. As the names imply, one group of subjects seemed to have based their classification judgments primarily on similarity distance, and the other group on grammaticality.

Much of the preceding research into implicit learning is conceptually comparable to many of the studies dealing with automatic processing. Both seek to determine the amount of conscious effort that is required to induce specific classes of information. Experiments have shown the acquisition of frequency information generally to be unconscious and independent of instructions. For example, Brenner (1986) assigned a group of subjects to a vigilance task observing the critical stimuli and a second group to a distractor task. His results showed a lack of relationship between attention and the acquisition of frequency information. This was also the finding of Marmurek (1983) who queried subjects on the frequency of words used as distractors during short term memory tests of digit sequences.

Similar results were found in experiments dealing with other types of fundamental information. Lindberg and Garling (1983) corroborated that spatial information is encoded automatically. They found that subjects instructed to develop cognitive maps did not do significantly better than those who incidentally learned while performing another task. In a related study (Park & Mason, 1982) subjects were asked to study multi-colored drawings. They were instructed to study the entire drawing, the drawings and associated colors, the drawing and its position, or the color and the position of the drawing. They found that memory for color was associated with instructions and effort, but memory for spatial location was not. They concluded that this contributed further evidence for the theories of Hasher and Zacks.

Fisk and his co-workers (e.g. Fisk & Schneider, 1977; Fisk, 1986) agree with the premise of this section, although for a very different reason. They suggest, as did Schiffrin and Schneider, that all processes are controlled on some level. According to this point of view there are no truly automatic processes; instead there are processes that become so rapid that they seem unconscious. Thus, automatic processes are in no way different from those encoded intentionally; they both are controlled processes.

This dissertation provides a strong test of this model. If this model of unconscious is true, then impaired individuals who cannot do as well in conscious and effortful tasks should be at a distinct disadvantage in developing automaticity in the first place. Therefore, if implicit learning is a result of conscious learning made automatic through practice, then impaired individuals should do significantly worse on an implicit learning task.

Essentially, this line of argument holds for all models of unconscious induction. This is evident from the earliest cognitive filter experiments such as Broadbent's (1958) in which subjects could recall some information from unattended channels. It is also corroborated by those studies (e.g., Eich, 1984; Nisbett & Wilson, 1977; Kolers & Roedinger, 1984) which show that people can acquire memories -- and in some cases use them as a basis for decisions -- without having attended to the source of information. An adjunct issue is the means of such a process in the case of implicit learning. Specifically, is implicit learning fundamentally unconscious (or automatic) or is it a conscious process that appears unconscious due to experimental demand or structure?

The evidence as reviewed suggests that both implicit learning and other fundamental processes are largely independent of explicit information or training, although in some circumstances instructions or other explicit information can have some impact on these types of unconscious processes.

The primary concern of this dissertation is the study of impaired populations, and any differences they display in their ability to acquired fundamental or implicit information. There is significant evidence that people suffering from an assortment of mental disabilities at least can automatically tabulate frequency to essentially the same extent as normals. Students with learning disabilities (Ceci, 1983), adults with depressive disorders (Ellington, 1984; Remien, 1986; Roy, 1986; Henderson, 1984), the mentally retarded (MacFarland & Sandy, 1982) and even those with the severe memory impairments brought about by Alzheimer's disease, Korsakoff's syndrome and Huntington's disease showed markedly less impairment in automatic frequency processing than in effortful memory tasks (Strauss, Weingartner & Thompson, 1985).

In fact, Ceci (1982) hypothesized, based on these data, that the differential between automatic and effortful semantic processing may be the primary deficit in many learning disabled children. Newman, Weingartner, Smallberg and Calne (1984) observed that an artificially induced individual difference, the administration of l-dopa, had an impact on effortful cognitive processes, but not automatic ones like frequency counting. In addition, Keel, Nakayama, Cervantes and Osaze (1985) found no differences among races in the automatic encoding of category. In general, the evidence supports the hypothesis that fundamental processes are relatively insensitive to individual differences.

Roter (1986) has demonstrated that children as young as five years can implicitly learn an artificial grammar as well as adults. In addition several studies (e.g. Attig & Hasher, 1980; Lehman and Mason, 1982) specifically set out to test Hasher and Zacks' proposition that automatic processing will not vary by age. They compared elementary school age children with college students in the ability to automatically encode information on presentation (verbal or printed) of words, and found little or no difference between the groups.

However, there is research which suggests that age plays a role in automatic processes. Freund and Witte (1986) observed that deterioration of frequency processing in the elderly was greater than losses in recognition memory. Zehr (1983) also found diminutions in the ability of the elderly to automatically count frequency. He concluded that it is an automatic process, but like most processes it declines with age. Whinery (1986) found a small difference in frequency learning between young and elderly adults, but still concluded that the process is automatic for both groups. Finally, Kellogg (1982) found that frequency counting ability followed the same developmental patterns observed in controlled attentional processing by 5 year old children, college students, and the elderly. His conclusion, however, was that frequency counting is not automatic.

The research when viewed as a whole suggest that Hasher and Zacks' six criteria are rarely completely satisfied. However, there can be little doubt that there are processes that are mediated without conscious control. Some, like implicit learning, do not seem to require the type of repeated practice that some assert must be performed before some operation can be made automatic. The following section considers some perspectives on how such processes may have come about.

Speculations on Brain Evolution & Modular Systems

Overall, the preceding review of the literature suggests that automatic and implicit processing of information is universal and robust in the face of factors that have been shown to have a negative influence on other cognitive processes. This suggests that unconscious mechanisms of this type are inherently different from the conscious cognitive processes. That is, the brain mechanisms supporting these processes are different those that underlie conscious processing.

One way to approach this problem is to raise the classic question, why should any of our cognitive abilities have evolved? The literature is replete with analyses of this issue (see Appendix A for a further discussion of some of the related concepts). The basis for frequency and covariation counting from the evolutionary point of view is that it is a simple process that requires no high level cognition. Information induction based on identifying the covariations of events is possible even in the most simple of organisms. This point is corroborated by the fact that even creatures such as round worms can be classically conditioned. And what is classical conditioning if not the act of associating events? In fact, Hasher & Chromiak (1977) point out that there is evidence that frequency counting can be carried out by animals. Rescorla's work (e.g., Rescorla, Grau & Durlach, 1985) demonstrated that classical conditioning in animals is dependent on their ability to distinguish genuine covariation from fortuitous co-occurrence. In addition, such a system would permit animals to associate locations with food or predators. Thus, it would allow them, without any conscious thought, to avoid danger and find sustenance.

In fact it is difficult to imagine any other memory system that would be more efficient and less costly. Brown (1975) points out that a large complex nervous system carries with it some very great costs. It requires a disproportionate amount of food, energy, and oxygen, and its very complexity makes it susceptible to catastrophic malfunctions. Very complex brains are complexly interwired and damage even to a relatively small part will have wide ranging consequences. In contrast, a learning system that is based on recording simple associations or covariations would be much less energetically costly and structurally risky. The relevance of such a simple system to the complex human brain and its resultant complex cognitive processes is demonstrated by the work of MacLean (1949,1960,1983).

The human brain, although capable of learning in much more complex ways, contains structures homologous to the brains of much simpler organisms. As it evolved, it carried along both the structures and functions of much simpler organisms. It is not unlikely that our more complex and conscious learning has components similar to that of our distant ancestors. This would explain why humans can learn through abstraction as well as through conditioning.

A prominent component of many cognitive models is that all memories are linked in some type of network with all related memories. This is, in fact, the modal theory of memory storage. For example, Morton's logogen theory of memory (1970), Anderson's propositional networks (Anderson, 1983), and Hayes-Roth's (1977) notion of cogit representations are all variations of this theme. Such a memory system would probably begin with a primary counting process. Every perception would be categorized and stored in a manner that would permit its association with related perceptions. No higher cognition is required for this process. The more complex propositional networks may be built upon a simple memory of covariations. It is compellingly logical that even the most neurologically primitive organisms have evolved a memorial system that would organize related perceptions, and as they evolved this system was enhanced and elaborated to yield a brain that can learn both implicitly and consciously.

# Chapter 3

## Implicit Learning and Experimental Psychopathology

### Cognitive Psychopathology

Individuals suffering from psychiatric impairments generally perform more poorly than normals on most cognitive tasks. If such people are capable of performing as well as normals, or at least showed diminished impairment in tasks measuring unconscious learning, it implies that this type of learning is not mediated by the same cognitive mechanisms that control the attentive processes. The following is an overview of some of the related research into psychopathology which relates to an important element of the research in this dissertation. A goal of this paper is to improve the understanding of psychiatric infirmity by demonstrating that implicit learning is among those operations that appear resistent to psychiatric impairment. Finding cognitive operations that are resistent to mental illness has been a major tool in understanding the nature of specific illness. For if one can identify the intact areas of cognition, than one may be better able to isolate the diseased areas.

Below a variety of forms of disorders is reviewed with respect to the degree to which it is known just how much each disorder affects cognitive processing. Of special interest for this dissertation are, schizophrenia, depression and chronic alcoholism.

Schizophrenia

Schizophrenia is known to result in deficits in virtually every cognitive and intellectual task (e.g. Liddle & Crow, 1984; Lifshitz, Kugelmas & Karov, 1985; Kietzman, Spring, & Zubin 1985; Asarnow & MacCrimmon, 1982). Current psychological research in psychopathology is faced with the problem of separating the generalized deficit from the differential or specific deficit in information processing (cf., Kietzman, Spring & Zubin 1985). The differential deficit refers to the impediments to information processing that are peculiar to the illness, and in principle are distinguishable from the global debilitation of many faculities due to serious illness of any kind.

For example, if one were to give intelligence tests to individuals suffering with the flu, one would probably find lower scores than non-flu controls. Does this mean that influenza lowers intelligence? Or, more likely, does it mean that the flu disrupts all faculities and diminishes motivation such that most any measure will be reduced. If, in fact, influenza does actually result in lower IQ, does it do so by impairing memory recall, problem solving, or perceptual input? These questions are the core of the investigation on the repercussions of psychiatric illness.

In general, the experimental solution to the problem of isolating specific or differential deficits is to match tasks on several psychometric characteristics (Chapman and Chapman, 1978). Another way this can be accomplished is by designing experiments in which there are group by treatment interactions (e.g. Kendall & Butcher, 1982). For example if the impairment in reaction time, usually exhibited by schizophrenics, were to shift as a result of changing preparatory interval, it would be evidence for a differential deficit in the early stages of attention. This is commonly referred to as the reaction time cross-over deficit, and it was among the first differential deficits identified.

Bellisimo and Steffy (1972) examined the influence of information redundancy by manipulating the degree of regularity in the presentation of preparatory interval durations. They utilized runs of 2 and 4 identical presentation intervals which were embedded in an irregular order of trials to test the influence associated with regular presentation. They found an interaction for process schizophrenic patients. This interaction took the form of a crossover in which the regular presentation interval trials yielded poorer performance than the irregular trials at long presentation interval durations with the opposite being true for short durations. Redundant presentation intervals usually resulted in improved performance immediately and then, for process schizophrenics, a progressive loss on successive trials.

This result demonstrated that process schizophrenics have specific attentional deficits relative to both normals and other diagnostic categories of schizophrenia.

The identification of this deficit has helped in the understanding of both the unique nature of the illness and its etiology. For example, Greiffenstein, Milberg, Lewis, and Rosenbaum (1981) employed the reaction-time cross-over phenomenon to test the thesis that temporal-limbic dysfunction is responsible for schizophrenic symptomatology. Their approach was to use a variable foreperiod reaction-time task, on which early crossover has been found to be characteristic of many schizophrenics. They compared four groups: schizophrenics, temporal lobe epilepsy patients, generalized seizure patients, normal controls. Their results revealed that both temporal lobe epilepsy patients and schizophrenics showed an early crossover of regular and irregular preparatory interval gradients, but the generalized seizure patients and the normals displayed no such effect.

A striking example of a specific deficit was obtained by Orlowski (1986). Her findings indicated that deficits in perceptual organization allows the schizophrenic to avoid a Stroop - like distractor. In this situation the schizophrenic actually had a rare advantage in that they had faster reaction times.

Thus, even though it is well established that schizophrenics display reductions in general intellectual functioning, reasoning ability and perception (e.g., Liddle & Crow, 1984), it provides little information particular to the disorder. What is more significant is finding the unique deficits in information processing that define the illness. Such information can be meaningful in resolving the etiology and developing treatments for the illness.

Progress in this direction was made several years ago when it was observed that schizophrenics had deficits in the ability to filter cognitively irrelevant sensations (e.g. McGhie & Chapman, 1961). Other researchers have identified what may be cognitive markers of the illness. For example, schizophrenics commonly manifest reductions in the span of apprehension (Neale, et al., 1969; Kietzman, 1985). Perhaps the most notable marker of the syndrome is the schizophrenic's longer reaction time in virtually every situation (Nuechterlein, 1977).

The awareness of the need to discriminate differential deficits versus generalized deficits has prompted a large number of studies. In an early study Chapman and Chapman (1973b) performed an experiment with the express purpose of discriminating between the two types of deficits. They found that schizophrenic patients, when compared with normal subjects, showed a significantly greater deficit on a with-associates sub-test than on a no-associates sub-test. Their finding contributed evidence for heightened susceptibility to associative distraction in schizophrenia, without the possible confound of a generalized deficit.

Others have found additional differential deficits. Calev, Venables, and Monk (1983) found that severely disturbed schizophrenics showed the following: (1) a recall deficit, even after effective encoding and mnemonic organization were induced; (2) excessive forgetting over 24- and 48-hr periods; and (3) a recognition memory deficit. The use of a matched tasks check led them to conclude that these deficits were specific. Calev (1984) also found that schizophrenics have a chunking deficit at the encoding stage of information processing. In essence, these findings indicate that schizophrenics have several distinct memory deficits that would probably appear to be a general deficit in memory if viewed grossly.

