UNIVERSITY OF ALBERTA

COGNITIVE FUNCTIONING IN DEPRESSED ELDERLY PATIENTS

BY

SIMITA SCHWARTZBERG ©

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled Cognitive Functioning in Depressed Elderly Patients submitted by Simita Schwartzberg in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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DEDICATION

With love to my husband Cam, whose patience, love and support helped me through this dissertation from start to finish.

Abstract

The primary goal of this study was to determine how depression in elderly patients affects consciously controlled and automatic processes. A process dissociation procedure developed by Jacoby (1991) was used to investigate this. This procedure allowed for a quantitative separation of consciously controlled and automatic influences within a stem completion task. A secondary goal of this study was to investigate executive functioning in these depressed patients. Executive functioning has been related to consciously controlled processing. Performance on a variety of tasks, assessing different aspects of executive functioning (e.g. verbal fluency, use of imagery in free recall, Stroop task, a working memory task, a sequential movements task, and the Wisconsin Card Sorting task), was evaluated. Motivation was assessed via a complex visuoperceptual task (Incomplete Letters task). Seventeen elderly depressed patients and 17 nondepressed controls matched for age, education and gender were evaluated. The process dissociation procedure provided data consistent with the suggestion that depression significantly affects consciously controlled processes but not automatic memory processes. Results also indicated that the performance of depressed elderly patients was impaired relative to that of matched control subjects on a working memory task, verbal fluency tasks, overall recall of words on free recall, a measure of perseverative responses on the Wisconsin Card Sorting task, and the sequential movements task. There were no reliable motivational differences between depressed and nondepressed subjects as assessed by the Incomplete Letters task. Limitations of the study are discussed in terms of sample size, potential confounds of medication, institutionalization and motivational differences. Directions for future research are discussed including the potential advantage of using Jacoby's process dissociation procedure to more clearly separate the influences of different cognitive processes to task performance.

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I. Introduction

A. Overview of goals

Depressive symptoms and syndromes are highly prevalent in community, medical and institutionalized populations, and are associated with significant functional disability, morbidity and mortality (Bland, Orn & Newman, 1988; Caine, Lyness & King, 1993). Depression also is one of the most prevalent mental health problems in the elderly community (Alexopoulous, Young, Meyers, Abrams & Shamoian, 1988; Jenike, 1989a; Ruegg, Zisook & Swerdkiwm, 1988; Salzman & van der Kolk, 1984). According to one estimate, nearly one-third of people over the age of 60 experience depressed mood to some degree (Gianturio & Busse, 1978). It is further estimated that two to thirteen percent of elderly people experience true major clinical depression (Gurland & Cross, 1982), and that depression constitutes the most frequent reason for psychiatric hospitalization in patients over the age of 60 (Mei-Tel & Meyers, 1985; Spar, Ford & Liston, 1980).

Difficulty in memory ability is a frequently cited complaint among depressed adults, and the one that most commonly prompts referrals for neuropsychological evaluation (Albert, 1981; Williams, Watts, MacLeod & Mathews, 1988). Although cognitive impairments have been reported extensively in the depression literature with younger and older patients, Miller (1975) noted that studies of cognitive deficits in depression have given very little attention to theoretical issues. Similarly, Niederehe (1986) pointed out that research is needed based on theoretical models of both depression and cognitive functions to specify the kind of changes expected in depressed patients and to develop appropriate measuring instruments. Given the prevalence of depression in the elderly population, as well as prominent cognitive changes associated with depression, it is important to understand not only depressive symptomatology but also associated cognitive changes that may occur.

Understanding memory and other cognitive functions in depressed patients has diagnostic and prognostic implications. The presence of cognitive dysfunction in depressed patients may affect the ability of patients to comply with, and benefit from, pharmacological and psychotherapeutic interventions. Performance on cognitive tasks may be used as diagnostic aids, and as markers for a resolving depression. The differentiation of cognitive changes associated with depression and normal aging from those accompanying dementia is another challenging task facing neuropsychologists working with older adults (LaRue, D'Elia, Clark, Spar & Jarvik, 1986). Because cognitive deficits can be similar in dementia and depression, diagnoses can be difficult, yet have significant consequences given that cognitive changes associated with depression are reversible with treatment, while those associated with dementia are not (Mahendra, 1986). The relationship between depression and dementia is multifaceted and remains one of the most challenging aspects of the evaluation and treatment of these patients (Cummings, 1989). Further research in this area will contribute not only to our understanding of the nature of these cognitive changes but will also enhance our ability to care for both depressed and demented individuals (Cummings, 1989).

Hasher and Zacks (1979) were the first investigators to suggest that depression imposes a limitation on cognitive resources available for performing memory procedures. Consistent with their framework, Ellis and Ashbrook (1988) proposed that deficits in memory that are seen in depression result from a reduction in cognitive capacity. Although the presence of cognitive deficits in depression has been reported extensively (see reviews by Cassens et al., 1990; Jorm, 1986; Miller, 1975; Weingartner, 1986), findings in the literature are equivocal. Where deficits have been noted, it has been suggested that cognitive processes requiring cognitive capacity and conscious control are most sensitive to depression (Hasher & Zacks, 1979), while performance on automatic tasks (i.e., those requiring minimal cognitive resources) remains intact.

The following dissertation will address issues of cognition and depression. First, the theoretical distinction between the concepts of consciously controlled and automatic processes will be outlined in terms of theories in contemporary cognitive psychology. I will then review background literature concerning depression and cognitive functioning in terms of this distinction. Third, an analysis of reasons for the equivocal findings in the literature on depression and cognition will be presented. This will be followed by a discussion of difficulties in empirically distinguishing between consciously controlled and automatic processes. In general, the approach taken in the extant literature has been to identify a task with a process (i.e., automatic or consciously controlled). Jacoby (1991), as well as others, have discussed the problems this assumption of a one-to-one relationship between task and process entails, and their arguments will be presented. Jacoby (1991) developed a mathematical procedure to separate automatic from consciously controlled influences within a task. Next, I will use this improved methodology developed by Jacoby (1991) for distinguishing between these two types of processes to investigate the hypothesis of a deficit in consciously controlled processing in elderly depressed patients. Finally, interpretation of the results of the present study, and directions for future research will be presented.

B. Consciously controlled and automatic processes: theoretical distinctions

The information processing paradigm which began to dominate cognitive psychology in the late 1950's and 1960's, and which led to the development of contemporary cognitive two-process theories focused on the notion of limited capacity stores (Neumann, 1984). Conscious attention has been identified with this limited capacity processing system. One way to understand the distinction between consciously controlled and automatic processes is to conceive of a continuum of attentional requirements among cognitive processes which range from those requiring minimal attentional resources to those requiring a great deal of attentional resources (Hasher & Zacks, 1979; Kahneman, 1973; Posner & Snyder, 1975; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). Cognitive processes requiring capacity are thought to be consciously or intentionally controlled, while processes thought to be relatively capacity-free have been conceptualized as occurring rapidly and without intention, under the control of stimulation (Posner & Snyder, 1975; Shiffrin & Schneider, 1977). Furthermore, automatic processes do not interfere with the successful performance of other cognitive operations, are insensitive to the influences of strategies and instructional manipulations and do not improve with practice. In contrast, consciously controlled processes are thought to require significant processing capacity or cognitive resources, and are conceptualized as being sensitive to strategic and instructional influences (Hasher & Zacks, 1979; Posner & Snyder, 1975; Shiffrin & Schneider, 1977). It has been argued that with practice, some consciously controlled processes can become more automatic and hence will require minimal or less allocation of attention for successful performance (Hasher & Zacks, 1979).

Given the proposed continuum of attentional requirements, a variety of other processes has been identified along this dimension. For example, processes such as imagery, rehearsal, organization, elaboration and mnemonic techniques have been considered to be under conscious control and to require greater cognitive resources, while processes such as encoding of spatiotemporal attributes, or those which are overlearned are considered to be automatic (Hasher & Zacks, 1979). Paced tasks are considered to be less automatic than unpaced tasks (Raskin, Friedman & DiMascio, 1982). Because automatic processes are thought to be devoid of attention or intention, and to require minimal cognitive capacity, they are thought to occur equally well under incidental and intentional learning conditions (Hasher & Zacks, 1979). Many researchers have operationalized this theoretical distinction by assuming a one-to-one correspondence between task and process. In investigations of the distinction between automatic and consciously controlled processing, tasks have been assumed to tap either one or the other process. Most of the researchers investigating cognition in depressed patients have looked at performance of these patients on traditional tasks such as free recall, cued recall and recognition memory. These tasks have been referred to as explicit memory tasks (Graf & Schacter, 1985), requiring intentional retrieval processes whereby subjects are directed to retrieve information from specific learning episodes (Schacter, Bowers, and Booker, 1989). Although these tasks have been grouped together under the category of explicit memory tasks, most researchers have attributed different retrieval demands to successful performance on recall and recognition tasks (Arenberg, 1973; Burke & Light, 1981; Craik, 1977; Shimamura & Squire, 1988). It has been suggested that recall involves more consciously controlled processing than does recognition (Hasher & Zacks, 1979). A slightly different conceptualization suggests that various retrieval tasks can be ordered with respect to the amount of controlled, self-initiated processing involved. Recall requires more self-initiated processing than recognition tasks (Craik, 1983; Craik & McDowd, 1987). In recall tasks, few retrieval cues are provided and the participant is required to make use of more cognitive resources to initiate appropriate cognitive operations. In contrast, in recognition tasks, information is re-presented to the participant, and thus the cognitive processes involved in recognition are driven mainly by the external stimuli within the task itself, and minimal self-initiation of processes is required for successful performance (Craik & McDowd, 1987).

A method that has been used extensively to measure attentional demands of cognitive operations is to investigate dual task performance. This is based on the assumption that if task performance does not interfere with other simultaneous processes, it is thought to require minimal attentional capacity (Neumann, 1984). Capacity-free operations are assumed either if a concurrent secondary task does not suffer interference (i.e., if performance does not decline on the secondary task), or if task parameters believed to operate at a particular stage do not interact with the performance of the concurrent task. Craik and McDowd (1987) found that recall tasks negatively influenced secondary task performance compared to recognition tasks. Based on the latter findings, the authors concluded that recall tasks require more self-initiated processing resources (and are hence more effortful) than recognition tasks.

Implicit memory tasks have been conceptualized as tasks which do not require the conscious recollection of a specific prior episode, but which nevertheless can be influenced by exposure to recent information (see Schacter, 1987, for a review). For example, subjects may be exposed to a list of words, and later presented with word fragments for them to complete. When exposure to previously presented information facilitates their performance on the word fragment task (for example, if they use a word from an earlier presented list to complete the word fragment without explicit instructions to do so), it is assumed that the subjects are using implicit memory processes (Schacter, 1987). As with recognition memory tasks, information is (at least partly) re-presented to participants and is thus thought to be more automatic (Richardson-Klavehn & Bjork, 1988) and to be less demanding of self-initiated processing (Craik, 1983; Craik & McDowd, 1987) than recall tasks.

Self-initiated behaviours have been related to self-monitoring and self-control (Coyne & Gotlieb, 1983; Rehm, 1982), and such behaviours have commonly been labelled "executive functions" (Stuss, 1992). Stuss (Stuss, 1991; Stuss & Benson, 1986) proposed a hierarchical model of brain abilities. At the lowest level, neuropsychological input is sensory/perceptual. At this level, abilities are thought to be overlearned, routinized and virtually automatic, and are not conscious or easily changed by conscious effort. (Stuss, 1992). The second level in this model is associated with executive control or supervisory functions of the frontal system (Stuss, 1992). Stuss (1992) suggests that the primary role of this level is conscious direction of lower level systems toward a goal. He further suggests that this control can be divided into specific functions such as anticipation, goal selection, plan formulation, evaluation and monitoring of behaviour, as well as selectivity and persistence (Stuss, 1991; Stuss, 1992; Stuss & Benson, 1986). This level is thought to operate in the processing of new or complex information, where routine responses are unavailable. The highest level of the model is hypothesized to be consciousness and self awareness. The higher levels of this model are more flexible (Stuss, 1992). From a neuropsychological perspective, these higher levels are believed to be mediated by the frontal lobes (Stuss & Benson, 1986). However, although executive functions may be mediated by the frontal lobes, they also involve related cortical and subcortical areas and hence can be conceptualized as "executive system" functions (Stuss, 1992). Moscovitch and Winocur (1992) also suggest that consciously controlled processes are more dependent on frontal lobe (executive) functions than are automatic processes. Self-initiated processing has been related to effortful processing (Craik, 1983; Craik & McDowd, 198[illegible] clear that executive functioning encompasses many different cogniti[illegible], all of which predominantly emphasize consciously controlled, rath[illegible] than automatic, processes for successful performance. The extant literature on depression and cognition will be reviewed in the next section in terms of the distinction between automatic and consciously controlled processes.

C. Background and review of the literature

As noted in the previous section, much of the research investigating cognition in depression has focused on performance of these patients on explicit memory tasks such as free recall, cued recall and recognition. Relatively few investigators have studied executive function or implicit memory function in depression. There is preliminary evidence for the validity of the consciously controlled/automatic distinction across a variety of tasks (e.g. free recall, priming, recognition, executive function). Because of the hypothesized differences in the amount of consciously controlled processing that is required for successful performance of these tasks, I will review the findings separately for the different tasks. After reviewing the literature, a discussion of methodological and theoretical problems in the extant literature will follow.

1. Recall tasks

As noted previously, free recall tasks are thought to require more processing capacity than recognition memory tasks. In general, where deficits have been noted in memory testing with depressed patients, free recall tasks have been shown to be more sensitive. However, the literature on potentially adverse effects of depression on these types of tasks is equivocal. Although many investigators have reported that the performance of depressed patients on these tasks is poor relative to normal controls, other studies have found that depression has no effect on overall memory performance.

In studies of free recall, where lists of words are presented to patients, deficits have been noted with depressed patients (e.g. Caine, 1981; Danion, Willard-Schroeder, Zimmermann, Grangé, Schlienger & Singer, 1991; Gibson, 1981; King, Caine, Conwell & Cox, 1991; Speedie, Rabins, Pearlson & Moberg, 1990; Williams, Little, Scates and Blockman, 1987). For example, in Danion et al's study, younger depressed patients were presented with a study word list, were required to indicate how much they liked/disliked each word and were instructed to try and remember the words. Following the word presentation, they performed a word completion (priming) task, and were then asked to recall the words from the study list. These authors found depression related differences on the free recall task with depressed patients recalling less words compared with control subjects. Williams and his colleagues (1987), using older, less severely depressed patients, found depression-related deficits on a twelve-item, six trial selective reminding list learning test, although performance for all subjects was in the average to above average range. King and her colleagues (1991) as well as Speedie et al. (1990) using elderly depressed patients found impaired list learning relative to matched control subjects. Caine (1981), using young and old depressed patients also found impaired list learning. He found a correlation of -0.82 between age and neuropsychological performance (list learning and other cognitive tests) and suggested that this reflected an interaction between age and depression. However, a limitation of this study is that there was no control group and hence it is unclear whether the correlation reported reflected an age by depression interaction or whether it reflects the effects of age alone, or depression alone.

Hart and his colleagues (Hart, Kwentus, Taylor and Hamer, 1987) studied the performance of older severely depressed patients (prior to treatment) on the Buschke selective reminding task using high and low imagery words. On each subsequent trial of this task, only those items that were not recalled on the immediately preceding trial were presented. The authors found differences between groups with unreminded high imagery words, suggesting that the depressed patients did not spontaneously make as effective use of imagery. O'Hara, Hinrichs, Kohout, Wallace and Lemke (1986) studied community dwelling elderly depressed patients. They compared the performance of subjects who met clinical criteria for major depression and subjects with high levels of self-reported depressive symptoms and low levels of self-reported depressive symptoms. The latter two groups did not meet criteria for a major depression. They found no significant group differences in the amount recalled or in the serial position of words on an immediate free recall task with concrete, high imagery words. Abas, Sahakian and Levy (1990) found that elderly depressed patients performed more poorly relative to matched controls on a test of object learning. Dannenabaum, Parkinson and Inman (1988), with older depressed patients and matched control subjects, tested subjects for their immediate recall spans and found group related differences. They equated the two groups on immediate recall spans, then had them perform the Brown-Peterson task. A series of letters was presented and studied briefly. Subjects performed a distracter task for various time intervals, after which they were asked to recall the letters in the order of presentation. Although there were no significant differences in immediate recall, the depressed group performed more poorly on delayed recall performance.

Several investigators have examined the effects of encoding manipulations on free recall performance. (Cohen, Weingartner, Smallberg, Pickar and Murphy, 1982; Roy-Byrne, Weingartner, Bierer, Thompson & Post, 1986; Weingartner, 1986; Weingartner, Cohen, Murphy, Martello & Gerdt, 1981). In one study (Weingartner, 1986), younger moderately to severely depressed and control subjects were instructed to either listen to words and provide words related in meaning to the target stimulus (presumably a semantic, consciously controlled cognitive process), or to generate words that sounded like each stimulus word (an auditory perceptual task presumably requiring little consciously controlled processing). In another study, Roy-Byrne et al (1986), using a paired associates task, had their subjects provide frequency judgements or provide semantic judgements regarding the pairs of words. The assumption by these authors was that initiating processes to semantically encode words requires more cognitive capacity and if performed successfully, would result in a deeper level of encoding. It was predicted that depressed patients would be more impaired when required to semantically encode words because this process requires more consciously controlled processing. As predicted, the depressed patients were more impaired on the tasks requiring more self initiated processing.

In another experiment, Weingartner (1986) examined the effects of depression on the recall of highly organized versus unorganized lists. Subjects were instructed to listen to a list of unrelated words and to try and organize and relate them to one another (presumably a task requiring greater self initiated processing). On another occasion, these subjects listened to a list of highly related words requiring minimal organization and were instructed to relate these words, a task requiring less self initiated processing. Results indicated that depressed patients were much poorer in recalling the unrelated lists requiring greater organization, and with greater delay between presentation and recall, and with greater severity of depression, performance on the free recall tasks became increasingly impaired. Based on these findings, the authors suggest that depressed patients are more impaired on tasks requiring greater self-initiated processing. Where they were not required to initiate as much processing, that is, where the processes were presumably more automatic (organized lists, frequency judgements, acoustic word generation), their performance was relatively intact. Where they were required to initiate more processing (semantically relate, organize words) they did not initiate processing as successfully and hence did not encode words as well. Consistent with these findings, Tancer and his colleagues (Tancer, Brown, Evans, Ekstrom, Haggerty Jr., Pedersen & Golden, 1990) in a study with younger depressed patients and psychiatric control patients, had subjects listen to lists of concrete words, half containing categorically related nouns and half containing unrelated nouns. Following free recall of these words, they were provided with categorical prompts. Consistent with Weingartner and colleagues' findings, the authors found that depressed patients were impaired on free recall of unrelated words, i.e., they recalled fewer of the words from the unrelated lists. Although categorical cuing aided recall for both groups, the depressed patients still recalled significantly less words. Both groups were unimpaired on recall of categorically grouped words spontaneously or with prompting. The authors suggest that unstructured recall is more effortful because cognitive processes must be expended in organizing unstructured lists prior to recall, and that depressed patients are less able to take advantage of prompting in consciously controlled tasks.

Channon, Baker & Robertson (1993), using younger depressed and normal control subjects, compared retrieval (free recall) of high, medium and low structured material. They used word lists consisting of uncategorized words and categorized words presented in randomized and clustered order. The authors predicted that performance of depressed patients would be impaired relative to control subjects when attempting to recall words from lists containing implicit semantic structuring (categorized words presented randomly), as encoding of these words would require more cognitive resources for successful performance. As expected, they found that depressed patients, compared to normal control subjects, recalled significantly less words from the list of categorically related randomly presented words. Although they did find poorer performance (i.e. less words were recalled) from the uncategorized list of words, there were no significant group differences and recall was poor for both groups. The authors argue that attempts to relate unrelated words would be futile and non-beneficial, and this would explain the relatively unimpaired performance of depressed patients relative to control subjects with the uncategorized word list. They suggest that deficits are most apparent where ease of encoding is high and organizational requirements are low.

In a study with young and old less severely depressed, highly educated patients and matched control subjects (Niederehe, 1986), both retrieval and encoding were manipulated. Subjects were presented with a list of high frequency nouns coming from several taxonomic categories, and then free recall, cued recall and recognition were tested successively. In the cued recall condition, subjects were presented with the taxonomic categories as the cues. Encoding was manipulated by having a prompted condition, where subjects were required to answer questions regarding whether each item belonged to one or another of the taxonomic categories, and a spontaneous condition, where they were simply presented with the words. It was hypothesized, based on Craik and Lockhart's (1972) levels of processing model, that subjects would perform better in the prompted condition as they would be encouraged to actively encode the words in a personally meaningful way, and hence would be encoding the information at a deeper level which would make it easier for them to reconstruct the prior experiences at the point of retrieval. Consistent with previous researchers, the findings indicated that performance for all subjects was best with the recognition test and worst with the free recall condition. However, contrary to his expectations, Niederehe found that encoding had a small but significant effect in the opposite direction. Subjects performed more poorly following the prompted condition. The authors suggested that prompting interfered with, rather than facilitated, spontaneous encoding strategies. Although in both the old and young groups, the depressed subjects performed more poorly than the control subjects, there were no significant depression-related differences. Although significant age-related differences were found, there were no significant age by depression interactions. Niederehe (1986) suggests that depression results in "executive level failures", that is, reduced self initiation, preventing the use of efficient encoding strategies, such as organizational strategies.

In investigations of paired associate learning, Hart, Kwentus, Wade and Hamer (1987) tested participants for recall of digit-symbol pairings following performance of the digit symbol subtest of the WAIS-R, where subjects are required to associate symbols with numbers according to a reference key. They found no significant differences between moderately to severely depressed older patients compared to matched control subjects. Sternberg and Jarvik (1976) tested hospitalized depressed patients and matched control subjects on a 15-word pair test paired associate learning test. The word pairs were only slightly conceptually related. Findings indicated that depressed patients were significantly impaired relative to the matched controls on paired associate learning. LaRue et al (1986), with older depressed hospitalized patients, using a five-trial learning of three word pairs found no significant difference between severely depressed patients and matched controls. This lack of significant findings may be due to the small amount of information that had to be encoded (only three word pairs). However these authors did find a significant group difference on the Fuld Object Memory test. On this task, subjects were presented ten common objects over five trials in visual and tactile modalities. A selective reminding procedure was used whereby only words not generated on the previous trial were reminded from trial to trial. The authors did not find any specific error patterns across the groups.