Braff (1981) had argued that the specific deficit in schizophrenia occurs early in information processing. He utilized a tachistoscopic backward masking task, and found that schizophrenic subjects had unimpaired visual input thresholds but abnormally slow processing immediately thereafter. Similarly, Braff and Saccuzzo (1985) found, after testing schizophrenics on a backward visual masking task, that the information processing deficit in schizophrenics occurred at interstimulus intervals of greater than 60 msec and less than 500 msec. They concluded that the schizophrenic's visual processing impairment is specific and time linked rather than a reflection of the effects of gross psychopathology or medication.

There is also evidence that schizophrenics suffer specific deficits in the latter stages of information processing. Sengal and Lovallo (1983) found that implementing an interval between recall trials in a memory task produced a differential deficit for both schizophrenics relative to both depressives and normals. They hypothesize that this deficit could be a result of either deficient encoding processes or retroactive interference.

Depression

In depression, like schizophrenia, most cognitive measures display signs of the affliction (Remien, 1986; Fischer, Sweet, Phaelzer, 1986); depressives typically exhibit a generalized deficit. However, as with schizophrenia, the study of generalized deficits tell us little about the illness. The common goal is to identify deficits unique to the illness.

Some researches have found more specific deficits in the depressed. For example, Colby (1982) found that mildly to moderately depressed college students exhibited deficits in retrieval from short term but not sensory memory. In addition a large body of research has shown that the depressed individual has tends to exhibit impairments among the effortful processes as opposed to those believed to be automatic (Roy, et al, 1986; Remien, 1986). This is especially so for effortful processes that involve sustained attention (Cohen, et al., 1983). This position is consonant with the theories that suggest that cognitive impairments in depression are due to motivational deficits (e.g. Kuhl & Helle, 1986; Layne, Heitkemper, Roerig, & Speer, 1985; Layne, Merry, Christian, & Ginn 1982 ).

These theories have in common the notion that depression is a result of motivational deficits or learned helplessness. The depressed individual, the argument goes, has learned not to expect success from his efforts and has, therefore, given up. Such perspectives are largely derived from the work of Aaron Beck (1967, 1973 ; Loeb, Beck, & Diggory, 1971 and Seligman (1974) who see depression as a learned versus physiological or medical condition. Interestingly a large portion of the experimental evidence for their position has been derived from animal studies in which animals place in inescapably stressful situations eventually act withdrawn and depressed. However, what may appear to be motivational deficits may in fact merely be motoric impairments resulting from neurochemical imbalances.

The possibility that depression resulting from learned helplessness is actually a neurochemical phenomenon is the finding of some researchers. Zacharko, Bowers, Anisman

(1984) and Maier (1984) observed that stressors that ostensibly result in learned helplessness or cognitions of impotence are actually resulting in reductions of neurotransmitters that are essential for mobility. Thus, animals who appear to have given up hope may actually have become immobile with neurochemical imbalance. Whatever the underlying cause, depression tends to result in profound decrements in all cognitive domains.

However, there are reasons for suspecting that complex automatic processes such as implicit learning may yield a genuine differential deficit in depressives. That is, since it has been demonstrated that normal populations can implicitly learn without effort, if depression is actually an impairment of motivation it should effect implicit learning less than effortful processes. As noted above in previous studies in implicit learning instructing subjects to look for the rules of the grammar system tended to results in decrements in performance in the well-formedness task. Therefore, at best motivation doesn't matter, and at worst it actually may hurt.

Alcoholism

Alcohol is a toxic substance that will effect permanent brain damage if used in sufficient quantity for extended periods (Meldgaard, 1984). The effects of this damage differs widely among individuals in terms of both specific deficits and intensity. The individuals who have suffered from alcoholism for long periods usually display most extensive and serious cognitive damage, which presents symptoms more similar to those seen in organic brain syndrome than in other psychiatric disorders (Overall, Hoffmann, & Levin, 1978).

Chronic alcoholics usually experience deterioration in general intelligence (Goldman, 1983) and have been found to score significantly lower on all but the vocabulary subtests of the WAIS (Clarke & Haughton, 1975). More specific deficits have been observed in abstract problem solving and long-term memory (Shaw & Spence, 1985). Chronic alcoholics also tend to be impaired in perception, problem solving, and visual-spatial ability (Goldman, 1983), they also show specific deficits in conceptual shifting abilities and nonverbal abstraction, memory for spatial relations, and short-term memory (Clifford, 1986). Pishkin, Lovallo and Bourne (1985) performed an experiment to define cognitive deficits in detoxified male alcoholics having early or late onset and short or long term drinking histories utilizing cognitive rule learning task. They found pronounced cognitive deficits in both early onset, and long term alcoholics. Impairment was severest in the early onset group, even though they were on the average 15 yrs younger than the late onset alcoholics. The early onset alcoholics were relatively more impaired on both the abstract and the verbal measures from the Shipley Institute of Living scale for the measurement of intellectual impairment. This early onset group also exhibited a relative deficit in ability to show positive transfer across problems. Chronicity of alcoholism also interfered with acquisition of an abstract relationship between concrete stimulus attributes. These results were in harmony with those of DeFranco, Tarbox and McLaughlin (1985) who observed that five, or more, years of alcohol abuse resulted in specific cognitive deficits observed in tests of psychomotor speed, recent memory, and overall alertness relative to less chronic alcoholics. They noted that this pattern was independent of age and education of the alcoholics.

Korsakoff's syndrome is an illness that typically results from chronic alcohol abuse, and the nutritional deprivation that is commonly associated with alcoholism (Kandel & Schwartz, 1981). This disease, in which there is profound memory loss, has been linked to damage to the temporal lobes of the cortex and the hippocampus. Similar brain damage has been noted even in alcoholics with less severe impairments (Shaw & Spence, 1985; Ciesielski, et al., 1985).

On average, chronic alcoholics will perform worse than normals on most cognitive tasks. In fact, the wide range of specific deficits discovered almost appear to sum to yield a generalized deficit. That is, specific deficits have been found in so many domains that it may not be possible to find truly specific deficits.

The fact that alcoholism seems to impact virtually every stage in the information processing system makes this investigation all the more interesting. Since implicit learning may be a basic and fundamental process, alcoholics should not exhibit deficits to the same degree as observed in higher cognitive functioning. Their ability to perform well on a implicit learning task would be especially interesting in light of the neurological handicaps identified in most chronic alcoholics.

Implicit Learning Research and the Brain

The application of implicit learning techniques to the study of depression, schizophrenia, chronic alcoholism and related disorders may help to clarify some of the issues mentioned above. If individuals suffering from these disorders were shown to be able to learn unconsciously to a degree commensurate with normals it would also suggest that the overt, explicit cognitive functions typically studied in psychiatric disorders are operationally discrete from those involved in implicit cognition. Such a finding would have implications for both cognitive psychology and neuropsychology and help to provide a better understanding of the pathologies themselves

If implicit learning represents a capability developed early in our evolution, the neural mechanisms that regulate it will reside in regions of the brain that correspond to the more basic functions. This is highly relevant to the understanding of psychopathology, since a prime goal of researchers in this area is to identify those portions of the human brain that become afflicted by the various pathologies.

Based on this scenario of brain evolution, the brain consists of layers of systems, the lower of which represent the earliest levels of our neurological evolution and the upper representing the most recent. A good deal of the research discussed in the first part of this dissertation suggests that these more primitive non-verbal layers are not fully capable of communicating their processes to the newer and the verbal neo-cortex. Thus, the unconscious processes are cognitions performed by the more primitive structures within the human brain. These primitive brains are capable of thought, but this thought is not accessible to the verbal consciousness. They are instead experienced as the intuitions or vague sensations, sometimes ego dystonic, that are the product of unconscious cognition.

A striking example of this is the phenomenon called blindsight. This occurs in people with damage, to the occipital lobes of the brain such that their visual association areas fail to function properly. Despite the damage many of these people are able to describe simple objects held before their eyes, although they typically deny they can see and report that their visual perception is in the form of an intuition of obscure origin (Zihl & Werth, 1984a; Zihl & Werth, 1984b; Bridgeman, B. & Staggs, D., 1982).

The aforementioned implies that at least some unconscious processes exist because the human brain consists of several discrete systems or structures which are capable of performing cognitive processes independently. If such lower level or otherwise separate systems of mind are the basis for automatic and implicit learning, then impairment of the higher functioning of the mind should produce differential deficits. That is, individuals with affective, schizophrenic and related disorders should perform relatively better on implicit learning than on tasks requiring conscious or effortful processing, and they should differ from the norma control subjects on the conscious, effortful tasks but not the automatic implicit ones.

# Chapter 4

## Methods and Results

### Overview

The following five experiments used several common features. They all involved a learning phase in which subjects are exposed to exemplars generated by a rule system. Experiments 1,2, and 3 employed a highly complex artificial grammar, while Experiment 4 utilized a relatively simple rule system. All experiments had a testing stage in which subjects were required to apply any knowledge of the rule systems they may have acquired during the learning phase. In Experiments 1, 2, and 3 subjects were presented with novel letter strings and they were asked to judge whether these strings are consistent with the grammar. In Experiment 4 the rule system is such that each letter string is uniquely associated with one number and each subject was be required to select the number correctly associated with each letter string.

Each experiment involved a comparison between a group that was impaired in some way with a group that suffered no prominent impairments. This comparison was variously between psychiatric patients who suffered from chronic alcoholism, affective and schizophrenic disorders and college students.

## Experiment 1

This experiment was, in part, a replication of the original implicit learning experiments of Reber. The prototypical experiment has subjects memorizing letter strings from the artificial language, either with and without the foreknowledge that these strings are rule governed. The issues under study include whether or not the grammar of the synthetic grammar can be learned, whether or not the subjects who function as though they have acquired an understanding of the rules are conscious of them, and whether or not prior instructions play a role in the acquisition of the rules.

The last problem of the instructional set is important in the conscious versus unconscious distinction. If conscious or attentional processes directly mediate the acquisition of the grammar, it would follow that the awareness of relevant information should play a major role. The particular purpose of this experiment was to determine if individuals who suffered from profound cognitive deficits that emerge in virtually all circumstances differ on this task from students.

### Subjects

The type of individuals selected for the impaired group were 13 males with a mean age of 40 years who were receiving treatment for chronic alcoholism. Every participant had suffered from alcoholism at least five years; all were inpatients at the Brooklyn Veteran's Administration Hospital. All subjects were diagnosed as suffering from some degree of organic brain syndrome. The diagnosis of alcoholism and organic brain syndrome was made by the Hospital medical and psychiatric staff.

A comparison group consisted of 36 students at Brooklyn College, with a mean age of 21.5 years, who participated in the study to satisfy an academic requirement. The younger and non-alcoholic college students provided a compelling contrast.

Stimulus Materials

The stimuli consisted of letter strings of length 2-6 using combinations and permutations of four letters (J T X V). The strings were created based on a set of rules that are presented in Appendix (B). Grammatical strings are those items which conform to the finite-state artificial grammar. The ungrammatical strings were produced by introducing a single or double letter violation into a grammatical string. The strings were presented on the screen of a portable personal computer. The entire stimulus set is presented in Tables 1 and 1a.

Procedure

The subjects were randomly assigned to the two instructional groups. The first group were only informed that they are to learn the letter strings as best as they can and that they are to be tested on them later. Subjects were instructed to read the following instructions which were presented on the computer display screen.

Instruction set one

You are participating in a cognitive psychology experiment, the purpose of which is to better understand human thinking and learning.

You will be shown a series of letter strings. Your task is to learn the strings to the best of your ability.

After you have learned the strings as well as you can, you will then be tested on your knowledge of them.

I m p o r t a n t: this is not an IQ test, nor does it measure any standard criterion of academic or social ability.

The second group was informed that the strings were constructed based on a set of complex rules that they were encouraged to learn. The second group was further instructed that they were going to be tested on their knowledge of the rules, as follows. This group was given instruction set two, which was also displayed on the computer screen.

Instruction set two

You are participating in a cognitive psychology experiment, the purpose of which is to better understand human thinking and learning.

You will be shown a series of letter strings. Your task is to learn the strings as best you can.

The strings are formed based on

A specific set
of ordering rules

*** it would be to your advantage to try to
develop an understanding of these rules ***

In other words, the letters are not random strings. They are structured based on a type of grammar such that the letters have to be ordered in a specific and consistent way...

After you have learned the strings as well as you can, you will be tested on your knowledge of them, <u>and their underlying rules</u>.

I m p o r t a n t: This is not an IQ test, nor does it measure any standard criterion of academic or social ability.

The subjects were seated in front of a personal computer, and were presented one of the two instruction sets above. The subjects were then told to wait for further verbal instructions. After the subjects were verbally given the same instructions from the investigator, they were asked to strike any key to begin. When they did so, the string presentations began. Each string was displayed on the computer screen for three seconds, and the screen was then cleared and the subject was prompted for a response.

The program responded to a correct response with a flashing reverse video screen displaying VERY GOOD. If the subject entered an incorrect response the screen was cleared and the subject was shown: THAT WASN'T IT PLEASE

TRY AGAIN. The screen would once again be cleared and this time the string would appear in the center of the screen. Each subject was permitted three incorrect responses, whereupon the program moved on to the next exemplar. The response time the subject took to enter each string correctly was calculated by the program. This was used as a comparative measure of impairment. The learning phase of the experiment included two presentations of the 25 strings listed in Table 1.

After all the strings were presented, the subjects were given a 30 second rest period. Both the group that received neutral instructions and the group that was informed that the strings were based on rules then received identical instructions for the testing phase of the experiment. Both groups were told that the strings were structured based on a specific set of ordering rules. They were informed that their task was to distinguish novel strings that conformed to the rules from novel strings that violated the rules. They were further informed that 50% of the novel strings that they would see would conform to the rules and 50% would violate the rules. All subjects were asked to read instruction set three.

Instruction set three

The preceding letter strings were based on rules. Or, in other words, a grammar.

If you had been learning sentences (which are based on English grammar) you would probably be able to detect if a new sentence was grammatically correct.

The following letter strings may or may not be consistent with the grammar that the strings you learned were based on.