In tests of story recall, which are more contextually based than list learning, Breslow (1980) found that medicated depressed inpatients recalled fewer positive aspects of the stories, but did not differ in their recall of negative or neutral story details. Hart, Kwentus, Taylor and Harkins (1987) found that moderately to severely depressed older patients performed more poorly on story recall. Consistent with this, Williams et al. (1987) found that depressed elderly patients performed more poorly relative to control subjects on the Logical Memory subtest of the Wechsler Memory Scale, although all subjects performed in the average range. In the Williams et al. (1987) study, patients were younger and less severely depressed. Gass and Russell (1986) did not find depression-related impairments on recall of these stories. In their study, however, they used a wide variety of brain damaged subjects, and depression was assessed according to the MMPI, which incorporates more than just depressive symptoms on the scale, and which was not designed as a diagnostic tool.

Although in general, depression-related deficits have been found across free recall tasks, suggestive of impairments on tasks emphasizing consciously controlled processes, these findings are equivocal, and may be related to methodological and theoretical problems. This will be discussed later on.

2. Executive function tasks

As noted earlier, executive function tasks are thought to emphasize consciously controlled processing and the use of considerable self initiated processing for successful performance. Studies of executive function are considerably less frequent than studies of memory abilities in depression (Cassens et al., 1990; Martin, Oren & Boone, 1991). For example, few investigators have studied problem solving ability or abstract thinking in depressed patients. Raskin (1986) suggests that depression-related deficits may be more evident on tasks tapping the ability to shift cognitive set and requiring reasoning skills rather than on simple recall and recognition tasks. Many different cognitive processes have been postulated to underlie executive functions. Performance of depressed patients on a variety of tasks presumed to tap executive functions will be presented in this subsection.

Deficits across a variety of tasks assessing executive functions have been demonstrated in depressed patients. Diminished performance by moderately to severely depressed patients, more pronounced in older depressed patients, has been observed on the Stroop task (Raskin et al., 1982; Raskin, 1986), a task measuring the ability to inhibit the output of an automatic response tendency. They found that their older patients (over 40 years old) performed slower, with less accuracy and showed more perceptual rigidity and concreteness in thinking than the younger (less than 40 years old) depressed group as well as the younger and older normal control groups. In contrast, Rush and his colleagues (Rush et al., 1983) found intact performance on the Stroop task with younger, more mildly depressed patients.

Several studies have investigated verbal fluency in depressed patients. Verbal fluency tasks require subjects to systematically retrieve words beginning with particular letters or belonging to specific categories, and generate as many words as they can within a given time period. Successful performance on letter fluency tasks relies solely on phonemic or lexical cues to guide the retrieval process, while category fluency tasks require systematic retrieval of organized information from semantic memory (Butters, Granholm, Salmon, Grant & Wolfe, 1987). Category fluency tasks, where subjects are required to generate as many meaningfully related words as possible to a particular taxonomic category, are thought to provide increased structure as the set that must be searched is more constricted. In general, significant depression-related deficits have been found with younger and older depressed patients, including unmedicated patients on verbal fluency tasks (Caine, 1981; Hart, Kwentus, Taylor and Harkins, 1987; King et al., 1991). In contrast, intact performance has been found with medicated unipolar or mixed unspecified depressed patients (Johnson & Crockett, 1982; Wolfe, Granholm, Butters, Saunders & Janowsky, 1987).

One of the most widely used tests of problem solving is the Wisconsin Card Sorting task (WCST) (Heaton, 1981). Only two studies have used this task with depressed patients. This task taps several aspects of problem solving, including categorization, deduction of conceptual principles, and ability to maintain and shift set in response to external feedback. Martin and his colleagues (Martin, Oren & Boone, 1991), in a study with younger mildly depressed and dysthymic patients found no significant differences in categorization and perseverative responses relative to a normal control group. Severity of depression emerged as a significant predictor of total errors, number of perseverative responses and failure to maintain set, with a higher level of depression predicting poorer performance. Depressed patients had relatively higher perseveration indices compared to normal control subjects. The authors suggest that with higher levels of depressive symptoms, patients are more cognitively inflexible in problem solving and hypothesis testing as evidenced by their continued use of incorrect strategies. Hart et al. (1987), using Nelson's (1976) modified version of the WCST (which alters the administration of the task, as well as making the task relatively easier), found no differences between elderly depressed patients and matched control subjects.

In a hypothesis-testing task similar to the WCST, that required subjects to sort cards on the basis of different principles with feedback provided by the examiner, Silberman, Weingartner and Post (1983) found that with younger, moderately depressed, mixed (unipolar and bipolar) patients, depressed patients made more perseverative errors, indicating difficulty with responding to external feedback. The Halstead-Reitan Category test is a task assessing the ability to discern abstract relationships between non-verbal stimuli, where subjects must deduce the correct organizing principles with feedback. Impaired performance on this task has been found with younger, unmedicated bipolar depressed patients (Donnelley et al., 1980; Savard et al, 1980), although not consistently (Gray et al., 1986). Donnelley et al (1980) found that both age and depression adversely affected cognitive performance. The authors reported that the slopes relating age to performance did not differ between depressed and normal control groups. In contrast, Savard and his colleagues (1980) found that the degree of cognitive deficit was more consistent in older (over 40 years old) versus younger (less than 40 years old) bipolar patients. They also found that older bipolar patients made more errors than did younger bipolar patients (less than 40 years old).

Several studies have reported significant decrements on tasks assessing abstraction in unmedicated mixed depressed patients. Two studies (Raskin et al, 1982; Caine et al., 1984) found impaired interpretation of proverbs in unmedicated depressed patients. Abstraction ability was found to be impaired in other studies with mixed depressed patients (Clark, Clayton, Andreason. Lewis, Fawcett and Scheftner, 1985), while Andreason (1976) found no deficits in a group of younger, medicated, less severely depressed patients. However, in the Clark et al. study, patients were suffering from a variety of major affective disorders, and were undergoing a variety of treatments, some including ECT.

Finally, ability to maintain and shift cognitive set has been investigated with a sequencing task, the Trail Making task. Deficits on Trails A and Trails B have been noted with depressed patients in several studies (Caine, 1981; Caine et al., 1984; Shipley, Kupfer, Spiker, Shaw, Coble, Neil & Cofsky, 1981; Rush, Weissenburger, Vinson & Giles, 1983 and Gray et al., 1986). Niederehe (1986) found intact performance by depressed patients on this task, although it should be noted that his patients were less severely depressed and more highly educated.

Findings of deficits across a variety of executive function tasks have been demonstrated in the literature, although as with free recall tasks, these findings have not been replicated consistently. This will be further addressed following a review of the literature.

3. Recognition memory tasks

In general, performance of depressed patients on recognition memory tests, presumably requiring less capacity and self-initiated processing, has been found to be intact, or less impaired, than on free recall tasks (Channon et al., 1993; Hart et al. 1987; King et al., 1991; Miller & Lewis, 1977; Niederehe, 1986; Tancer et al., 1990 and Weingartner et al., 1981). Niederehe (1986) found no significant differences between depressed and control subjects on recognition testing of words. However, signal detection analysis of the data for recognition memory indicated that depressed patients tended to be more conservative or cautious in responding, resulting in fewer false positive, but more false negative errors than normal controls. This is consistent with Miller and Lewis' (1977) finding of increased cautiousness in responding of depressed patients, and the Channon et al. (1993) finding that depressed patients were less accurate overall in detecting items. King and her colleagues (1991), in a study with severely depressed elderly unipolar patients, investigated delayed recognition of word items. Group differences were found between the depressed and control subjects. In contrast to previous investigators, signal detection analysis did not yield differences in response style between depressed and control subjects. The authors suggest that a genuine deficiency in learning is present in elderly depressed patients, and that it is not solely a retrieval deficit which underlies performance differences between depressed and control subjects. This is in contrast to relatively intact recognition performance of younger depressed patients. In another study, King, Caine and Cox (submitted), using a larger depressed sample, found parallel age effects in older depressives and control subjects on tests of verbal memory, providing no support for an age by depression interaction.

Hart, Kwentus, Taylor and Harkins (1987) found that older depressed subjects demonstrated normal forgetting but required longer stimulus exposure times than matched controls to acquire the same amount of information. Deficits in pattern and spatial recognition testing with elderly depressed patients (medicated, mostly inpatients) were found by Abas et al. (1990). In Abas et al's study (1990), latencies on recognition tasks were found, with no significant differences between medicated and unmedicated subjects, and no correlation between severity of depression and cognitive performance. Wolfe et al., (1987), using a five-trial recognition learning format of the Rey Auditory Verbal Learning task, found that unipolar depressed patients were significantly worse at recognition compared to normal controls.

Tancer and his colleagues (1990), in a study with younger depressed inpatients and psychiatric inpatient controls wanted to determine the effects of hospitalization and the specificity of cognitive impairments to depression. They found that with an "effortless" task of recognition, depressed patients were unimpaired relative to psychiatric controls, although they were impaired on free recall tasks. They concluded that impairment on consciously-controlled tasks does not seem to be a function of hospitalization per se. They do note that recognition tasks are generally untimed and suggest that this may be one reason for relatively intact performance.

Hertel and Hardin (1990) suggest that depression reduces the initiative to use beneficial strategies when their use is not demanded by the task. They tested mood-induced (clinically non-depressed) college students, as well as a group of clinically depressed college students. For the former group, they experimentally induced a temporary depressive emotional state in students who were not experiencing a clinical affective disorder. They found that the performance of clinically depressed patients was impaired on a recognition memory task. They further found that providing a strategy in a recognition memory task elevated the performance of the depressed subjects. Hertel and Hardin (1990) argue that the focus on cognitive effort as an explanatory concept should be limited to the stage of initiating such effortful processing, rather than a discussion of the ability to perform effortful processing per se. These authors hypothesize that initiating the effortful process requires more cognitive resources for successful performance. According to these authors, depressed people have a deficit in cognitive initiative, and it is this deficit that underlies poor performance on memory tasks, rather than reduced availability of cognitive resources, as has been suggested by others (Ellis & Ashbrook, 1988; Hasher & Zacks, 1979). Ellis (1990), however, argues that the initiative idea and the resource notion should not be viewed as competing explanations because initiative refers to the allocation of processes that can itself be the outcome of capacity allocation. In general, studies have demonstrated relatively intact performance for depressed patients with recognition tasks.

4. Implicit memory tasks

Relatively few studies have investigated the performance of depressed patients on tasks conceptualized as being dependent on implicit memory. These types of tasks (e.g. priming) are thought to use few cognitive resources or self-initiated processing (Craik, 1983; Craik & McDowd, 1987). Williams et al, (1987) suggest that explicit memory tasks involve strategic retrieval whereas implicit tests of memory can be accomplished by automatic processes.

In one study examining younger depressed patients, Danion and her colleagues demonstrated that these patients were significantly impaired, relative to age, sex and education-matched controls, on a task of free recall of a word list, and were not impaired on a word-stem completion (implicit memory) task. Other studies examining cognition in depressed (younger) patients have yielded similar findings, with generally intact performance on implicit memory tasks, while deficits were evident on free recall tasks (Denny & Hunt, 1992; Hertel & Hardin, 1990; Watkins, Mathews, Williamson & Fuller, 1992). Hertel and Hardin (1990) had clinically depressed patients and mood-induced subjects answer questions which were worded to reflect homophones' less common meaning. They were then required to spell these homophones, and findings indicated intact performance of depressed subjects relative to control subjects. Denny and Hunt (1992) found no effect of word valence on a stem completion task, although depressed patients recalled more negatively valanced words on a free recall task. They suggest that depressed patients encode negative information more deeply, and that word fragments may act as cues, thus eliminating the word valence effect observed on the word fragment task. A study conducted by Watkins and his colleagues (1992) yielded similar results.

In contrast to findings of intact performance on implicit memory tasks, Elliot and Greene (1992) found that depression affected performance on both explicit and implicit memory tests. Their implicit memory tasks consisted of a word completion and a homophone spelling task. They concluded that in depression, the nature of the cognitive impairment is more global and depression may interfere with the encoding and storage of both surface level and meaningful features of stimuli.

5. Performance of younger versus older depressed patients

Most of the studies investigating cognition and depression have used either younger depressed patients, or elderly depressed patients and have matched these patients to normal control subjects. Relatively more studies have investigated the performance of younger depressed patients on cognitive tasks. A review of the literature indicates that cognitive deficits have been found in samples of young, as well as elderly depressed patients. Few studies have adequately addressed the role of aging in depression (King et al., 1991). Siegfried (1985) noted that although cognitive symptoms of depression in early (less than 65 years old) and late (older than 65 years) life depression do not differ qualitatively, there seem to be clear quantitative differences. He suggests that this is likely due to a combination of detrimental effects of depression and age related reductions in cognitive functioning.

Consistent with this, Raskin and his colleagues (Raskin, 1986; Raskin et al., 1982), as well as others (Donneley et al., 1980; Savard et al., 1980) found that cognitive deficits were more pronounced in older depressed patients. Consistent with this, Niederehe (1986) found that there was a trend for older depressed patients to perform worse than younger depressed patients. More recently, King and her colleagues (1991) suggested that there is an interaction between depression and increasing age associated with deficient neuropsychological performance. Preliminary findings in the literature suggest that there is increasing variability and heterogeneity among elderly depressed samples. However, carefully controlled studies comparing patterns of impairment across the lifespan have yet to be conducted (Caine, Lyness & King, 1993). Although it is not an explicit goal of the present study to investigate the role of aging in depression and cognition, given findings of qualitatively similar findings in cognitive performance, as well as the relatively lesser emphasis on older depressed versus younger depressed patients in the extant literature, the present study investigated the cognitive performance of older depressed patients. In the following section, a discussion of possible reasons for discrepancies in the literature on cognition and depression will be addressed.

D. Analysis of discrepancies in the cognition-depression literature

The literature on cognition and depression indicates that cognitive function in depressed patients ranges from virtually intact to extremely impaired. In general, findings suggest impaired performance on tasks conceptualized as being consciously controlled and requiring greater self initiated processing such as free recall and executive function tasks, with intact performance on tasks hypothesized to be relatively automatic such as recognition and implicit memory tasks. In general, the dissociation in performance on tasks presumed to assess consciously controlled and automatic tests shown by depressed patients has been interpreted as evidence that automatic tasks reflects a form of processing that depression spares. However, findings of dissociations have not been replicated in all studies to date, and this section will focus on possible reasons for these discrepancies.

Westermeyer (1985), as well as others (e.g., Feinberg and Goodman, 1984; Gray et al., 1986; O'Hara et al., 1986) pointed out that there is a great deal of variability in the criteria used to assess depression, and often the criteria used are unstated, making it uncertain whether or not subjects were reliably diagnosed as depressed. Furthermore studies vary in terms of subjects' severity of depression, may not specify severity or may not take severity into account when analyzing the data (Cassens et al., 1990). This is unfortunate given that it has been argued that symptom severity, rather than simply the presence of depression, is important in predicting cognitive impairment in depressed elderly patients and differences in severity may, at least partly, explain discrepant findings in the literature (Kelley, 1986; Niederehe, 1986; O'Hara et al., 1986; Raskin, 1986). Additional interpretational difficulties arise from inadequate means of determining severity of depression in the elderly population. Depression scales used in many investigations of elderly patients have been validated in younger populations (for example, the Beck Depression Inventory and the Hamilton Depression Rating Scale). Several of these rating scales which are used to quantify the severity of depression are heavily biased to items inquiring about physical symptoms or vegetative signs of depression. Because somatic complaints and sleep disturbances are more frequent in normal non-depressed elderly, these scales may overestimate depression in older persons (Chaisson-Stewart, 1985). Brink, Yesevage and their colleagues (1982) designed a scale specifically for rating depression in the elderly. The Geriatric Depression Scale has been shown to have both high sensitivity (84%) and specificity (95%) (Brink et al, 1982).

Niederehe (1986) points out that conflicting studies have used significantly different samples as well as different ages. He did not find depression-related deficits on free recall tasks with elderly depressed patients, and suggests that this may be explained by differences in his sample, specifically that his sample was made up of well educated, less severely depressed unipolar depressed outpatients, while others who have found deficits (e.g., Weingartner and his colleagues) used less educated, more severely depressed unipolar and bipolar depressed patients. Consistent with this, Raskin (1986) concluded that in general the findings in the literature suggest that more severely depressed patients, and those with low education do poorest on cognitive tests. Jorm (1986), as well as King and her colleagues (King et al., 1991) noted that very few studies of cognitive deficits associated with depression have explicitly taken age into account. In addition, Jorm (1986), as well as O'Hara et al. (1986) noted that depressed patients were often medicated at the time of testing, thus potentially confounding the findings. However, in several studies comparing performance of medicated and unmedicated patients, no significant differences have been found (e.g., Abas et al., 1990; King et al., 1991).

Jorm (1986) also points out that there is a problem of sampling bias which is inherent in the literature, specifically that patients who are both depressed and cognitively impaired may be more likely to come to the attention of investigators than people who are just depressed or just cognitively impaired. He suggests that future research look at epidemiological studies with community dwelling subjects. O'Hara et al. in their epidemiological study found intact performance of elderly depressed patients (those meeting clinical criteria for major depression and those not meeting these criteria but nevertheless endorsing low and high levels of depressive symptomatology respectively). In their study, they found no significant group differences on an immediate free recall task. However, although their results provide no support for depression related memory deficits, it is possible that their lack of deficits was due to their word stimuli. The words they used were all concrete, high frequency and high imagery words, and it is possible that these stimuli would not be sensitive enough to detect group differences because encoding of these words would be less dependent on self initiated processes for successful performance.

Another potential confounding factor is institutionalization. Many of the studies investigating cognition and depression have used hospitalized depressed patients. It is possible that the hospitalization per se may result in anxiety and apprehension, which will then affect the ability of patients to sustain concentration (Tancer et al., 1990). Tancer and his colleagues (Tancer et al., 1990) found that depressive deficits could not be completely explained by the effects of hospitalization as they found relatively intact performance of hospitalized psychiatric control patients relative to hospitalized depressed patients.

Raskin (1986) suggests that another possible reason for the discrepancy in the literature may related to the differing levels of difficulty and nature of cognitive tests used. Miller (1975), and more recently Weingartner (1986) as well as Niederehe (1986), point out that one major problem with the clinical research in depression is that there is not enough concern regarding the theoretical underpinnings of studies. In many of the studies, there has been inadequate theoretical justification for selection of tasks. In addition, cognitive tasks that are used do not always clearly measure what they purport to measure and may often lack sensitivity and specificity (Weingartner, 1986).

As reviewed in the previous section, Elliot and Greene (1992) found impaired performance of depressed patients on both implicit and explicit memory tasks. This is in contrast to other researchers who found intact performance on implicit memory tasks, with deficits evident on tasks conceptualized as tapping explicit memory. Roediger and McDermott (1992) discuss reasons for inconsistent findings of depression and implicit memory. They point out that Elliot and Greene (1992) found that depression affected performance on implicit memory tasks, specifically homophone spelling and word stem completion, while others, using the same types of tasks found intact performance of depressed patients on these tasks. They suggest that future research, with improved methodologies, are needed before any more definite conclusions about cognition and depression can be drawn.

Although many researchers have suggested that depressed patients are more impaired on tasks emphasizing consciously controlled, as opposed to automatic, processes, a priori definitions of the consciously controlled construct have been lacking (King et al., 1991). It is important to have clearer criteria for the distinction between consciously controlled and automatic concepts so that operationalizations of these concepts would be more appropriate. Consistent with this, Blaney (1986) noted that future research should include an improved technology for distinguishing effortful from automatic processes in memory, and Niederehe (1986) suggested that future research should quantify the amount of "cognitive effort" or "processing resource" each task demands. Elliot and Greene (1992) suggest that what is needed for future research are improved task analysis techniques such as Jacoby's (1991) process dissociation procedure, rather than just applying operational distinctions between different tasks. The following section will expand on this notion by presenting a discussion of the problems inherent in equating performance on a task with a specific process. The use of Jacoby's (1991) process dissociation procedure, which has as its goal to dissociate processes within, rather than between, tasks will be proposed as a method for investigating memory processes in depression, while overcoming the problems inherent in assuming a one-to-one mapping of process and task.

E. Process Dissociation Procedure

As noted earlier, the hypothesis that depressed patients are impaired on tasks assessing consciously controlled processes, and are unimpaired on tasks assessing automatic processes, has been widely suggested as an explanation for findings in studies investigating depression and cognition. This hypothesis has been based on findings of task dissociations between free recall and recognition tasks (hypothesized to emphasize consciously controlled and automatic processes respectively), and between explicit and implicit memory tasks (which are assumed to depend on consciously controlled and automatic processes respectively). However, as section D noted, these task dissociations have not been consistently found in the literature. This may be because of the overlap in the processes contributing to performance on the different types of tasks (Dunn and Kirsner, 1989; Jacoby, 1991). Jacoby (1991) points out that one major problem with investigations comparing automatic and consciously controlled processing is that many investigators equate a particular task with a particular process. Neumann (1984) suggested that although tasks thought to be automatic do minimize opportunities for consciously controlled processing, they cannot do so completely or reliably enough to satisfy definitions of automatic or unconscious processing.

Consistent with this notion, Bargh (1989) criticized standard definitions of automaticity. He argued that the criteria laid out by Posner and Snyder (1975) and Shiffrin and Schneider (1977), namely being capacity free, outside of awareness and unintentional are rarely met simultaneously. For example, recognition memory tasks, thought to be solved by intentional recollection of the study episode, can be equally solved without intention to recollect or awareness of recollection of the study episode (Dunn & Kirsner, 1989). It has also been argued that a task such as stem completion, which is thought to be an implicit memory task and is thought to emphasize more automatic and less self initiated processing (Craik & McDowd, 1987), may be solved equally well via intentional use of memory for words presented earlier (Dunn & Kirsner, 1989; Jacoby, 1991; Richardson-Klavehn and Bjork, 1988). The processes underlying performance on an (implicit) stem completion task are at times the same as those underlying performance on an explicit test of recall cued with word stems (Dunn & Kirsner, 1989; Jacoby, 1991; Jacoby, Toth & Yonelinas, 1993; Richardson-Klavehn and Bjork, 1988). Jacoby (1991) notes that because of this overlap, it is difficult to determine the processes underlying successful performance of various tasks. Roediger and McDermott (1992) argue that although implicit memory tasks are thought to be more automatic than explicit memory tasks, they are not automatic based on the criteria provided by earlier investigators (Posner & Snyder, 1975; Shiffrin & Schneider, 1977). They point out that completing word fragments is an "effortful" process, and that it is the priming on implicit memory that is automatic, and not the task per se. Given this conceptualization, stem completion tasks are not purely automatic tasks-they are sufficiently complex to involve a combination of automatic and consciously controlled components. In line with this, Jacoby (1991) argues that automatic and consciously controlled processes underlie performance of all tasks and hence tasks cannot be treated as process pure.