*** In fact half the strings will be consistent
*** and half inconsistent ***

You are requested to make this determination. That is, make your best guess as to whether they conform, or do not conform to the grammar.

You may decide based on whether they seem or feel right or you may simply guess. In any case make the best possible decision.

When the subjects fully understood the instructions, with the criterion that they were able to verbally express what they were to do, the testing portion of the experiment began. The computer displayed a letter string, and the subject was asked to make a well-formedness decision. That is, he was asked whether he believed the string conformed the rules that generated the ones he learned.

The subject had to strike either the Y key or the N key to respond. One half second after each response a new string was displayed within the screen window, all other aspects of the screen stayed fixed. The subject was tested on 46 novel strings and 4 strings duplicated from the learning set. The series was repeated two times resulting in 100 exemplars. The repetition of the test strings permitted an analysis of the consistency of subjects' decision making process.

## Results

### Learning Phase

The learning portion of the experiment served two purposes. The first was to teach the subjects the structure of the letter strings generated by the finite-state artificial grammar. The second purpose was to validate the hospital's diagnosis of impairment. This was accomplished by measuring the time it took for each subject to learn each string. As explained above, each string was displayed for three seconds, after which the subject was required to type it from memory. If the subject typed it incorrectly, he was given two more chances to enter it correctly.

The statistics on time are based on the average time to re-enter a string correctly. As Table 2 denotes, the alcoholic subjects took substantially longer to learn the strings than the normal subjects. An analysis of variance indicated that overall difference in mean learning times was significant with $F(1, 48) = 4.22$ and $p < .05$. The learning time statistics are presented in table 3.

There was no statistical trend associating learning instructions and learning time. The mean learning times by instructional set can be seen in Table 4.

### Testing Phase

The primary purpose of this experiment was to compare the implicit learning by impaired alcoholics with that of unimpaired individuals. This was accomplished by examining three basic measures: the total number of correct decisions on the well-formedness task, the pattern of consistency and errors over the repeated presentation of the test strings, and the time to criterion in the learning phase.

There was no significant difference between the alcoholic and normal groups in the ability to distinguish between well-formed and non-grammatical strings. Table 5 displays the means and related statistics for the number correctly identified out of the 100 test strings for both groups of subjects

Although there was virtually no difference between the alcoholics' and students' overall abilities to apply the implicit knowledge acquired during the presentation of the exemplars, there were differences when the instruction set was considered.

Table 6 details the mean correct by instruction time, it shows that the instructional set had a different effect on the alcoholics than the normals. In earlier experiments (e.g., Reber, 1976) subjects, who were given explicit instructions that the strings were formed on a set of rules performed worse on the well-formedness task than those who were not informed. This is the case with the normals, but not the alcoholics, whose performance improved when given explicit instructions in the learning phase of the experiment.

The alcoholics performed substantially better when given explicit instructions. As the ANOVA in Table 7 shows there was significant group by instructional set interaction with $F(1, 48)=6.3$ $p <.02$. As mentioned above, the alcoholics were the most motivated of all subjects tested. They seemed eager to demonstrate that they were recovered from alcoholism, and had regained all their faculties. However, they also tended to be highly anxious, easily distracted, and had notable memory impairments. However, even though the explicit instructions increased their anxiety and their learning times, it also served to help them attend more closely to the letter strings.

The next analysis considers the consistency of the subjects responses. The well-formedness task was performed with 50 strings presented twice. This permitted an analysis of four possible outcomes: 1) CC - the subject made a correct judgment concerning a specific string on both presentations, 2) CE - the subject made a correct judgement on the first presentation and incorrect one on the second, 3) EC - an incorrect on the first and a correct on the second and 4) EE - incorrect on both presentations.

The purpose of such an analysis is to evaluate the extent to which an implicit learner's knowledge can be said to be representative of the structure of the learning array. If a subject has developed and utilized a non-representative set of rules then EE should be higher then EC or CE. An incorrect rule system will produce consistent errors, and EE should be statistically distinguishable from CE and EC. If CE is larger than EC then it is likely that forgetting was occurring, and if EC is larger than CE, it provides evidence for the notion that learning was taking place during the test phase. Finally, an overall estimate of the knowledge of the grammar can be obtained by reviewing the value of CC which contains only those items whose status is known plus those guessed consistently on both presentations. Thus, and an examination of these measures yields a more detailed comparison between the normal and abnormal groups.

Table 8 presents a summary of the consistency measures by group. The results of a two-way analysis of variance indicated that there is no statistical difference between the consistency scores of the two groups. This is borne out by the remarkable correspondence between the four measures of both groups. The consistency scores were then pooled to examine any differences among them. The pooled measures presented in Table 9, futher illustrate the differences between the consistency scores. A one way analysis of variance in Table 10 confirmed that the combined consistency measures are significantly different ($\underline{F}(3, 192)=354$ $\underline{p} < .001$). A post-hoc Scheffe multiple range test showed that the scores fell into three distinct groups

1) CC 2) CE & EC 3) EE. This means that CC is significantly larger than the other three groups; and EE is significantly larger than CE & EC. The most cogent explanation for this result is that subjects in both groups tended to form internally consistent but incorrect rule systems. More significant, however, is the fact that both groups of subjects, the normal and the impaired, tended to do this to the same extent. This result supports the trend mentioned earlier that suggested the alcoholics were extremely motivated, which led them to create rules in order to classify the test strings.

The effects on instructional set can be seen in Table 11 which displays the means for each consistency category for both the alcoholic and the student groups. A 3 way ANOVA in Table 12, which examined the interactions of consistency score, group (student vs. alcoholic), and instruction set proved the group by instruction by consistency score interaction to be significant with $\underline{F}(3, 97)=5.51$ and $\underline{p}<.01$. This 3-way interaction is best understood by noting that the number of consistent correct well-formedness decisions (CC) was roughly the same for students under both the explicit and neutral conditions, while the alcoholics scored substantially higher on CC under explicit conditions than they did under neutral instructions. In addition, the number of consistent errors (EE) increased for students who received explicit instead of neutral instructions; the opposite was true for the alcoholics. This probably indicates that when alcoholics were given neutral instructions they guessed at the purpose of the experiment and induced incorrect rules. When informed of the rule driven structure of the learning strings they attended more closely, and deferred model formation. This is probably the result of the improvement of both the CC and EE scores for the alcoholics while operating under the explicit instruction set.

Experiment 2

The design and method of this experiment was identical to the first experiment but it involved a different population of subjects. This experiment sought to determine if mild to moderate depression impairs the implicit learning process. The hypothesis tested was that subjects who are depressed will implicitly learn as well as non-depressed subjects on the grammar learning task; that is, implicit learning should show no sensitivity to depression. However, the depressed subjects were expected to perform more poorly in the learning phase, a conscious, non-automatic task.

Subjects

The 38 subjects in this experiment were selected from a larger pool of subjects who were administered the Zung Self Scoring Depression Scale (Zung, 1965, 1969, 1973). The Zung test (See Appendix C) a highly reliable and valid test for clinical depression, consists of several statements that are associated with affective disorders. Individuals taking the test check off a box for each of 20 statements indicating whether, and to what degree, that statement applies to him or her.

In order to encourage candor in completing the test, the subjects were given complete anonymity. They were asked to provide their age and any three initials on the Zung form. When they completed the test, they put the exam into a bin that contained all the other completed forms. When the subjects began the primary part of the experiment they were prompted using the same three initials they wrote on the Zung form. This assured all subjects that the experimenter would not be able to correlate a Zung score with a specific individual, only with the scores obtained on the experiment itself.

Subjects were tested until a substantial and equal number of depressed and non-depressed students were identified. After the final day of testing, 19 students were identified by the exam as depressed as defined by a Zung score of greater than 50. This depressed group was compared with the 19 lowest scorers on the exam; the lower the score the more confident one could be that there was no evidence of depression, and conversely the higher the score the greater the degree of depression. Table 13 presents the means and the related statistics for the Zung scores of the two groups, which confirm the mean Zung scores of the two groups are significantly different with a $t=11.19$ and $p<.001$. All subjects were Brooklyn College undergraduate students who were required to participate in psychology experiments for course credit.

## Results

### Learning Phase

It was expected that the impaired group would be slower in learning the grammar strings, as was the case in the previous experiment. This result was not forthcoming. The depressed group actually took slightly less time, although statistical tests revealed that chance is the most likely explanation for this difference, $F(1, 37)=1.19$, $p=.28$. Table 14 displays the mean learning times for the two groups. This implies that there is no difference in the learning times. This result is in sharp contrast to those obtained with the alcoholic and psychiatric groups. Both of these groups took significantly longer to learn the strings. A possible explanation for this result is that depression in college students tends to be reactive or cognitive, where clinical depression may have more of a neurochemical foundation.

Testing Phase

There was virtually no difference between the depressed and non-depressed groups in their ability to discriminate well-formed strings from those who failed to conform to the grammar. In essence, college students who are mildly to moderately depressed are indistinguishable from non-depressed students in terms of implicit learning. Table 15, which shows the number of correctly identified strings out of 100 test strings by both groups, proves this to be the case. Because there were no differences between the two groups, the consistency measures were not analyzed.

## Experiment 3

This third experiment employed the same methodology as the first and second experiments, differing only in the type of subjects selected. As in the first experiment, an impaired population was compared to Brooklyn College students. And, as before, half of each group received the neutral instructions and half were given explicit information concerning the rule-governed nature of the stimuli. In this experiment, the impaired group consisted of psychiatric inpatients with impairments severe enough to require extended inpatient hospitalization. The difficulty in obtaining such patients as subjects precluded a focus on any one diagnostic category. Instead this experiment looked at both schizophrenic and depressed subjects, to explore the robustness of implicit learning.

The premise of this experiment was based on a comparison of the strong form of automaticity of Hasher and Zacks (1985) and the weaker form of Kellogg and Dowdy (1986) and Greene (1986). Specifically, Hasher and Zacks predicted that there should be no commensurate degeneration in automatic processing with increasing impairment. In comparison, Kellogg and Dowdy (1986) argued that automaticity is just one of many cognitive dimensions that vary based on situation, need, and individual condition. Since a contention of this dissertation is that implicit learning is an automatic process akin to those studied by

Hasher and Zacks, it should be robust in the face of serious psychiatric illness. Thus, the hypothesis was the psychiatric patients would perform no differently on the well-formedness task than the college students. As above, differences were expected during the more overt, explicit task that makes up the learning phase.

Subjects

The psychiatric group consisted of 12 inpatients at the Brooklyn Veteran's Administration Hospital. The mean age of the hospitalized subjects was 37 years, only one subject had any college education. All patients were moderately to acutely ill suffering from chronic psychiatric ailments. The subjects were diagnosed as follows: six with Schizophrenia, four with Depression, one with Bipolar - depressed, and one with Post-traumatic stress disorder - depressed.

These diagnoses were assigned by the hospital psychiatric staff. All subjects were given an informal interview prior to the experiment, to validate psychiatric impairment. In general, if a depressed patient exhibited or expressed two or more of the following the diagnosis of depression was judged to be valid: melancholic affect, mood congruent delusions or hallucinations, suicidal thoughts, or psychomotor retardation. Similarly, if a patient diagnosed with a schizophrenic disorder expressed or exhibited two or more of the following his diagnosis was validated for the purpose of the experiment: delusions, auditory hallucinations, incoherent/irrational speech, inappropriate affect, or disorganized thinking.

The comparison group was the same 36 Brooklyn College undergraduate students used in Experiment 1. These students had a mean age of 21.5 years, and typically were in their first or second year of college. All were participating to satisfy a course requirement.

## Results

### Learning Phase

The learning portion of this experiment served the same two-fold purpose as in Experiments 1 and 2, that of presenting the exemplars of the grammar and of providing a secondary measure of impairment. As expected, the psychiatric patients took markedly longer to learn the exemplars to criterion. Table 16 contrasts the learning time statistics for the psychiatric and student groups.

The difference in the mean learning times were significantly different (see Table 17). This confirmed the hypothesis that the group defined as impaired performs in an impaired fashion, in a task based on conscious overt memorial processes. There was a slight trend associating instructional set, with learning time (see Table 18). However the analysis of variance in Table 19 proved this trend to be non-significant.

Testing Phase

Both the student group and the psychiatric patient groups scored well above chance levels. In addition, the performance of psychiatric subjects was statistically indistinguishable from the students in the well-formedness task (see Tables 21 & 22). Despite the psychiatric patient's severe disabilities their mean score of 65% right was virtually the same as the 66.4% obtained by the students.

An analysis of the consistency measures for the psychiatric subjects revealed that the four measures differed significantly with $F(3, 47)=63.0$, $p=.001$. A post-host Scheffe test showed that the difference was between CC and the other three measures: CE, EC and EE.

## Experiment 4

The purpose of this experiment was to test the effect of implicit learning with a rule system that is accessible and somewhat more obvious than the complex artificial grammars used in the first three experiments. This is in part to help resolve some of the differences found between Danks and Gans (1975) and Reber (1980) which were discussed above. The difference in their experimental results raised the point that as rule systems become more apparent in the exemplars, explicit processes play an increasingly larger role. If this is the case, then people with psychiatric impairments who perform less well on the learning task, which is conscious and controlled, should also exhibit relative degradations in their ability to induce the more obvious rule systems. The reason for this is that the more obvious rule system should be at least partially accessible to the conscious cognitive processes.

The experiment performed here involved changing from a complex generative grammar to a simpler system utilizing a straight-forward arithmetic relationship. In the earlier experiments predicated on the generative grammar, it would have been virtually impossible for the brightest person to induce the exact principles of the grammar given the limited exposure to the subset of exemplars. In this study, it is difficult to perform such an induction, consciously easier. Therefore, it was expected that, unlike the experiments utilizing the complex grammars, psychiatric subjects will perform worse than the normal subjects. This aspect was examined further by studying the subject's verbal reports concerning their decision justifications.