Jacoby (1991) devised what he referred to as the process dissociation procedure, with the goal of quantitatively separating the contribution of automatic and consciously-controlled processes to performance on memory tasks. This framework differs from previous frameworks in that it does not suggest one-to-one correspondences between tasks and processes. Rather, it considers task performance as a mixture of automatic and consciously controlled processes, and to quantitatively separate the contributions of each of these processes to task performance.

The rationale underlying the process dissociation procedure is that if responding is under conscious control, people should be able to respond differentially to items of a given class depending on the demands of the task. Tasks in which automatic and intentional processes act together are termed facilitation paradigms. For example, in stem completion tasks, seeing a word earlier might facilitate performance by means of automatic processes but consciously controlled processing would yield the same result (Richardson-Klavehn & Bjork, 1988). What is meant by this is that if subjects are instructed to complete stems with the first word that comes to mind, words that they have seen earlier may be activated for completion by the cuing of parts of the words. Alternatively, if subjects are presented with a stem of a word, and are instructed to complete the words with words that had been presented earlier, recollection of the earlier-presented words might yield equally effective performance. Performance on a task in which the two types of processes act in opposition can be seen in interference paradigms, such as the Stroop task (Jacoby, 1991). In the Stroop task, subjects are instructed to name the ink colour of words where ink colour and semantic content do not correspond (e.g. "BLUE" is printed in red ink). Intentional processing of to-be-ignored events (i.e. intentional output of the word name) is unlikely because such processing would run counter to the purpose of performing well on the task (cf. Jacoby, 1991).

Conscious control in Jacoby's studies (Jacoby, 1991; Jacoby, Toth & Yonelinas, 1993; Jennings & Jacoby, 1993) is measured as the difference between performance when a person is trying to (facilitation) as compared to trying not to use information from some particular source (interference). Jacoby and his colleagues argue that unlike consciously controlled processing, automatic processes will proceed whether or not one intends for them to do so. Automaticity is thus defined as the lack of intentional control. Jacoby and his colleagues (Jacoby, Toth & Yonelinas, 1993) examined the effects of dividing attention on consciously controlled and automatic influences as bases for stem-completion performance. In this study, the authors used an opposition, as well as a facilitation paradigm. Participants were presented a list of words. Following this presentation, they were required to complete three-letter stems. In the opposition component of this task, participants were instructed not to use an earlier presented word to complete the stems, that is to exclude earlier presented words as possible completions for the stems. In the exclusion condition, any increase in the probability of using an earlier presented word to complete the stem would not be caused by consciously controlled processing because this type of processing would lead to the exclusion of earlier presented words. The exclusion condition is a means of determining the extent to which automaticity exists and consciously controlled processing has failed. In the exclusion condition, an earlier presented word would be given as a completion only if automatic responding is sufficient for it being given as a response, and the word is not consciously recalled (i.e., there was a failure of conscious recollection). The probability of an earlier presented word being (mistakenly) given as a completion in the exclusion condition is:

$$A\,(1 - C)$$

where A refers to automatic influences on memory, and C refers to consciously recalling the word as being on the initial list. Thus, 1-C is a measure of the failure of conscious recollection. In the inclusion condition, participants are instructed to complete the stems with an earlier presented word, or the first word that comes to mind. Participants are thus instructed to include earlier presented words. In this condition, consciously controlled processing acts together with automatic processing, and is thus referred to by Jacoby (1991) as a facilitation condition. Stems could be completed with earlier presented words because either participants consciously recalled these words (C) or because even if consciously controlled recollection failed (1 - C), the effects of automaticity (A) were sufficient for stems to be completed with earlier presented words. The probability of completing a stem with an earlier presented word in the inclusion condition is:

$$C + A(1 - C)$$

Jacoby's (1991) process dissociation procedure requires both an inclusion and exclusion condition. The extent to which stem-completion performance is determined by consciously-controlled processing is estimated by subtracting the probability of (mistakenly) completing a stem with an old word when subjects were instructed not to use an earlier presented word (exclusion condition) from that of completing a stem with a previously presented word when instructed to do so (inclusion condition). Thus, the estimate of consciously controlled recollection provides a measure defined in terms of selective responding. The probability of consciously controlled recollection can be estimated as:

$$\text{Inclusion} - \text{Exclusion}$$

$$[C + A(1 - C)] - A(1 - C)$$

From this, automaticity (A) can then be estimated by dividing the probability of mistakenly responding with an earlier presented word in the exclusion condition by a failure in consciously controlled recollection.

$$\text{Exclusion}/(1\text{-}C)$$

Automatic processes do not support selective responding, that is, they result in the same effect regardless of whether they are in accord or in opposition to intention. If the probability of consciously controlled recollection were 1.0, this would suggest that subjects always completed stems with earlier read words in the inclusion condition, and never completed stems with those words in the exclusion condition. Conversely, if the probability of consciously controlled recollection were 0, this would suggest that subjects would be as likely to complete a stem with an earlier read word in the inclusion and exclusion conditions as a result of automatic processes (Jacoby, Toth & Yonelinas, 1993). This procedure allows for the identification of factors which selectively influence automatic and consciously controlled processing. For example, results from Jacoby's lab indicate that dividing attention during study greatly reduces the probability of consciously controlled processing, but leave automatic influences unaffected. The use of the process dissociation procedure has yielded results indicating that aging (Jennings and Jacoby, 1993), as well as amnesia (Verfaellie & Treadwell, 1993) adversely affect consciously controlled processing, while leaving automatic processing intact. Based on the evidence gathered using the process dissociation procedure, Jacoby and his colleagues conclude that automatic based responses require little processing capacity, and that conscious control and automaticity are independent processes.

The process dissociation procedure proposed by Jacoby (1991) appears to be promising as a means of more directly testing the hypothesis of a deficit in consciously-controlled (effortful) processing in depressed elderly patients. Unlike procedures used in previous investigations which equate tasks with processes, this procedure attempts to more clearly separate the contribution of automatic and consciously controlled aspects of processing to memory performance within a task. If depressed patients are impaired on the more consciously controlled aspects of memory and unimpaired on the more automatic aspects of memory, the process dissociation procedure would be expected to reveal this difference. Roediger and McDermott (1992) recommend the use of Jacoby's (1991) process dissociation procedure as an improved methodology for investigating the effects of depression on memory.

The primary goal of the present study was to determine whether depression adversely affects the consciously controlled processes required by the stem completion task, while leaving the automatic processes required by this task relatively intact. Previous researchers have looked at performance of depressed patients across tasks thought to emphasize automatic and consciously controlled processing respectively, and results have been inconsistent. Given the potential overlap in cognitive processes underlying successful performance across different tasks, this study investigated the separate influences of automaticity and conscious control within a task, rather than between tasks, using Jacoby's (1991) process dissociation procedure. A sub-goal of the present study was to investigate executive functioning in depressed elderly patients, using a variety of tasks assessing different executive function processes. As noted earlier, although there has been some research aimed at investigating executive functioning in depressed patients, it has been relatively sparse compared to investigations of memory (see Cassens et al., 1990 for a review). Tasks thought to tap executive functioning emphasize greater self initiated processes and are related to consciously controlled processes. Given that Jacoby's procedure is relatively new, it was important, for comparative purposes, to include tasks that have already been used and found to be sensitive to the elderly depressed population. This would allow for a comparison of the performance of these patients on a new task using Jacoby's improved methodology for process analysis, with performance on tasks and have been shown to be sensitive to depression in the literature. Although the notion of a deficit in executive functioning is not mutually exclusive from the suggestion of a deficit in consciously controlled processing in depressed patients, the involvement of these (executive function) processes in depression was analyzed separately in the present study as they were not amenable to the same type of process dissociation analyses as Jacoby's task. Correlational analyses were conducted to determine relationships between performance on the entire set of tasks used. The following section will discuss the rationale for selection of particular tasks used in the present study.

F. Task selection

To investigate the hypothesis of a specific deficit in consciously controlled processing in depressed patients, Jacoby's (1991) process dissociation procedure was used as this procedure allows for a mathematical dissociation of the separate contributions of consciously controlled and automatic influences to performance. Pilot testing with depressed elderly patients indicated that the procedure used in the stem completion task by Jacoby and his colleagues (Jacoby, Toth & Yonelinas, 1993) was too difficult for this population of patients. The present study used a modified version of this task which preserved the utility for process dissociation.

To test the more general aspects of executive functioning in depressed elderly patients, a variety of tasks presumably assessing various aspects of executive functioning was used. Many different cognitive processes have been postulated to underlie executive functions, including sequential organization, self monitoring, planning, initiative, reasoning, decision making, inhibition, susceptibility to interference and maintenance and shifting of cognitive set (Baddeley, 1986; Damasio & Van Hoesen, 1983; Fuster, 1989; Lezak, 1983; Norman & Shallice, 1986; Schacter, 1987; Stuss, 1992; Stuss & Benson, 1986; Weintraub & Mesulam, 1985). Many executive function tasks or similar tasks have been demonstrated to be sensitive to depression in younger patients. However, not all of these tasks have been used with older depressed patients, and some have never been used with depressed patients.

An impairment in the depressed patient's ability to spontaneously use strategies for successful memory performance has been proposed (Hasher & Zacks, 1979; Hertel & Hardin, 1990). This is related to the notion that depressed subjects are less likely to engage in the spontaneous use of processes which require a considerable amount of conscious control or self initiated processing. Hertel and Hardin (1990) found that when depressed subjects were provided with a strategy, i.e., they did not have to spontaneously initiate the use of a strategy, their performance on a recognition memory task was intact relative to control subjects. It has been demonstrated that the reported use of imagery in word recall tasks is positively related to recall level (Richardson, 1985), and that when subjects are instructed to use imagery, performance improves in recall tasks (Hulicka & Grossman, 1967; Masson & Smith, 1977; Pavio, 1971). Previous research further indicates that depressed patients may not spontaneously use imagery to improve recall. However, when provided with high imagery words, recall is relatively intact, suggesting that using an imagery strategy with high imagery words does not require as much self initiated processing. In the present study, the spontaneous use of a mental imagery strategy versus the prompted use of this strategy was investigated. It was expected that providing an imagery strategy would improve performance for depressed patients relative to a condition where no such strategy was provided and where it had to be self-initiated.

Susceptibility to interference, i.e., to the output of an automatic response tendency was assessed with the Stroop task, which has been shown to be sensitive to depressive deficits (Caine, 1981; King et al., 1991; Raskin et al., 1982). The Wisconsin Card Sorting Task (Berg, 1948; Grant & Berg, 1948) requires subjects to generate and test hypotheses with minimal feedback. It requires the ability to form abstract concepts as the bases for sorting, and to maintain or shift between sorting principles in response to feedback. This task been used extensively in the neuropsychological literature. It was used in the present study because of its demonstrated sensitivity in a variety of neuropsychological populations, including depressed patients (Martin et al., 1991).