Subjects

Nine psychiatric inpatients at the Brooklyn VA Hospital and three at Brookdale Medical Center served as the impaired subject population. All patients were acutely ill inpatients with the following distribution of diagnoses: three with Schizophrenia, six with Depression, one with Post-Traumatic Stress Disorder with Depression, and two with Bi-Polar Disorder-depressed phase. As in Experiment 3, the diagnoses were assigned by the psychiatric staff of the Brooklyn VA Hospital and were informally validated by the same method used in Experiment 3. The mean age of the psychiatric subjects was 38 years.

Twenty four undergraduate students served as the comparison group. All students were selected from a subject pool and participated to satisfy a course requirement. The average age of this group was 21 years.

Procedure

The experiment began with each subject receiving the following instructions:

You are going to see a string of letters followed by a number. Your task in this phase of the experiment is to type the number as fast as possible, only after you have read the letters. You will be tested on your knowledge of the letters, but your reaction time in typing the numbers is also important.

After the instructions the subjects saw, one at a time, the 48 string-number combinations presented in Table 23 below. Each stimulus was presented on a computer screen, and it was cleared as soon as the subject struck the number on the keyboard corresponding to the number in the string-number stimulus.

After each subject was presented with the training stimuli, they were given a rest period followed by a second set of instructions:

During the first part of the experiment there were letters that preceded the numbers you were entering.

These letters formed a pattern or code that corresponded to the numbers. That is, it was as if every number was presented twice, once in letter form, and second in numeric.

In the second part of the experiment you are going to see letters that follow the same code.

Your task is to determine what number they represent. You will be given a choice of 3 numbers.

PICK THE NUMBER THAT YOU FEEL IS THE SAME OR CORRESPONDS TO THE LETTERS.

The 48 strings used are presented in Table 24. Each string shown in the table was presented one a time on the computer screen. Along side each string the three numbers, also shown on the computer, that each subject had to choose from.

After the subjects completed this last phase of the experiment, they were all polled as to the basis of their decision. This was to determine if any subjects were able to discern any of the rules associating the numbers with the letter strings.

## Results

### Learning Phase

As in Experiments 1-3, the learning phase of the experiment served a dual purpose: to expose the subjects to the exemplars of the rule system and to corroborate their impairment. If the psychiatric subjects take longer to learn or respond to the stimuli than the normals, it indicates some degree of generalized deficit. This is what was found (see Table 25).

The psychiatric subjects took more than 40% longer to respond to the learning strings. A one way analysis of variance indicated that this difference was statistically significant with $F(1, 35)=5.06$, and $p< .05$. The next analysis was performed to determine if there was any learning effect. That is, did subjects take less time to respond to the stimuli as they progressed through the experiment? In order to answer this question the 48 response times were split into two groups of 24, and then an analysis of variance was performed to discern any differences.

The results displayed in Table 26 disclose that both groups took significantly less time to respond to the second half of the stimulus set. It is interesting to note that although both groups improved with time, the normal group's first half performance was better than the psychiatric group's second half performance. This implies that even with practice the psychiatric subjects still were impaired relative to the normals.

In order to examine further the improvement with practice a time series regression analysis was carried out. This analysis revealed that both groups were improving with each item at approximately the same rate. The regression equations presented in Table 27 also confirm that the students performed substantially and significantly better than the psychiatric subjects.

The final analysis of the learning phase utilized a simple correlation. This was performed to examine the relationship of stimulus item and response time. All subjects were told to read the string prior to striking the appropriate number on the keyboard. If individuals in both groups were doing so and using roughly the same operations, then the time by item for the two groups should be correlated. In fact, there was a .83 correlation between the response times for each stimulus string for the two groups. This correlation was significant with a $p<.001$.

Testing Phase

The outcome of the preceding discussion was expected -- the psychiatric patients were not able to infer any rules nor did they utilize any strategies. In contrast, the students attempted to use strategies, sometimes ones that were essentially correct. The following results show that these conscious stategies gave the students an advantage in an experiment where the rule system is accessible.

Unlike the experiments utilizing the complex grammar, in this experiment psychiatric patients performed substantially worse that the college students. Table 28 sets forth the statistics for the number correct out of 48 obtained by both groups, which reveal that the students performed above chance levels while the psychiatric patients performed at chance.

The difference between the two groups was significant with an analysis of variance resulting in $F(1, 35) = 4.9$ and $p < .05$ (see Table 29). This result shows that the student controls performed significantly better than the impaired subjects. In addition, the student control group's performance was significantly above chance with $t = 3.8$ and $p < .001$, while the psychiatric group's performance was no different than chance with $t = .23$.

These results are especially interesting when compared to those of the complex grammar experiments. In those experiments individuals with impairments affecting all cognitive functioning were able to perform above chance in judging the well-formedness of exemplars based on a very complex rule system. In contrast, in this experiment, which utilized a much simpler rule system, the impaired subjects failed to perform above chance levels.

Because a major aspect of this research is predicated on that the poor performance of the impaired group was due to fact that the simpler rule system was more consciously accessible, it would be interesting to examine the subjects' decision justifications.

As noted above, all subjects were queried about the basis for their decisions in the test. This was to see if any had inferred the rules underlying the experiment. The following is an informal analysis of their responses. Only two subjects, who were in the student control group, could explicitly state any of the specific rules. They inferred that the number was related to the sum of values assigned to letters. However, neither of these subjects was able to express the specific value of all the letters. These two subjects got 37 and 38 right out of 48. This result suggests that they had completed their discovery of the rules by the end of the test phase. Five students indicated they believed there was a relationship between the length of the letter string and the magnitude of paired number. All the rest of the students said they were guessing and judging based on the similarity of the test pairs to the learning pairs. Only two subjects said they were guessing with no associated decision strategies.

None of the psychiatric subjects saw any relationship between the numbers and the letters, even for those who did fairly well. All of the subjects expressed decision rules that were completely unrelated to the actual rules. This analysis confirms the supposition that the students were able to enhance their performance in this experiment by utilizing conscious stategies. This proved not to be the case for the psychiatric subjects.

# Chapter 5

# Discussion

## Complex Grammar Experiments

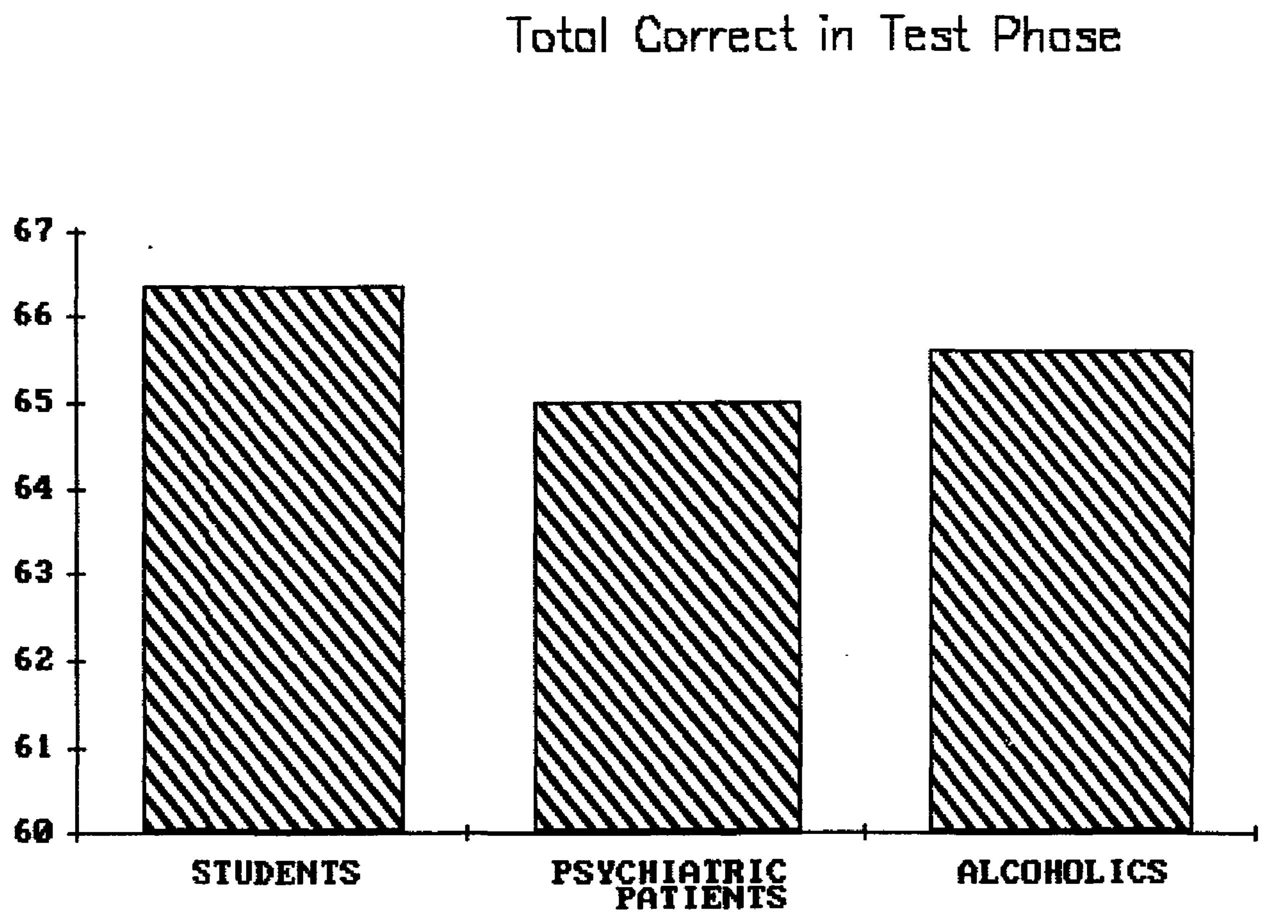
The most intriguing aspects of this dissertation are found when looking at patterns of results across experiments. In doing this it becomes clear how dramatic the differences between the populations are, when the proper conditions hold, and equivalently, how stunning the similarities when other conditions prevail. In order to highlight these patterns, cross-experiment comparisons need to be discussed. The simplest breakdown is by severity of psychiatric disorder.

### Studies with Psychiatric Inpatients

The complex grammar experiments examining psychiatric subjects involved three groups: a control group made up of undergraduate students, the alcoholic group and the psychiatric patient group. All of these groups performed statistically equivalently to one another in the implicit learning, well-formedness task. Therefore, it appears that neither chronic alcoholism nor profound psychiatric illnesses, conditions which normally seriously impair cognitive functioning on complex tasks, prevented individuals from inducing complex rules by observing rule-governed exemplars. The measure utilized in the well-formedness task was the total number of letter strings correctly identified out of 100. There were only small differences in this measure among the three groups. Figure 1 displays the total correct for each group.

The performance of the three groups supports the hypothesis that implicit learning is as insensitive to impairment as Hasher and Zacks' (1984) fundamental processes have been shown to be. The results also support the propositions set forth by Reber (1985) and Lewicki (1986) that implicit learning may be based on the frequency counting of event covariation, since it, like the fundamental processes, appears immune to the influence of mental impairment.

Figure 1. Mean total correct in test phase of Experiments 1 and 2, for three groups consisting of 36 students, 12 psychiatric patients, and 13 alcoholics, respectively.



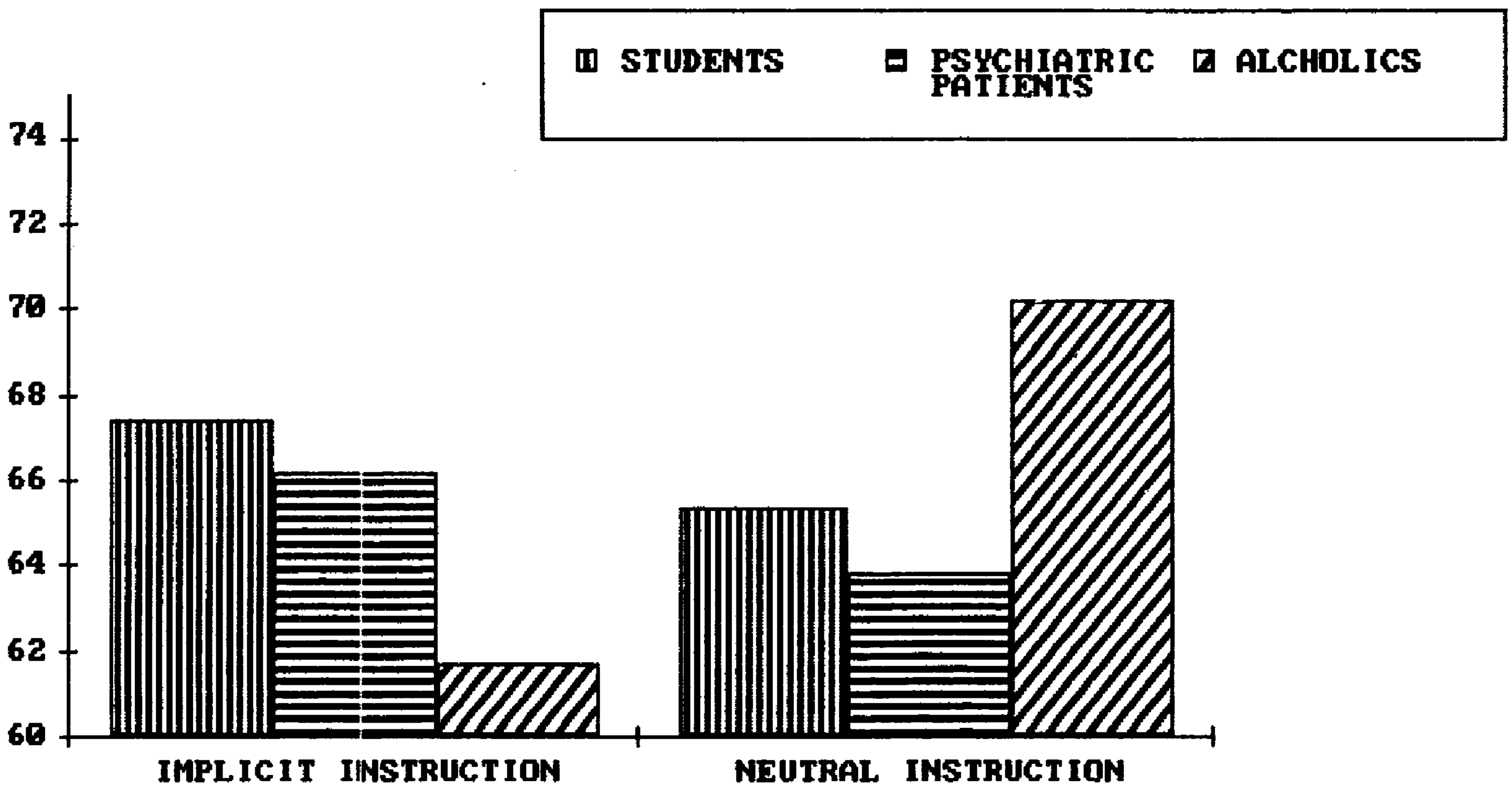
Total Correct in Test Phase
67
66
65
64
63
62
61
60
STUDENTS
PSYCHIATRIC PATIENTS
ALCOHOLICS

Differences among the three groups became apparent when the instructional set was considered (see Figure 2). In the three experiments, subjects, during the learning phase, were randomly assigned to either an explicit or an implicit instruction group. Subjects receiving implicit instructions were told to try to learn the letter strings but were not told why. Those given explicit instructions were informed that the strings were constructed based on a set of complex rules and they were to try to infer these rules.