Verbal fluency tasks, where participants are required to generate words to particular letters or categories are measures of the ability to initiate and sustain behaviour, and these tasks have also demonstrated sensitivity in depressed populations (Caine, 1981; King et al., 1991), as well as many other neuropsychological populations (Weintrub & Mesulum, 1985). Letter fluency tasks are reliant on phonemic or lexical cues to guide the retrieval process, while category fluency tasks require search from semantic memory for successful performance (Hodges, Salmon & Butters, 1990). Category fluency tasks are thought to provide additional structure by narrowing the set that needs to be searched (Troster, Salmon, McCullough & Butters, 1989). Search for categorically (semantically) related information is less reliant on self initiated processing than search for phonemically related words (words beginning with the same letter). It has been further suggested that letter fluency tasks may be more sensitive to the ability to initiate and sustain behaviour (Randolph, Brown, Goldberg & Chase, 1993), although clearly, both phonemically and semantically based word generation task performance is dependent on initiation and maintenance of this behaviour. Given the hypothesized differences in self initiated processing for letter and category fluency task, performance on both types of fluency tasks were investigated in the present study. It was expected that performance would be better on the category fluency task because the search for semantically related information was expected to rely more on automatic processes. The set of letters F,A, and S have been used extensively in the literature, and was thus chosen for this study. The frequency of English words varies as a function of their initial letter.Words beginning with S have a relatively high frequency, followed by F and then A (Lezak, 1983; Spreen & Strauss, 1991). It was expected that the higher frequency letters would yield better performance as the set to be searched is larger.

A task measuring the ability to copy and maintain a set of sequential movements (Sequential Movements task, Kiss, 1990), was used in the present study as a measure of non-verbal sequencing ability. Performance on this task has not previously been studied in depressed patients.

Finally, a working memory task which requires relatively rapid and repetitive shifts in processing requirements (e.g. encode, store, retrieve, drop from memory), and therefore may be said to invoke executive function, was used. This measure has been shown to be sensitive to age, minor head injury, and early Alzheimer's disease (Dobbs & Rule, 1989; Schwartzberg, Dobbs & Rule, 1992; Schwartzberg, Dobbs, Rule & Vanast, 1988).

Severity of depression has been suggested as an important factor in determining depression-related impairments on cognitive tasks. Severity of depression was estimated in our patients using the Geriatric Depression Scale (Yesavage, Brink, Rose, Lum, Huang, Adey & Leirer, 1983). This scale is one of the few scales devised for, and standardized with, elderly patients. In addition, it has high sensitivity and specificity (84% and 95% respectively) in geriatric depressed patients, as well as in populations with mild dementia and physical illness (Brink, Curran, Dorr, Janson, McNutlty & Messina, 1985; Sheikh & Yesavage, 1986). Furthermore, it is relatively easy to administer and does not require extensive training for reliable administration.

Because level of intellectual functioning may affect performance on cognitive tests, it was deemed important to obtain a measure of general intellectual functioning. Tests assessing word knowledge tend to be relatively well preserved across a wide variety of patient populations, and was thus not expected to be sensitive to depression. The Vocabulary subtest from the WAIS-R has been identified as the single best measure of both verbal and general intellectual ability (Lezak, 1983). A test that correlates well with general intellectual ability was chosen to determine if there were differences between groups in this ability. Although this was not an explicit goal of the study, a measure was provided by the Quick Test (Ammons & Ammons, 1962), similar to the Peabody Picture Vocabulary Test (Dunn, 1965). This particular task has a very strong correlation with the Full Range Picture Vocabulary Test (Ammons, Larson & Shearn, 1950) which correlates highly with performance on the WAIS Full Scale IQ. It was chosen as a rapid way of obtaining an estimate of general level of intellectual ability.

It could be argued that deficits found for the depressed group on cognitive tasks could be explained by a general lack motivation per se, that depressed patients might not have the motivation to put forth a good effort when presented with a complex task. An incomplete letters task, a complex visual perceptual task using familiar and verbal stimuli was used. A task graded in difficulty only in terms of its perceptual aspects (Warrington & James, 1967), requiring sustained motivation that is generally thought not to be a measure of executive functioning as described earlier, and that does not require a memory load, was used in the present study. Memory load is minimized because all the information seen on each card is re-presented with additional information on each card. This task is thought to rely less on self initiated processing for successful performance. It was used to assess motivational level to some extent. A finding of no group differences on this task would provide some evidence that motivation level did not differ between groups. If the depressed patients were simply unmotivated throughout the test session, one would expect deficits on any type of complex task. It was thus important to select a task that was relatively complex, but that was not expected to demonstrate deficits between the groups. The task used to determine this was an Incomplete Letters task, a complex visual perceptual task. It was expected that depressed patients would not be impaired on such a task relative to matched control subjects.

II. Method

A. Subjects

Two groups of subjects were studied. One group consisted of 17 clinically depressed elderly patients (4 males and 13 females), obtained through the Edmonton General (Grey Nuns) Hospital in Edmonton, Alberta. Twelve of these patients were community-dwelling and attended the Geriatric Depression Day Treatment Program twice a week. The other five depressed patients were inpatients. The patients in the depressed group were given a diagnosis of major depression by a psychiatrist using the DSM-III-R criteria. They were not psychotic or bipolar. Severity of depression was quantified by the Geriatric Depression Scale (GDS, Brink et al., 1982). The mean GDS score was 18.3, indicating mild depression (high end of mild range). Six of the depressed patients were moderately to severely depressed, and eleven of the depressed patients were mildly depressed according to the Geriatric Depression Scale. Participants were excluded if they had any other psychiatric illnesses, any known central nervous system disorders or a history of alcoholism. None of the participants had any obvious co-existing or previously diagnosed organic dementias. None were colour-blind, and all had normal or corrected visual acuity. Mean age for the depressed group was 73.4 years old and mean years of education was 10.7 years. Table 1 gives the means and standard deviations for age, years of education, the score on the Quick Test (with an IQ equivalent, according to Ammons & Ammons, 1962) and the score on the Geriatric Depression Scale (GDS) for the depressed and control groups.

Three of the depressed patients had been started on tricyclic anti-depressants, although this medication had been discontinued two days prior to testing for one of the patients. Eleven of the depressed patients had been started on a newer agent anti-depressant (considered to have minimal anti-cholinergic and sedative side-effects), although this medication had been discontinued for two of the patients, 7 days and 3 days prior to testing respectively. Thirteen patients had been prescribed an anti-anxiety medication. Table 2 provides information regarding medication use for the depressed patients obtained from hospital records.

The control group consisted of 17 healthy community-dwelling volunteers (4 males, 13 females) matched to the depressed group on the basis of age, education and gender. These subjects were obtained via a newspaper advertisement requesting volunteers for a study on memory. They were all informed of the purpose of the study, and were told what participation would entail. They were all screened to rule out any psychiatric disorders, alcoholism, medical illnesses or neurological disorders. None of these subjects reported taking any psychotropic medications. None were colour-blind, and all had normal or corrected visual acuity. Mean age for the control group was 73.1 years old, and mean years of education was 11.7 years. All control subjects were given the Geriatric Depression Scale to screen out depression in this group. The mean GDS score was 3.1, indicating no depression in this group.

There were no significant differences between the two groups on age, education and score on the Quick test or estimated IQ scores (all F's < 1.5, ns). As expected, one way analysis of variance indicated a significant group difference in terms of severity of depression, $F(1,32) = 87.1$, $p < .001$. Participants in both groups were included only if they were proficient in written and spoken English.

Table 1: Means, standard deviations and range of scores for age, education, GDS and Quick Test

	Depressed Group Means (std. dev) n = 17	Control group Means (std. dev.) n = 17
AGE	73.4 (6.4) Range = 62-87	73.1 (5.5) Range = 65-82
YEARS OF EDUCATION	10.7 (3.4) Range = 6-18	11.7 (2.6) Range = 9-18
GERIATRIC DEPRESSION SCALE	18.3 (6.47) Range = 8-29	3.1 (1.9) Range = 1-6
QUICK TEST	43.6 (3.9) Range = 37-49	45.3 (2.9) Range = 39-49
ESTIMATED IQ	106.0 (12.4) Range = 89-130	110.8 (10.2) Range = 92-130

Table 2: Medication use of depressed patients

SUBJECT NO.	MEDICATION(S)	COMMENTS
1	Luvox Librium	d/c 1 day prior 10 year duration
2	Prozac Halcion	d/c 1 wk prior
3	Deseryl Serax	
4	Clonazepam (Rivotril)	
5	Aventyl Lectopam	d/c 2 days prior
6	None	
7	Serax	
8	Norpramin (Desipramine) Serax	
9	Flurazepam (Dalmane)	
10	Luvox Ativan	d/c 2 days prior
11	Prozac Norpramin Rivotril	
12	Restoril	
13	Prozac Norpramin Ativan	
14	Luvox	
15	Zoloft	
16	Deseryl Ativan	
17	Luvox Deseryl	

All participants gave informed consent to participate in the study, and were told that they could withdraw from the study at any time without penalty.

B. Procedure

All participants were administered the same battery of tests. They were tested individually over two sessions to minimize fatigue. Each session lasted approximately an hour. The first session consisted of the following tasks: the Quick Test, a free recall memory task without the provision of any strategy, the Wisconsin Card Sorting Task, the Sequential Movements task, the Dobbs and Rule Working Memory task, the verbal fluency tasks, and a free memory recall task with the provision of an imagery strategy. The second session consisted of the following tasks: the Incomplete Letters task, the stem completion task, and the Stroop colour-word interference task. All relevant task materials can be found in the Appendix.

C. Tasks

Word Stem Completion Inclusion/Exclusion task: The procedure for this task is a modification of a task used by Jacoby, Toth & Yonelinas (1993), designed to place automatic influences of memory in opposition to consciously-controlled influences of memory. A list of 58 5-letter words varying in frequency (as determined by Thorndike & Lorge, 1944) was used. In the first phase, participants were visually presented with a list of 42 words, one at a time, on a laptop computer screen. Each word was presented for 1.5 s and the screen was blank for .5 s before the next word was presented. From the list of 42 presented words, 32 words were selected as target items. To minimize primacy and recency effects, 5 filler items were placed at the beginning and the end of the list. Sixteen new words which had not been presented earlier were presented randomly throughout the test phase (stem completion); however, due to the small sample size, this list of 16 words was not rotated to obtain base rates, and these words were not included in any of the analyses. Subjects were asked to read each word aloud, and try to remember it. The final phase was the test phase, the word stem completion. Subjects were informed that they would be shown the first three letters of a word (i.e., a word stem) and asked to generate a five-letter word that would be a completion for the stem. Prior to the presentation of each stem, they were instructed to do one of two things. They were instructed that they should either use the stem as a cue for recall of an earlier presented word (inclusion condition), or that they should complete the stems with a word that was not presented earlier (exclusion condition). In both cases, if they could not think of a word that fit the appropriate condition, they were encouraged to complete the stem with the first word that came to mind. Instructions to include or exclude earlier presented words as completions were presented in a random order, and there were no more than three stems representing the same condition (inclusion/exclusion) presented successively. Participants were presented with 48 three-letter word stems. Thirty two of these were stems that could be completed with words presented in the first phase of the experiment. There were an equal number of stems that required "inclusion" completion and "exclusion" completion. Participants were given up to 25 seconds to complete each stem. They were presented with the next stem once they completed a stem, or once 25 seconds had elapsed. The participants were given two practice trials of 3 words to ensure comprehension (by successful completion of inclusion and exclusion conditions) of instructions prior to the presentation of the test word list. The measures used were the following, and were calculated according to Jacoby, Toth and Yonelinas (1993):

1) Estimate of the proportion of old (previously seen) words used to complete the stems (correctly) in the inclusion and (mistakenly) in the exclusion condition: X/16 and Y/16 respectively, where X and Y refer to the number of previously seen words used to complete stems in each condition

2) Estimate of the probability of using consciously controlled processing as a basis for stem completion performance:

$$X/16 - Y/16$$

3) Estimate of the probability of using automatic processing as a basis for stem completion performance:

$$Y/16 \text{ divided by } [1-(X/16 - Y/16)]$$

Free recall task: In the first phase of this task, subjects were presented with a list of 14 English words. These words were chosen from Pavio, Yuille & Madigan's (1968) norms for concreteness, imagery and meaningfulness. Half of the words in the list were words with high imagery ratings (mean = 6.55) and half of the words had low imagery ratings (mean = 2.98). All words were high in frequency (A or AA). Subjects were told that they would be shown a list of words and once all the words had been shown they were to recall as many as they could. They were presented the words one at a time on index cards and were instructed to read each word out loud. They were shown each word for 3 s. Once all 14 words had been presented, they were asked to say as many of the words as they could recall. Three scores were obtained 1) the number of high imagery words recalled; 2) the number of low imagery words recalled and 3) the number of words listed twice or more (perseverative errors).

In the second phase, which was administered approximately 30-45 minutes after recall, they were presented with another list of 14 words, one at a time on index cards (matched for frequency and imagery ratings to the first list, and presented at the same rate). Prior to the presentation of the words, they were provided with an imagery strategy. They were instructed to try and make a picture in their heads of what each word represented as they saw and read each word out loud. They were informed that this may help them remember more words. As in the first phase, the score was the number of high and low imagery words recalled, as well as the number of perseverative errors. A separate difference score was calculated for the high and low imagery words respectively to determine whether the provision of the imagery strategy influenced recall. This score was obtained by subtracting the number of words recalled in the first phase from the number of words recalled in the second phase.

Wisconsin Card Sorting task: Four stimulus cards were laid out in front of the subject- one red triangle, two green stars, three yellow crosses and four blue circles. The subject was then given a pack of 64 cards on which were printed one to four symbols, triangle(s), star(s), cross(es) or circle(s) in red, green, yellow or blue. The subject was instructed to pick up the cards in the deck one at a time (starting from the top) and to match each one to one of the four stimulus cards by placing it below the card. They were required to deduce the principle or rule for matching by the feedback provided by the experimenter after each card in the deck was placed. The experimenter indicated only whether or not each response was correct. After a run of ten correct placements in a row, the examiner shifted the sorting principle for correct responding. The test began with colour as the basis for sorting, shifting to form, then to number and then back to colour, followed by form and then number. Several measures were calculated according to Heaton (1981): the number of correct responses, the number of errors, the number of categories achieved, the number of perseverative responses, and the number of perseverative errors. Perseverative responses were defined as responses which would have been previously correct (i.e. previous sorting principle), indicating an inability to shift response set despite negative feedback. Perseverative errors on this task are those perseverative responses which are errors. Perseverative responses which are not errors are those that match the "perseverated-to" principle and occur within a series of unambiguous perseverative errors.

Sequential Movements task: Subjects were shown a sequence of one to four hand movements, made up of the following: fist, palm, side and back. They were asked to copy the movements after seeing them. Once it was established that they could copy the single movements with each hand (they were given up to 3 trials per movement if required), they were shown sets of two, three and four sequential movements using both the left and the right hands. Different sequences of movements were shown for each hand. Three demonstrations of each sequence of movements were presented, with the subject copying the sequence after each presentation. After the third set was copied, the subject was instructed to demonstrate each set of movements five times. For each set of movements (2, 3 or 4), and for each hand, they could attain the maximum score of 5 (corresponding to the five times they correctly repeated each sequence). The maximum score attainable for each hand was 15, providing a maximum combined score of 30.

Dobbs & Rule Working Memory task: Digits were presented at a fixed rate of 1.8 seconds using a pre-recorded cassette tape. Subjects were asked to respond in each of several lag conditions. The participant was asked to repeat each item immediately after hearing it (Lag 0), the item one previous to the current item (Lag 1), two previous to the one being presented (Lag 2), and the item three previous to the current item (Lag 3). Ten correct responses were possible in each lag condition. The score was the number of items correct to first error for each lag condition.

Verbal Fluency tasks: Subjects were required to produce as many words as they could think of beginning with a given letter of the alphabet in a 60 second period. The three letters used in this phonemically based verbal fluency task were F, A & S. Subjects were instructed not to use proper nouns, numbers or the same word with a different suffix. Following this, they were instructed to name as many items as they could that fit into particular categories: names, foods, and vegetables. The category fluency task is a more structured, semantically based task than the letter fluency task. Consistent with previous clinical literature, subjects were given 60 s for the names category and 30 seconds each for the other two categories (vegetables and foods) (Fuld, 1980). The total number of appropriate words generated for each of the letters and each of the categories was determined. The total number of correct words generated over all three letters was used as one score, and the total number of words produced for the categories was used as the other score. Where subjects were given 60 seconds for word generation (letters F,A, and S and the names category), total number of correct words was scored at 30 seconds as well. Perseverative errors, i.e., the number of words that were repeated twice or more within a trial, were scored as well.

Stroop task: Subjects were presented with three types of material printed on three sheets of paper, which they were instructed to read aloud, in order and by column, as quickly as possible. The first sheet consisted of 100 colour words (e.g., BLUE, GREEN or RED) presented in black ink. They were instructed to read the words as quickly as they could, and were given 45 seconds to read as many as they could. On the second sheet, they were presented with 100 stimuli of the form "xxxx" printed in one of three colours (red, blue, green)in random order. The task required participants to correctly name the colours as fast as possible in a 45 second period. The third sheet consisted of 100 colour words (RED, BLUE, GREEN) printed in an ink whose actual colour was different from the colour designated by the word (e.g., the word BLUE was printed in red ink). Here the task was to name the colour of the ink in which the word was printed as quickly as possible. For all three conditions, participants were informed that if they made an error, they would be told 'No", and that they should correct their error and continue without stopping. The total number of items correctly named in 45 seconds for each of the 3 conditions was scored. The measure used was the interference score calculated as follows according to Golden's (1978) formula,

1) Calculation of the colour minus word predicted score using the formula

$$\frac{\text{Colour X Word}}{\text{Colour + Word}}$$

2) To obtain the interference score, an age corrected raw score for colour-word was used (see Golden, 1978). The predicted score is subtracted from the raw score, ie., raw score minus predicted score

3) The norm table (Golden, 1978) is then used to determine the T-score for the interference score.

<u>Incomplete Letters task:</u> Thirteen sets of incomplete letters were prepared. These letters were: B, K, V, H, A, Z, E, S, P, U, D, F and M. The letters used were 100-point capital letters from the Apple TrueType Helvetica font set. The dimensions of a rectangle capable of enclosing the largest of the letters were determined and then rounded up to the nearest whole centimetre. The dimensions of the rectangle were 2 cm (width) by 3 cm (height). The rectangle

was divided into a 5 by 5 grid resulting in cells of 4 mm (width) by 6 mm (height). Degraded letters were produced by centring each letter within the rectangle and superimposing white rectangles of grid cell size onto grid cell positions. For each letter used in the set, a series of five letters ranging in completeness was produced. The first degraded letter in each series was produced by placing 4 white rectangles at grid cell locations, leaving 84% of the cell complete. For each subsequent letter in the series, increasing degradations of the letter were produced by adding four white rectangles (16%) to those that had been previously allocated. For the most incomplete letter in the sequence, only five of the 25 grid cells (20%) were left unobscured.

Three practice trials were administered to familiarize subjects with the task, and to ensure comprehension of task instructions. On the first practice trial, all five cards in the series were laid out simultaneously to demonstrate to the subject how the letters increased in completeness of representation. For the other 2 practice trials, the most incomplete letter in a series was presented first and the subject was asked to identify it. Proceeding in the direction of increasing completeness the cards for each letter were presented until the subject either correctly named the letter or was shown all 5 cards. Following the practice trials, the subject was presented with ten series of letters to identify. Performance was scored in terms of the total number of cards that the subject had to see over the 10 series for identification of the letters, with the maximum being 50.

Approximately 30-40 minutes following the end of the 10 presentation series, this task (the 10 series) was repeated to determine if subjects would require fewer cards to identify the letters. The score was the same as had been used for the first attempt at the task.

Quick Test: Participants were shown a set of 4 pictures. They were then read a list of 50 words one at a time. They were instructed to point to the picture that best fit each word. They were encouraged to look at all 4 pictures prior to making a decision, and they were informed that they would not know all the words that were read to them. They were told that if they did not know a word, they should let the experimenter know, and the next word would be read to them. The raw score was the number of word meanings they correctly identified by pointing to the correct picture, the maximum being 50. An estimate of IQ was determined using Ammons & Ammons (1962) table of norms.

III. Results

A. Incomplete letters task

An incomplete letters task, a complex visuoperceptual task, was used as a task that requires motivation and effort for successful performance, but that does not require a memory load and is generally not thought to rely on executive functions. Table 3 contains the means and standard deviations for the Incomplete Letters task, on the first presentation trial and the repeat presentation trial of the letters. A 2 X 2 mixed model ANOVA with group (depressed and normal controls) as a between subjects factor and presentation trial (INCOMP LETT 1 and INCOMP LETT 2) as a within subject factor revealed a trend for a reliable group effect, $F(1,32) = 3.65$, $p < .07$, but no significant main effect of presentation trial and no significant interaction effect. Because of the trend for a reliable group effect, and the interest in assessing potential motivational differences, as well as potential differences in learning, between the depressed and control groups, one way ANOVAs were performed for the first and repeat presentation trials. Results indicated a significant difference between the two groups at the repeat presentation trial, $F(1,32) = 5.81$, $P < .05$, suggesting greater learning (i.e. requiring less presentation levels to identify the letters) by the control subjects. There was no significant group difference at the first presentation trial ($F < 1.5$, ns), suggesting that there were no differences in motivational level, as assessed by this task.

Table 3: Means and standard deviations for Incomplete Letters task.

	Depressed group	Control group
INCOMP LETT 1	35.8 (3.4)	34.2 (4.3)
INCOMP LETT 2	35.5 (3.0)	32.9 (3.4)

B. Inclusion/Exclusion task conditions

Proportion of earlier presented items selected

The first goal of this study was to determine whether depression affects the consciously controlled processes of a task, while leaving the automatic processes intact. This was investigated with Jacoby's (1991) process dissociation procedure using Jacoby, Toth and Yonelinas' (1993) stem completion paradigm.