Both control subjects and psychiatric patients showed no differences the test phase, regardless of instuctional set. This is different from many of the earlier implicit learning experiments (e.g. Reber, 1976) in which explicit instructions tended to degrade performance in the testing phase. Interestingly, alcoholic subjects performed noticeably better after being given the explicit instructions. As noted earlier, this was probably a result of the high motivation of the alcoholics. When given implicit instructions they became anxious and distracted when unable to directs their efforts in a meaningful way. They wanted to try hard, but they did not know what to do. However, when they were informed about the rule-governed nature of the strings they attended a lot more carefully to the letter strings during the learning phase and were able to induce more representative rules.

Figure 2. Average total correct out of 100 in test phase by group and instruction set. The bars labeled student depict the mean learning time of the 36 student subjects, similarly, bars labeled psychiatric patients, represent the 12 subjects in that group, and the bars labeled alcoholics represent mean learning time of the 13 alcoholic subjects. In the implicit instruction set subjects received no information about grammar rules; int the explicit subjects were that told letter strings were formed based on a set of complex rules.

Total Correct in Test Phase by Instructional Set



Differences in performance between the various subject populations, however, became more salient when learning time was considered. As Figures 3 and 4 indicate, the psychiatric patients and the alcoholics took significantly longer to learn the strings than the students during the learning phase. Therefore, on a basic performance task both the alcoholics and the psychiatric patients demonstrated deficits. This confirmed the prediction of impaired performance that was made based on the discussion of generalized deficits discussed earlier (e.g. Kietzman, Spring, & Zubin 1985; Asarnow & MacCrimmon, 1982).

As detailed earlier, consistency was measured by presenting each letter string twice during the well-formedness task. This provided four measures of consistency, CC, meaning correct on both trials; CE, correct on the first trial and an error on the second; EC, an error on the first and correct on the second; EE, an error on both presentations. If subjects are making decisions based on a representative set of rules that reflect, albeit partially, the underlying grammar and when they do not know, the value of EC, CE, and EE ought to be approximately the same. However, if subjects are systematically using non-representative rules it should show up as an inflated value of EE, since inappropriate rule use should dictate the making of systematic errors. Figure 5 compares the performances of the three groups on all of the measures.

With all groups, CC was significantly greater than any of the other three. In the student and alcoholic groups EE was greater than the means of CE and EC. This was not the case for the psychiatric group. This signifies that both the student and alcoholic groups were developing systematic, but incorrect, rule systems to aid them in the well-formedness task. The psychiatric subjects did not do this, they tended to be the most inconsistent of the three groups. This makes sense since their learning time was the longest of all groups and, in all appearances, they appeared to be the most impaired group.

The fact that the psychiatric subjects performed well-above chance, and, at the same time, very inconsistently, melds well with the idea that the illness is affecting higher brain areas to a greater extent than the more primitive brain regions. According to the models of MacLean (e.g. 1977, 1984) the lower brain areas are phylogenetically more primitive, yet complete cognitive systems. If implicit learning is a more primitive process centered in phylogenetically lower brain areas, then it should remain relatively intact in the face of an illness that affects the higher brain regions more so than the lower ones.

Figure 3. Mean time to learn letter strings in Experiments 1 and 2 for three groups consisting of 36 students, 12 psychiatric patients and 13 alcoholics, respectively.

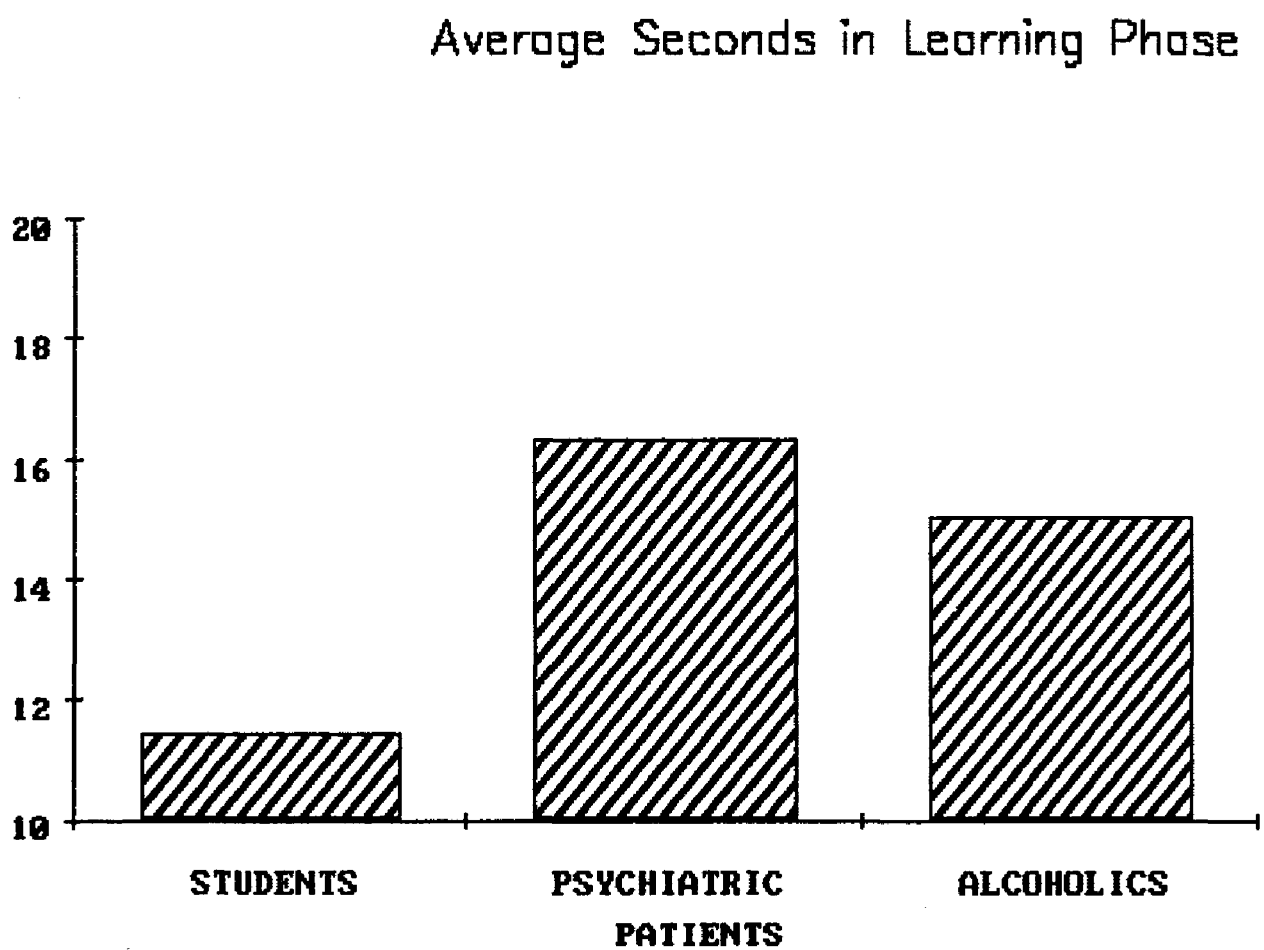

Average Seconds in Learning Phase
20
18
16
14
12
10
STUDENTS
PSYCHIATRIC PATIENTS
ALCOHOLICS

Figure 4. Average learning time per item in learning phase by group and instruction set. The bars labeled student depict the mean learning time of the 36 student subjects, similarly, bars labeled psychiatric patients, represent the 12 subjects in that group, and the bars labeled alcoholics represent mean learning time of the 13 alcoholic subjects. In the implicit instruction set subjects received no information about grammar rules; int the explicit subjects were that told letter strings were formed based on a set of complex rules.

Average Seconds in Learning Phase by Instructional Set

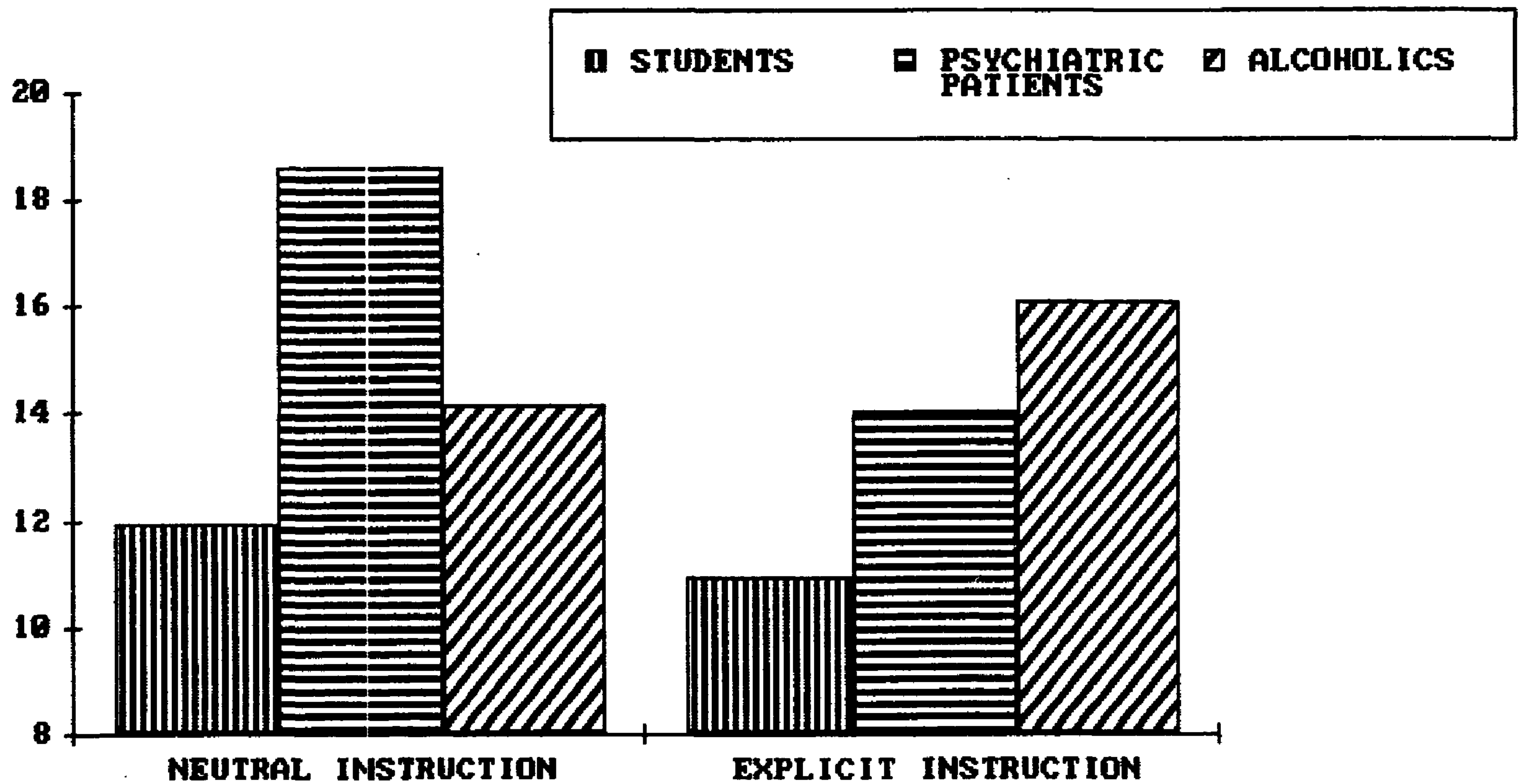
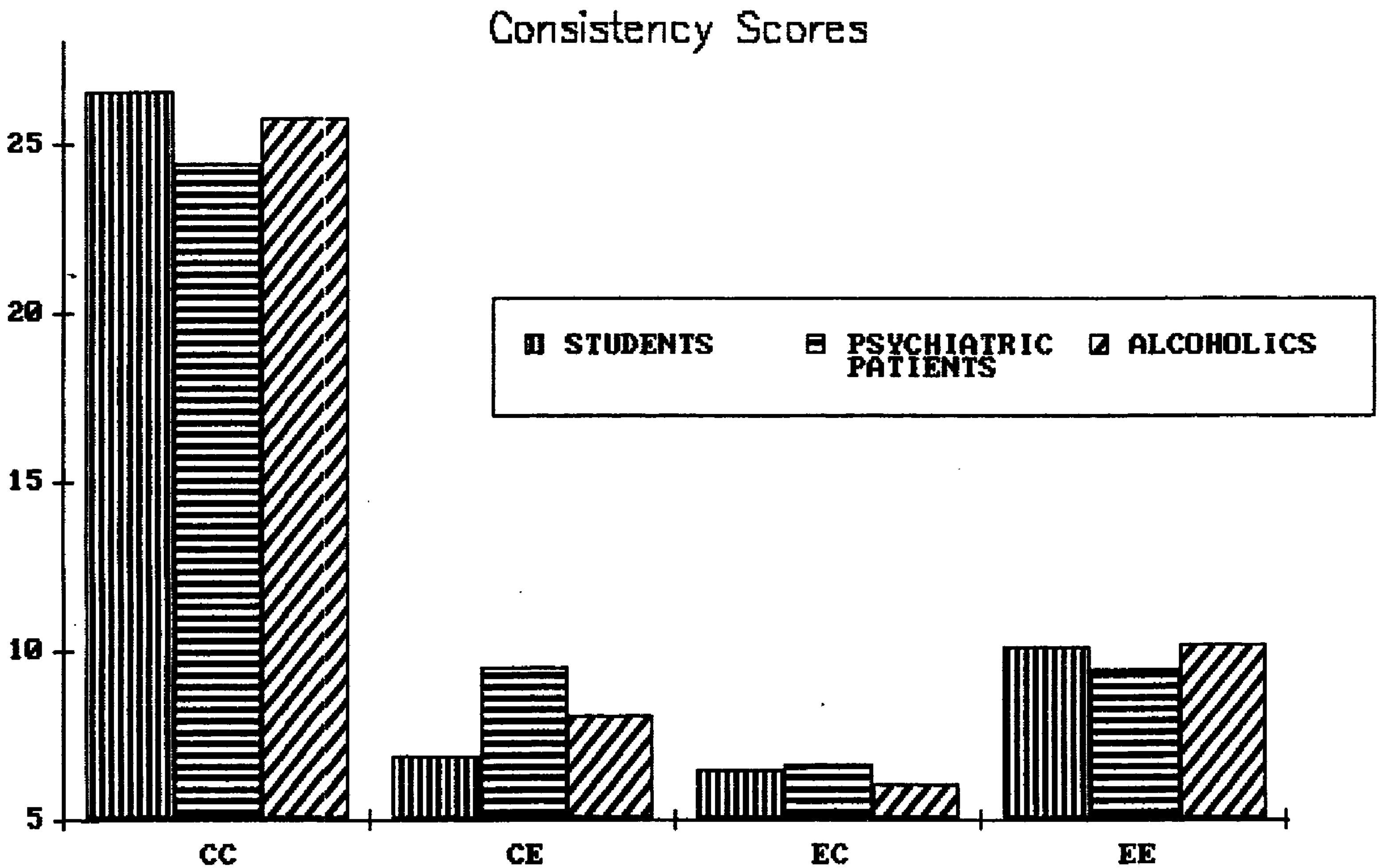


Figure 5. Total right by group and consistency category. The student bars represent the 36 student subjects, the psychiatric patient bars represents the 12 subjects in that group and the alcoholic bars represents the 13 alcoholic subjects. The CC (Correct-Correct) category refers to the number of times a subject correctly identified an item in the well-formedness task twice in a row. The CE (Correct-Error) refers to the number of times a subject identified an item correctly, then incorrectly. The EC (Error-Correct) refers to the number incorrectly identified on the first presentation, and correctly on the second. The EE (Error-Error) refers to those items incorrectly identified on both presentations.


Consistency Scores
25
20
15
10
5
STUDENTS
PSYCHIATRIC PATIENTS
ALCOHOLICS
CC
CE
EC
EE

On the other hand, alcoholism has been shown to result in less specific deficits than are found in psychiatric illnesses. The deficits in alcoholism tend to be diffuse and generalized. As such, it would be expected that alcoholics would follow essentially the same pattern as control groups as far as consistency is concerned.

Mild Depression in College Students

A different pattern became manifest when mild to moderately depressed college students were compared to non-depressed students. In general, there were no marked differences between the two groups in either the learning phase or the test phase of the experiment.

The important message from this experiment is that there are very real differences between the type of simple emotional disturbances that mildly depressed college students display and that suffered by individuals in psychiatric institutions. In addition, this experiment served to validate results in Experiments 1 and 3 by providing a further contrast between the hospitalized subjects and a group of students who suffer relatively mild emotional illness.

Simple Grammar Experiment

The hypothesis set forth earlier in this dissertation proposed that the induction of rules relating to complex grammars take place unconsciously. This was borne out in Experiments 1 - 3, in which all groups, even those with severe cognitive impairments performed above chance. This last experiment also compared cognitively impaired and non-impaired groups, but instead of utilizing a complex grammar, a much simpler one was used. This approach was based on the research, discussed earlier, that maintained that the human information processing system, intrinsically, has both conscious and unconscious components. For example, this is the finding of researchers who studied automatic frequency counting (e.g Kellogg, 1982; Hasher & Zacks, 1979, 1984). It is also the conclusion inferred from the result that both organic amnesiacs (Jacoby & Witherspoon, 1982) and individuals receiving subliminal stimuli seem to act on information they have no conscious awareness of (Marcel, 1983; Zajonc, 1984).

The research presented earlier indicated that, in general, both unconscious and conscious cognitive capabilities can be applied toward any task, if that task is accessible to both modalities. Recall that Reber (1976), Kellogg (1985), Kellogg and Dowdy (1986) and Danks and Gans (1975) all obtained results that showed that automatic processes are facilitated by conscious effort. Thus, in Experiment 4, where the induction operation required to acquire the structure of the grammar was consciously accessible, the likelihood that conscious, effortful processes would be used by subjects increased.

As the role of the conscious processes increased, the role of unconscious mechanisms tended to play a relatively less important role. Therefore, the subjects whose conscious, effortful cognitive systems were impaired by psychiatric disorders displayed poorer performance than the control subjects. The important finding here is that roughly equivalent groups of psychiatric inpatients function, (a) approximately the same as normals in one condition but, (b) significantly poorer than normals in another. What is striking about these results is that in (a) the groups are working in a highly complex, abstract induction task. Whereas in (b) they were confronted with a relatively simple, concrete rule learning task. As was argued above, the critical element here is that the grammar-learning task in (a) is mediated by deep "primitive" cognitive systems that operate outside of consciousness and independent from psychiatric impairment, while the concrete associative rule learning in (b) is administered by conscious, overt systems that are seriously hampered by psychiatric disorders. Put simply, patients with psychiatric disorders can, under the proper conditions, functions at levels equivalent to normals.

## Conclusion

It appears, then, that implicit learning is a robust process that is only minimally mediated by conscious or effortful cognition. Neither minor affective disorders, nor major psychiatric disorders were able to significantly diminish the ability to induce information in this way. This indicates that further study is required to determine why implicit learning is resistent to psychiatric illness. If, in fact, implicit learning is mediated by brain areas that are not affected by psychiatric illness it may provide the tools for better understanding the nature of certain illnesses. This may be accomplished by examining the many psychiatric illnesses separately to examine further the relative impact each may have on this process.

Table 1

<u>The Strings Generated by Finite State Grammar</u>

String Length:

| | TWO | THREE | FOUR | FIVE | SIX |
|---|---|---|---|---|---|
| 1 | VJ* | VXJ* | VXJJ | VJTVJ* | VJTVXJ* |
| 2 | VX | VTV | VTVJ* | VJTVX | VJTVTV |
| 3 | VT* | VXJ* | XXVJ | VJTVT* | VJTXVJ* |
| 4 | | XVX | XXVX* | VXJJJ | VJTXVX* |
| 5 | | XVT* | XVXJ | VTVJJ* | VJTXVT |
| 6 | | | XVTV* | XXXVJ | VXJJJJ |
| 7 | | | | XXXVX* | VTVJJJ* |
| 8 | | | | XXXVT | XXXXVJ |
| 9 | | | | XXVXJ* | XXXXVX* |
| 10 | | | | XXVTV | XXXXVT |
| 11 | | | | XVXJJ* | XXXVXJ* |
| 12 | | | | XVTVJ* | XXXVTV |
| 13 | | | | | XXVXJJ* |
| 14 | | | | | XXVTVJ |
| 15 | | | | | XVJTVJ* |
| 16 | | | | | XVJTVX |
| 17 | | | | | XVJTVT* |
| 18 | | | | | XVXJJJ |
| 19 | | | | | XVTVJJ* |

<u>Note:</u> an asterisk denotes a string actually used in the learning phase.

Table 1a

<u>Strings Used in Test Phase</u>

| | | | |
|---|---|---|---|
| VX | | JJJTV | * |
| XXXXVJ | | VJTXVT | |
| VXJJ | | VXTJ | * |
| TXJ | * | XXVTVJ | |
| XXXVV | * | XVXTTJ | * |
| XXVJ | | VJTVJ | |
| XVJ | | VXJJJ | |
| VTV | | XVJTVX | |
| JJ | * | TJV | * |
| XVX | | TTV | * |
| TTJX | * | VJTXT | * |
| XXVT | | XVTVJJ | |
| VJTVX | | TX | * |
| XVTVT | * | TJTVX | * |
| XXVXX | * | XX | * |
| XXXVTV | | XVXJJJ | |
| TXVJ | * | VT | |
| XVJTVJ | | XVV | * |
| XXXVJ | | VXJJJJ | |
| XXXVT | | VJTVXT | * |
| XXXJJ | * | XVVJ | * |
| VTJJJ | * | XXVJJ | * |
| XXVTV | | XXXXVT | |
| VJTVTV | | VJTJV | * |
| XVTJV | * | XXTXJ | |

<u>Note:</u> an asterisk denotes a string that does not conform to the grammar.

Table 2

ANOVA: Learning Time by Normals vs.Alcoholics

in Experiment 1

| Source | DF | Sum of Squares | Mean Squares | F Ratio | F Prob. |
|---|---|---|---|---|---|
| Between Groups | 1 | 125.57 | 125.57 | 4.22 | .04 |
| Within Groups | 47 | 1399.20 | 29.77 | | |
| Total | 48 | 1524.77 | | | |

Table 3

Learning Times in Experiment 1

| Group | N | Mean | SD | SE | 95% Conf. Int. | | |
|---|---|---|---|---|---|---|---|
| Normals | 36 | 11.41 | 5.77 | .96 | 9.46 | To | 13.35 |
| Alcoholics | 13 | 15.03 | 4.47 | 1.24 | 12.35 | To | 17.73 |

Table 4

Learning Time in Seconds by Instruction Set and Group in Experiment 1

| | GROUP | |
|---|---|---|
| | Student | Alcoholic |
| INSTRUCTIONS | | |
| Neutral | 11.91 | 14.16 |
| Explicit | 10.90 | 16.05 |
| Combined | 11.41 | 15.03 |

Table 5

Total correct out of 100 in Well-Formedness Task in Experiment 1.

| Group | N | Mean | SD | SE | 95% Conf. Int. | | |
|---|---|---|---|---|---|---|---|
| Normals | 36 | 66.36 | 5.73 | .95 | 64.42 | To | 68.30 |
| Alcoholics | 13 | 65.62 | 9.08 | 2.51 | 60.13 | To | 71.10 |

Table 6

Total Correct in Test Phase by Group and Instruction Set in Experiment 1

| | GROUP | |
|---|---|---|
| | Students | Alcoholics |
| INSTRUCTION SET | | |
| Neutral | 67.39 | 61.71 |
| Explicit | 65.33 | 70.17 |

Table 7

ANOVA: Total Correct in Test Phase by Neutral vs. Explicit Instructions and Students vs. Alcoholics in Experiment 1

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig. of F |
|---|---|---|---|---|---|
| Main Effects | 11.654 | 2 | 5.83 | .14 | .87 |
| Instructions | 6.343 | 1 | 6.34 | .15 | .70 |
| Group | 4.919 | 1 | 4.92 | .12 | .73 |
| 2-way Interactions | | | | | |
| Instructions group | 262.500 | 1 | 262.50 | 6.31 | .02 |

Table 8

Mean Consistency Scores in Experiment 1

| | CC | CE | EC | EE |
|---|---|---|---|---|
| Students | 26.47 | 6.92 | 6.50 | 10.11 |
| Alcoholics | 25.77 | 8.08 | 6.50 | 10.15 |

Note: CC refers to a subject correctly identifying a letter string on both presentations. CE refers to a correct identification on the first presentation and incorrect identification on the second presentation. EC indicates that the first identification was incorrect and the second was correct. EE denotes an incorrect identification on both presentations.

Table 9

Mean Consistency Scores For Alcoholics and Students Combined

| Category | N | Mean | SD | SE | 95% Conf. Int. | | |
|---|---|---|---|---|---|---|---|
| CC | 49 | 26.29 | 4.80 | .69 | 24.91 | To | 27.66 |
| CE | 49 | 7.22 | 2.76 | .39 | 6.43 | To | 8.02 |
| EC | 49 | 6.37 | 3.06 | .44 | 5.49 | To | 7.25 |
| EE | 49 | 10.12 | 2.87 | .41 | 9.30 | To | 10.95 |

Note: CC refers to a subject correctly identifying a letter string on both presentations. CE refers to a correct identification on the first presentation and incorrect identification on the second presentation. EC indicates that the first identification was incorrect and the second was correct. EE denotes an incorrect identification on both presentations.

Table 10

ANOVA: Consistency Score by Consistency Category

in Experiment 1

| Source | DF | Sum of Squares | Mean Squares | F Ratio | F Prob. |
|---|---|---|---|---|---|
| Between Groups | 3 | 12795.82 | 4265.27 | 354.02 | .001 |
| Within Groups | 192 | 2313.18 | 12.05 | | |
| Total | 195 | 15109.00 | | | |

Table 11

Consistency Scores by Group and Instruction Set

| | CC Neutral | CC Explicit | CE Neutral | CE Explicit |
|---|---|---|---|---|
| Students | 26.83 | 26.11 | 6.67 | 7.17 |
| Alcoholic | 22.57 | 29.50 | 8.71 | 7.33 |
| **EC / EE** | | | | |
| Students | 7.06 | 5.94 | 9.44 | 10.78 |
| Alcoholic | 7.86 | 3.83 | 10.86 | 9.33 |

Table 12

ANOVA: Consistency Score by Alcoholism, Instruction set and Consistency Category

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sign. of F |
|---|---|---|---|---|---|
| Main Effects | 12795.82 | 5 | 2559.16 | 226.02 | .01 |
| GROUP | 0.00 | 1 | .00 | .00 | 1.00 |
| INSTRUC | 0.00 | 1 | .00 | .00 | 1.00 |
| CONSIS | 12795.82 | 3 | 4265.27 | 376.70 | .01 |
| 2-way Interactions | 87.96 | 7 | 12.57 | 1.11 | .36 |
| GROUP INSTRUC | .00 | 1 | .00 | .00 | 1.00 |
| GROUP CONSIS | 20.08 | 3 | 6.69 | .59 | .62 |
| INSTRUC CONSIS | 67.98 | 3 | 22.66 | 2.00 | .12 |
| 3-way Interactions | | | | | |
| GROUP INSTRUC CONSIS | 187.15 | 3 | 62.38 | 5.51 | .01 |

Table 13

Zung Scores Statistics for the two groups in Experiment 2

| Group | N | Mean | SE | SD | 95% Con. Int. | | |
|---|---|---|---|---|---|---|---|
| Non-Depressed | 19 | 38.32 | 5.43 | 1.25 | 35.70 | To | 40.93 |
| Depressed | 19 | 55.42 | 3.86 | .87 | 53.56 | To | 57.28 |
| Total | 38 | 46.87 | 9.83 | 1.60 | 43.64 | To | 50.10 |

Table 14

Learning Time Statistics for Letter Strings in Experiment 2

| Group | N | Mean | Std Dev. | Std Err. | 95% Con. Int. | | |
|---|---|---|---|---|---|---|---|
| Non-Depressed | 19 | 10.52 | 1.58 | .36 | 9.76 | To | 11.29 |
| Depressed | 19 | 11.37 | 2.98 | .68 | 9.93 | To | 12.81 |
| Total | 38 | 10.95 | 2.39 | .38 | 10.16 | To | 11.73 |

Table 15

Total Correct in Test Phase in Experiment 2

| Group | N | Mean | Std Dev. | Std Err. | 95% Con. Int. | | |
|---|---|---|---|---|---|---|---|
| Non-Depressed | 19 | 66.26 | 6.40 | 1.47 | 63.18 | To | 69.35 |
| Depressed | 19 | 66.84 | 8.60 | 1.97 | 62.70 | To | 70.99 |
| Total | 38 | 66.55 | 7.48 | 1.21 | 64.09 | To | 69.01 |

Table 16

Learning Time Statistics for Letter Strings in Experiment 3

| Group | N | Mean | Std Dev. | Std Err. | 95% Con. Int. | | |
|---|---|---|---|---|---|---|---|
| Students | 36 | 11.41 | 5.76 | .96 | 9.46 | To | 13.35 |
| Psychiatric | 12 | 16.30 | 7.55 | 2.18 | 11.51 | To | 21.10 |
| Total | 48 | 12.63 | 6.53 | .94 | 10.74 | To | 14.53 |

Table 17

ANOVA: Learning Time by Psychiatric Impairment in Experiment 3

| Source | D.F. | Sum of Squares | Mean Squares | F Ratio | F Prob. |
|---|---|---|---|---|---|
| Between Groups | 1 | 215.89 | 215.89 | 5.56 | .02 |
| Within Groups | 46 | 1787.31 | 38.85 | | |
| Total | 47 | 2003.20 | | | |

Table 18

Learning Time by Group and Instructional Set in Experiment 3

| | GROUP | |
|---|---|---|
| | Student | Psychiatric |
| INSTRUCTIONS | | |
| Neutral | 11.91 | 18.58 |
| Explicit | 10.90 | 14.02 |
| Combined | 11.41 | 16.30 |

Table 19

ANOVA: Learning Time by Instruction Set and Psychiatric Impairment in Experiment 3

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig. of F |
|---|---|---|---|---|---|
| Main Effects | 259.10 | 2 | 129.55 | 3.32 | .05 |
| Instructions | 43.21 | 1 | 43.21 | 1.11 | .30 |
| Psychiatric Impair. | 215.89 | 1 | 215.89 | 5.54 | .02 |
| 2-way Interactions | | | | | |
| Instruc Psych. | 28.39 | 1 | 28.39 | .73 | .40 |

Table 20

Total Correct in Well-Formedness Task in Experiment 3

| Group | N | Mean | SD | SE | 95% Conf.Int. | | |
|---|---|---|---|---|---|---|---|
| Students | 36 | 66.36 | 5.73 | .96 | 64.42 | To | 68.30 |
| Psychiatric | 12 | 65.00 | 5.24 | 1.51 | 61.67 | To | 68.33 |
| Total | 48 | 66.02 | 5.59 | .81 | 64.40 | To | 67.64 |

Table 21

ANOVA: Total Correct in Test Phase by Psychiatric Impairment in Experiment 3

| Source | D.F. | Sum of Squares | Mean Squares | F Ratio | F Prob. |
|---|---|---|---|---|---|
| Between Groups | 1 | 16.67 | 16.67 | .53 | .47 |
| Within Groups | 46 | 1452.31 | 31.57 | | |
| Total | 47 | 1468.98 | | | |

Table 22

ANOVA: Total Correct in Well-Formedness Task by Instruction Set and Psychiatric Impairment

| Source | Sum of Squares | DF | Mean Squares | F Ratio | F Prob. |
|---|---|---|---|---|---|
| Main Effects | 70.86 | 2 | 35.43 | 1.12 | .34 |
| Instructions | 54.19 | 1 | 54.19 | 1.71 | .19 |
| Psychiatric Impair. | 16.67 | 1 | 16.67 | .53 | .47 |
| 2-way Interactions | | | | | |
| Instruc Psych. | .17 | 1 | 23.68 | .75 | .53 |

Table 23
Learning Phase Stimuli used in Experiment 4

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| YT | 5 | TBH | 9 | BBB | 9 | TY | 5 |
| BT | 4 | H | 5 | HT | 6 | TTGH | 9 |
| TTT | 3 | YTT | 6 | BBG | 8 | YBT | 8 |
| TTBY | 9 | TTTB | 6 | HGTT | 9 | T | 1 |
| GT | 3 | TGB | 6 | GBY | 9 | TTTG | 5 |
| TGH | 8 | YGG | 8 | YGT | 7 | TGY | 7 |
| HTT | 8 | BBB | 9 | YG | 6 | HY | 9 |
| HGG | 9 | BGT | 6 | BGTT | 7 | GGG | 6 |
| TBY | 8 | GBB | 8 | GTTT | 5 | TT | 2 |
| YY | 8 | BTTT | 6 | TT | 2 | TTT | 3 |
| HTT | 7 | TTTH | 8 | G | 2 | Y | 4 |
| GG | 4 | YBTT | 9 | BTT | 5 | TTY | 6 |

Table 24

Stimuli Used in Test Phase of Experiment 4

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| BG | 1 | 5* | 8 | TTG | 6 | 3 | 4* |
| TGGY | 9* | 7 | 2 | BTT | 8 | 6* | 2 |
| TGG | 3 | 4 | 5* | TBB | 7* | 3 | 1 |
| YH | 6 | 9* | 1 | GGTT | 2 | 9 | 6* |
| GGH | 3 | 6 | 9* | BGT | 3 | 4 | 6* |
| GGG | 5 | 2 | 6* | HGT | 4 | 8* | 2 |
| Y | 4* | 5 | 2 | B | 3* | 2 | 1 |
| BBT | 7* | 8 | 3 | GGY | 5 | 8* | 7 |
| T | 5 | 3 | 1* | HG | 8 | 2 | 7* |
| YGTT | 7 | 8* | 5 | YBG | 6 | 4 | 9* |
| GH | 7* | 3 | 1 | HB | 4 | 8* | 5 |
| TTGY | 5 | 8* | 2 | TGBB | 9* | 5 | 3 |
| HBT | 4 | 5 | 9* | BH | 8* | 9 | 4 |
| TGB | 6* | 7 | 1 | TYY | 5 | 7 | 9* |
| TTTB | 6* | 8 | 7 | TTB | 6 | 5* | 8 |
| GT | 3* | 5 | 2 | TH | 9 | 1 | 6* |
| TTTY | 7* | 4 | 9 | H | 4 | 3 | 5* |
| YTTT | 5 | 3 | 7* | TTH | 7* | 3 | 2 |
| GB | 2 | 5* | 3 | GGT | 6 | 5* | 7 |
| TTGG | 4 | 6* | 8 | GG | 4* | 7 | 9 |
| BBGT | 9* | 7 | 8 | G | 1 | 2* | 8 |
| GGT | 4 | 9* | 2 | YYT | 5 | 9* | 4 |
| GY | 6* | 3 | 7 | YY | 4 | 3 | 8* |
| GTT | 8 | 4* | 5 | TB | 3 | 5 | 4* |

Note: an asterisk denotes the number that is correctly associated with each letter string.

Table 25

Learning Time Statistics in Experiment 4

| Group | N | Mean | Std Dev. | Std Err. | 95% Con. Int. |
|---|---|---|---|---|---|
| Students | 24 | 1.83 | .74 | .15 | 1.52 To 2.14 |
| Psychiatric | 12 | 2.59 | 1.31 | .38 | 1.76 To 3.42 |
| Total | 36 | 2.08 | 1.02 | .17 | 1.74 To 2.43 |

Table 26

Learning Times for First and Second Half of Stimuli Set Presented in Experiment 4

| | Time 1st Half | | Time 2nd Half | |
|---|---|---|---|---|
| Group | Mean | S.E. | Mean | S.E. |
| Students | 2.21 | .06 | 1.84 | .04 |
| Psychiatric | 2.77 | .09 | 2.42 | .05 |

Table 27

Linear Equations: Learning Time as a Function of Repeated Exposure to Stimulus Items In Experiment 4

Learning time for students = 2.39 - .015 * (Stimulus item)

$T$ = 33.92 (-5.88)
$p$ < .01 .01

$F$ = 34.5

Learning Time for Psych. = 3.03 - .018 * (Stimulus item)

$T$ = 31.44 (-5.36)
$p$ < .01 .01

$F$ = 27.7

---

Note: Both equations are in seconds and indicate that subjects tended to respond more quickly to the stimulus items over the course of the learning phase of the experiment.

Table 28

Mean Correct in Test Phase in Experiment 4

| Group | N | Mean | Std Dev. | Std Err. | 95% Con. Int. | | |
|---|---|---|---|---|---|---|---|
| Normals | 24 | 20.67 | 5.99 | 1.28 | 18.14 | To | 23.20 |
| Psychiatric | 12 | 16.33 | 4.40 | 1.23 | 13.54 | To | 19.13 |
| Total | 36 | 19.22 | 5.83 | .97 | 17.25 | To | 21.19 |

Table 29

ANOVA: Total Correct out of 48 by Experimental Group in Experiment 4

| Source | DF | Sum of Squares | Mean Squares | F Ratio | F Prob. |
|---|---|---|---|---|---|
| Between Groups | 1 | 150.22 | 150.22 | 4.92 | .03 |
| Within Groups | 34 | 1038.00 | 30.53 | | |
| Total | 35 | 1188.22 | | | |

# APPENDIX A

## NEUROPSYCHOLOGICAL SPECULATIONS

The preceding discussions about unconscious and implicit processes can be associated with a long history of neuropsychological research. What follows is a review of some of the more salient of these issues. The connection of the unconscious to specific brain stuctures goes back over a hundred years and will probably continue for another hundred. It has a long way to go but it should not be ignored, for even the most psychodynamic oriented theorist cannot deny that ultimately all explanations will be physiological.

In 1937 (see Groves & Schlesinger,1982) J. W. Papez proposed that human emotions are mediated by structures within the limbic system (rhinencephalon). His system consists of a circuit in which the hippocampus, mammillary nuclei and the thalamus modulate the more primitive and basic responses arising from the hypothalamus. This theory was enlarged by Paul MacLean to yield a more global model of neurological correlations to psychological and psychosexual operations. MacLean identifies three evolutionarily distinct structures within the human brain: the reptilian, located near the top of the brain stem; the old mammalian brain, consisting of the limbic cortex, which we share with lower mammals, marsupials and the like; and the neo-mammalian brain, consisting of the neo-cortex are found only in higher primates (including humans).

The brain stem and spinal cord caudal to the anterior neuropore are essentially the same in all animals; this would represent what MacLean refers to as the Archicortex. This region is circumscribed by the limbic cortex,which represents the next phylogentic accretion. This structure, as noted earlier, is similar in most primates. The highest layer, the neo-cortex is layered above the limbic system. The human brain, according to MacLean, evolved too quickly for adequate integration of the various layers. In a very real sense we have three separate brains which perform many redundant functions -- each accomplishing them in a way commensurate with its phylogenetic level.

An analog of the human limbic system represents the entire brain of lower animals such as rats or rabbits. The limbic forebrain consisting of several structures - the amygdala, the hippocampus, the septum etc. in lower animals would perform basic cognitive processing. The role of the limbic system in human cognition tends to corroborate this fact. The hippocampus in humans is critical for memory, and its mnemonic functions have become integrated with the phylogenetically recent temporal lobes. Lesions to the hippocampus can result in a conditon called Milner's syndrome (Klatsky, 1980) in which there is nearly complete loss of short term memory.

Thus, the primitive limbic structures are capable of more simple cognition and contribute these rudimentary cognitions to the higher brain regions,as well as being responsible for motivating and effecting many basic drives. Significant evidence exists that the limbic system in humans is responsible for emotional control, and dysfunctions in this system are associated with disorders ranging from panic attacks to schizophrenia. MacLean (1962) examined the neuroanatomical phylogeneny of psychosexual functions by studying the behavior and neuroanatomy of the squirrel monkey. He concluded that the limbic system is that region of brain which processes and directs operations related to survival and reproduction which occupy the greater portion of the cognitive efforts of lower mammals. He cites the strong connections between this system and the hypothalamus -- which provides the basic drives for survival but is not capable of analysis towards that end.

When lesions were made in the amagdala, the monkeys in effect became both docile and unable to discern what substances were appropriate for food. MacLean points out than in man, injuries to the frontotemporal region of the limbic system commonly result in feelings of anger, danger, or threat; in addition the same individual may have vague sensations of hunger, nausea or olfaction. The conclusion is that regions of the limbic system are responsible for self-preservation as it relates to feeding and the behavior that is involved in the competitive efforts to obtain food. This is in contrast to the hippocampus, which he suggests plays a role in expressive and feeling states and is "involved in the sustaining the species rather than the self". This is true for both aggressive and sexual behavior (MacLean, 1960). Notably, in examining the functions of regions within the limbic system anatomical connections between oral and genital behaviors. For example, stimulating certain parts of the amygdala produces both chewing behavior and penile erection. This fact prompted MacLean to say:

> This close neural relationship helps in understanding the intimate interplay of behavior in the oral and sexual spheres, examples of which we are accustomed to see in the activities of our domestic animals. Such interplay is readily taken for granted in animals, but one has only to consider the last fifty years of Freudian Psychiatry to realize the trouble that it may lead to in human affairs.

The phylogenetic differences among these brain structures do not facilitate efficient communications.

This poor communication serves to explain many paradoxes of human arousal, attention and thought. The limbic system serves as a non-specific activator of all cortical activities (Herrick, cited in MacLean, 1949) yet its relatively primitive construction precludes it from communicating in a means other than vague sensations.

However, since the anatomy of this brain region is remarkably similar to the complete brains of primitive mammals, it is reasonable to expect that it is capable of performing evaluations of raw perceptions. That is each layer can think and feel independently of the neo-cortex. This would probably lead to situations in which there can be autonomic arousal due to some stimuli that are not consciously perceived or, similarly, mistakes in the attribution of the basis for arousal (Schachter and Singer, 1962). It may also lead to affects and states of mind that are not in accord with conscious experience. The judgment that the unconscious is a result of independent brain structures was similary made by Brewer (1974), who noted that:

> In fact, given that homo sapiens evolved from much simpler organisms and that the lower brain centers still function, it would seem strange if human beings showed no unconscious, automatic learning, at all.

These phylogentically older brains correspond to what Jung referred to as the collective unconscious. They are the repository of the "Ancestral lore of the species" (Hamden-Turner, 1981). Dominance and submissive rituals; sexual courtship and display; seasonal migration are all behaviors which are believed to be genetically endowed (Brown, 1975).

Pathologies provide convincing evidence for the view of the unconscious. Among the more compelling is Giles de la Tourette's syndrome (GTS). Sufferers are compelled to make tic like or spastic motions. These tics may be random and purposeless or, sometimes may appear to be purposeful violent actions. Most striking is the associated disorder called coprolalia. The unfortunate GTS victims who suffer this affliction commonly are subject to uncontrollable bouts of profanity that may appear to be directed at nearby indivduals. However, there is no rage or emotion associated with these outbursts, and GTS victims affirm that the cursing was not in any way initiated by them. What is relevant to the present discussion is that the locus of the illness is centered in the basal ganglia and cingulate cortex, structures within the limbic system (Cummings & Frankel, 1985; Sandyk, 1985).

If the hypothesis that the unconscious is a consequence of non-verbal brain systems is correct, then an illness such as GTS should be expected. MacLean (1962) concluded the limbic system is responsible for aggressive, defensive and appetitive behaviors. If such a system which has powerful control over our cortex begins to operate independently of our cortex, violent verbal and physical behaviors are to be expected. Since the limbic system represents a stage of brain evolution antecedent to speech, one would expect that any verbal representation of its impulses would be primal and aggresive -- precisely what is observed in the coprolalic outbursts.

It is interesting to note (MacLean, 1985) that many of these brain regions are those that are responsible for alarm calls, separation calls and related primitive vocalizations of our distant mammalian ancestors. Further evidence that the basis of GTS is an abnormality of sub-cortical structures is derived from the efficacy of neuroleptics that act primarily on limbic dopaminergic tracts (e.g. Hoge & Biederman, 1986; Regeur, et al., 1986; Singer, Gammon & Quaskey, 1986). To summarize, GTS is an illness that historically has been treated with psychodynamic approaches because it seemed to dramatically represent the consciousness in conflict with the unconscious. Virtually all clinical evidence, however, suggests that this is incorrect. Rather, the research implies that primitive brain structures are in conflict with the more highly developed conscious ones.

Randall (1983) suggests that both GTS and schizophrenia are probably both unsuccessful variations of brain evolution:

> The clinical emergence of symptoms in the later stages of brain maturation may be dependent on myelination of these fibre groups, both of which have extended myelination cycles. Ontogenetically earlier variants of the same mechanism could theoretically result in dyslexia and the syndromes of Kanner and Gilles de la Tourette. As new and unique extensions of specialized function emerge within the evolving brain, biological trial and error of connection both within and between them may produce individuals possessing phylogenetically advanced abilities, or equally, others possessing a wide range of abnormalities including those which comprise the schizophrenia syndrome.

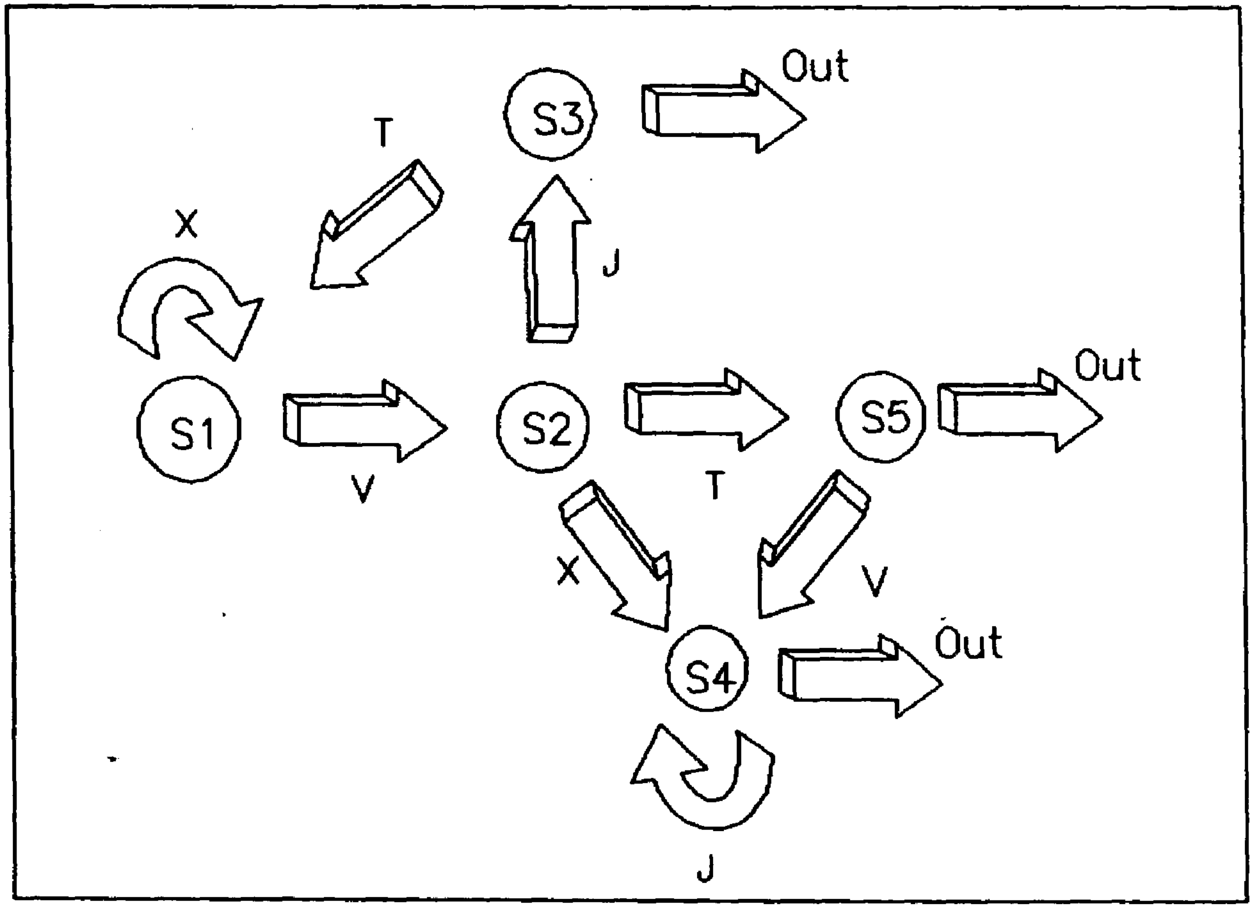
Irrespective of the means by which genetics may have encoded knowledge, it is highly probably that this knowledge, and the behavior it guides, is encoded in language that cannot be directly comprehended. In contrast to the neo-cortex which guides behavior based on reason, the older brains seem id-like in their striving. That is, they seek to fulfill their mission of satisfying drives without considering consequences. Similar to the brains of our distant ancestors, our lower brain areas are capable of processing the many variables that are necessary for a rational decision. This is a compelling explanation for the fundamental and implicit mentation. That is we can learn grammars or count frequencies because these functions are analogues of skills that were essential to the survival of our distant ancestors. They are now encoded in the deeper recesses of our brain and express themselves in ways we perceive as unconscious.

# Appendix B

Schematic for Finite-State Grammar

Note: This is the generating system which produced all letter strings used in experiments 1-3. Each circle represents a transition point. The flow from one transition state to another results in the generation of a letter; this is symbolized by an arrow. A curved arrow represents a recursive transition which can generate 1 to 4 of the appropriate letter.

Schematic of Grammar



# Appendix C

## Zung Self-scoring Depression Test and Scoring Key

Name ______________________ ______________________

Age ______ Sex ________ Date ______________________

| | None OR a Little of the Time | Some of the Time | Good Part of the Time | Most OR All of the Time | |
|---|---|---|---|---|---|
| 1. I feel down-hearted, blue and sad | 1 | 2 | 3 | ✓4 | 4 |
| 2. Morning is when I feel the best • | 4 | ✓3 | 2 | 1 | 3 |
| 3. I have crying spells or feel like it | 1 | 2 | ✓3 | 4 | 3 |
| 4. I have trouble sleeping through the night | 1 | 2 | ✓3 | 4 | 3 |
| 5. I eat as much as I used to • | 4 | 3 | ✓2 | 1 | 2 |
| 6. I enjoy looking at, talking to and being with attractive women/men • | 4 | 3 | [illegible] | 1 | 2 |
| 7. I notice that I am losing weight | 1 | [illegible] | 3 | 4 | 2 |
| 8. I have trouble with constipation | ✓1 | 2 | 3 | 4 | 1 |
| 9. *My heart beats faster than usual* | 1 | 2 | ✓3 | 4 | 3 |
| 10. I get tired for no reason | 1 | 2 | ✓3 | 4 | 3 |
| 11. *My mind is as clear as it used to be* | 4 | 3 | ✓2 | 1 | 2 |
| 12. *I find it easy to do the things I used to* • | ✓4 | 3 | 2 | 1 | 4 |
| 13. I am restless and can't keep still | 1 | 2 | ✓3 | 4 | 3 |
| 14. I feel hopeful about the future • | 4 | ✓3 | 2 | 1 | 3 |
| 15. *I am more irritable than usual* | 1 | 2 | ✓3 | 4 | 3 |
| 16. I find it easy to make decisions • | 4 | ✓3 | 2 | 1 | 3 |
| 17. I feel that I am useful and needed • | 4 | ✓3 | 2 | 1 | 3 |
| 18. *My life is pretty full* • | 4 | ✓3 | 2 | 1 | 3 |
| 19. I feel that others would be better off if I were dead | ✓1 | 2 | 3 | 4 | 1 |
| 20. I still enjoy the things I used to do • | ✓4 | 3 | 2 | 1 | 4 |



(KEY FOR SCORING. DO NOT REMOVE.) SDS Index 69 55 =

## INTERPRETATION OF SDS RATINGS IN DEPRESSION AND OTHER EMOTIONAL DISORDERS

Depression as a word can be used to describe: 1. An affect which is a subjective feeling tone of short duration. 2. A mood, which is a state sustained over a longer period of time. 3. An emotion, which is comprised of the feeling tones along with objective indications. 4. A disorder which has characteristic symptom clusters and complexes of signs and symptoms. The SDS is intended to rate depression as a disorder. However, the SDS is not intended to differentiate the different types of depression. It serves rather to quantitatively measure the intensity of depression regardless of the diagnostic label used.[9]

Certain safeguards are incorporated in the construction of this rating scale. The patient is unable to discern a trend in his answers because half of the statements are worded symptomatically positive and half are worded symptomatically negative. For example, Item #1: I feel down-hearted, blue and sad, is a positive. Item #2: Morning is when I feel the best, is a negative statement reflecting the opposite of the way most depressed patients feel, which is worst in the morning. Negatively worded items are identified by asterisks on the transparent overlay and the key words of the negative items are in italics in Table 2 on the back cover. Additionally, an even rather than an odd number of columns is used to offset any possibility of a patient's checking middle columns in order to look average.

Combining results from several studies, the SDS Index can be interpreted as follows:

| SDS INDEX | EQUIVALENT CLINICAL GLOBAL IMPRESSION |
|---|---|
| Below 50 | Within normal range, no psychopathology |
| 50–59 | Presence of minimal to mild depression |
| 60–69 | Presence of moderate to marked depression |
| 70 & over | Presence of severe to most extremely depressed |

The above interpretations are based upon data which compares depressed versus non-depressed patients, and depressed versus normal subjects in the 20 to 64 year old range. High scores are not in themselves diagnostic, but indicate the presence of symptoms which may be of clinical significance.

Results from several studies have shown that there is usually some depressive symptomatology present in almost all of the psychiatric disorders. Patients can have several diagnoses: headache AND depression, schizophrenia AND depression, diabetes AND depression. Thus, a primary diagnosis of the patient as "other-than-depression" does not eliminate the possibility that the patient is also depressed. If his SDS Index is above 50, he possibly needs treatment for his depression in addition to treatment for his primary diagnosis.

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