For each participant, the probability of completing a stem with an earlier presented word was determined for the inclusion and exclusion conditions respectively. It should be recalled that participants were instructed to complete stems with earlier presented words in the inclusion condition, while they were instructed not to use earlier presented words in the exclusion condition. The means and standard deviations of the proportion of stems completed with earlier presented words in the inclusion and exclusion conditions can be found in the first two rows of Table 4.

To determine differences in the probability of completing stems with previously presented words when instructed to and when instructed not to, a 2 X 2 mixed model ANOVA, with one between subject factor, group (depressed vs. controls) and one within subject factor, condition (inclusion vs. exclusion condition) was performed. Results confirmed the hypothesized interaction between group and task condition, $F(1,32) = 6.29$, $p < .05$. Neuman-Keuls test was then applied to determine which means significantly differed from each other. In the Neuman-Keuls test, the error rate falls between the expermimentwise and per comparison error rates, making it moderately lenient. Stevens (1986) suggests that with a small sample size, one should be very sensitive to the possibility of making a Type II error, and that it makes sense to be more liberal so as to increase power. Neuman-Keuls analysis showed that the mean score for depressed patients ($M = .42$) was reliably different from the mean score of the normal control group ($M = .29$), $p < .05$. in the exclusion condition, indicating that the depressed patients were more likely to mistakenly complete a stem with an earlier presented word when instructed not to compared to the control subjects. The mean score for depressed patients ($M = .51$) was not significantly different from the mean score of the normal control group ($M = .56$) in the inclusion condition, indicating that the likelihood for completing stems correctly with earlier presented words when instructed to do so did not differ between the depressed and control groups.

Table 4: Proportion of "old" items selected in the inclusion and exclusion conditions, and estimates of consciously controlled recollection and automaticity on stem completion task

	Depressed group	Control group
Proportion of "old" words used in inclusion condition	.51	.56
Proportion of "old" words used in exclusion condition	.42	.29
Estimate of consciously controlled recollection	.11	.28
Estimate of Automaticity	.45	.38

Separating consciously controlled and automatic influences

The extent to which stem completion performance was determined by consciously-controlled processing was estimated by subtracting the probability of completing a stem with an old word in the exclusion condition from that of completing a stem with an old word in the inclusion condition. The extent to which stem completion was determined by automatic processing was estimated using the estimated probability of conscious recollection. As discussed earlier, in the inclusion condition, participants completed the stems with earlier presented words either because they consciously recalled these words or because the effects of automaticity were sufficient for stems to be completed with earlier presented words. In contrast, using an earlier presented word to complete a stem in the exclusion condition would be due to a failure in conscious recollection. The estimated influences of automatic and consciously controlled processing are shown in the last two rows of Table 4.

A 2 (depressed, controls) X 2 (estimate of conscious control, estimate of automaticity) mixed model ANOVA, with group as a between subject factor and process (conscious control, automaticity) as a within subject factor was conducted. As expected, results indicated a reliable main effect for condition $F(1,32)=22.21$,

$p < .001$, and a significant group by process interaction effect, $F(1,32) = 6.52$, $p < .05$. A Neuman-Keuls test showed that the mean estimate of conscious control for the depressed group ($M = .11$) differed significantly from that of the normal control group ($M = .28$), $p < .01$. In contrast, the mean estimate of automaticity for depressed patients ($M = .45$) was not reliably different from the mean score for the normal control group ($M = .38$)

C. Executive function tasks

The second goal of the present study was to investigate executive functioning in depressed elderly patients, using a variety of measures that were not designed for clear mathematical dissociations with specific aspects of cognition, despite reasonable association with executive functioning.

Free recall tasks

A free recall task was used on two occasions, one where subjects were not given any encoding strategy, and another where they were provided with an imagery strategy to improve their recall. To determine the extent to which provision of a strategy had an effect on the free recall task, a difference score was calculated for high and low imagery words between performance in the condition where an imagery strategy was provided and in the condition where no strategy was provided. It was expected that if provision of a strategy improved performance, it would do so more for the high rather than the low imagery words. Table 5 shows the means and standard deviations for the free recall task with and without provision of the imagery strategy (rows 1-2, and 3-4 respectively) as well as the difference scores (rows 4-5).

Table 5: Means and standard deviations for free recall tasks

	DEPRESSED GROUP	CONTROL GROUP
RECALL HI IMAG-WITHOUT STRATEGY	3.41 (1.28)	4.29 (1.10)
RECALL LOW IMAG-WITHOUT STRATEGY	3.06 (1.39)	3.41 (1.18)
RECALL HI IMAGERY-WITH STRATEGY	4.29 (1.31)	5.06 (1.09)
RECALL LOW IMAG-WITH STRATEGY	2.59 (1.46)	3.29 (1.16)
DIFF SCORE-HI IMAGERY WORDS	.88 (1.76)	.76 (1.82)
DIFF SCORE-LOW IMAGERY WORDS	-.47 (1.74)	-.12 (1.32)

To determine the effects of strategy and imagery on recall of the words, a 2 X 2 X 2 mixed model ANOVA was conducted, with one between subject factor, group (depressed vs. controls) and two within subject factors, imagery (high, low) and provision of strategy (absent, present) was performed. Results indicated a significant interaction between strategy and imagery, $\underline{F}(1,32) = 5.77$, $\underline{p}<.05$, indicating that high imagery words were recalled better when participants were provided with a strategy. Results also indicated a significant main effect of imagery, $\underline{F}(1,32) = 34.85$, $\underline{p}<.05$, which as expected showed that high imagery words were recalled better than low imagery words and a significant main effect of group, $\underline{F}(1,32) = 7.30$, $\underline{p}<.05$, showing that over both tasks (with and without a strategy) the control group recalled more words. There was no other reliable main or interaction effects (Fs < 2.5, ns). Given the finding that high imagery words were recalled significantly better when an imagery strategy was provided, the difference score between number of words recalled with a strategy minus those recalled without a strategy was used in later correlational and discriminant function analyses.

Working memory task

A working memory task was used to measure the ability to rapidly and efficiently shift between processing requirements of encoding, storage, retrieval and drop from memory. On the working memory task, participants were tested on four lag conditions. The means and standard deviations are shown in Table 6.

Table 6: Means and standard deviations for each lag condition on the working memory task.

	DEPRESSED PATIENTS	CONTROL SUBJECTS
LAG 0	10.0 (0)	10.0 (0)
LAG 1	6.65 (2.76)	9.29 (2.02)
LAG 2	3.41 (2.03)	6.88 (2.09)
LAG 3	3.24 (1.99)	5.29 (2.47)

As can be seen, there was no variability at the Lag 0 condition (all subjects got a perfect score), indicating that all participants were able to track, encode, output and drop items from memory. Because there was no variability at the Lag 0 condition, this score was omitted from the analysis. A 2 (group) X 3 (Lag) mixed model ANOVA was conducted. As expected, results indicated a significant main effect of group, $F(1,32) = 16.47$, $p < .01$) and a significant main effect of lag, $F(1,32) = 45.31$, $p < .01$. The interaction effect was not reliable ($F < 1.5$, ns). Given these results, the scores on the three lag conditions (1,2 and 3) were combined to form a single measure of working memory for use in later analyses.

Wisconsin Card Sorting task

The Wisconsin Card Sorting task is a task assessing mental flexibility and the ability to generate and test hypotheses with minimal feedback. Several measures were calculated for this task: the number of correct responses, the number of errors, the number of categories achieved, the number of perseverative responses, the number of perseverative errors and the number of non-perseverative errors. Table 7 provides the means and standard deviations for these measures.

Table 7: Means and standard deviations for Wisconsin Card Sorting task measures.

	DEPRESSED PATIENTS	CONTROL SUBJECTS
# CATEGORIES ACHIEVED	2.47 (1.28)	2.94 (1.20)
# CORRECT	42.88 (9.19)	45.82 (9.49)
# ERRORS	21.12 (9.19)	17.12 (7.45)
# PERSEVERATIVE RESPONSES	14.12 (8.28)	9.53 (3.32)*
# PERSEVERATIVE ERRORS	11.53 (6.29)	8.00 (3.57)
# NON-PERSEV ERRORS	9.82 (6.13)	9.06 (5.71)

Separate one way ANOVAs were conducted on each of these measures to determine whether there were any significant group differences. A reliable group difference was found on the perseverative response measure, $F(1,32) = 4.50$, $p < .05$, and an almost reliable group difference was found on the measure of perseverative errors, $p < .06$. For both of these measures, the depressed patients made more perseverative responses and errors compared to the control subjects, indicating that they were less efficient at shifting cognitive set. There were no other reliable group differences (all Fs <2, ns).

Stroop task

The ability to inhibit the output of an automatic response tendency was assessed with the Stroop task, and it was expected that depressed patients would have more difficulty inhibiting this response tendency. For this task, a measure (T-Score) of the resistance to interference was determined based on Golden's (1978) formula noted earlier. It should be noted that a higher T-score indicates a higher resistance to interference. A one way ANOVA was performed to determine whether there was a significant group difference, on this measure (depressed group $\underline{M}$ =52.53; control group $\underline{M}$ =51.65). Contrary to expectations, results indicated no significant group difference on this measure ($F < 1$, ns). Separate one way ANOVAs were conducted on each of the three conditions (number of items read in the word naming, colour naming and colour-word conditions) to determine whether there were any significant group differences. A reliable group difference was found on the word condition, $\underline{F}(1,32) = 7.96$, $\underline{p} < .01$, and colour-word condition, $\underline{F}(1,32) = 4.17$, $\underline{p} < .05$, indicating that depressed patients were slower at reading words, and naming items in the interference condition. There was no group difference in the number of colours named ($F < 1.3$, ns).

Sequential Movements task

For this task, participants were shown sequences of 2-4 movements which they were instructed to copy and maintain over 5 trials. It was expected that depressed patients would have more difficulty maintaining the movement sequences. A score of the total number of correctly repeated sequences over all trials was obtained for each subject (depressed group, $\underline{M}$ =24.06, control group, $\underline{M}$ = 27.29). A one way ANOVA was performed, and as expected, results indicated a reliable group difference, $\underline{F}(1,32) = 5.1$, $\underline{p} < .05$.

Verbal Fluency tasks

These tasks were used to assess the ability to generate words within a given time period, and it was expected that depressed patients would perform poorer than control subjects. Participants performed two verbal fluency tasks, a letter fluency task where they were required to generate words to specific letters (F, A & S), and a category fluency task where they were required to generate words to specific categories (Names, Foods and Vegetables). Table 8 shows the means and standard deviations for the verbal fluency measures, for each letter (first three rows) as well as the total over all three letters (row 4), and for each category (rows 5-7), as well as the total over all three categories (row 8). As noted earlier, participants were permitted only 30 seconds for word generation in the Foods and Vegetables categories respectively, versus 60 seconds for each letter and the Names category. To equate performance across all letters and categories, performance was also measured for the first 30 seconds for each of the letters and for the Names category.

Table 8: Means and standard deviations for number of words generated for each of the letters and categories on the verbal fluency tasks. Numbers in [] parentheses indicate performance at 30 seconds.

	Depressed group	Control group
F	10.88 (3.92) [7.18]	13.94 (4.01) [9.35]
A	8.00 (3.87) [5.18]	12.29 (5.00) [8.12]
S	10.71 (3.70) [6.82]	13.53 (2.85) [8.53]
Total over F, A & S	29.59 (10.36) [19.18]	39.82 (10.07) [26.0]
NAMES	11.82 (3.84) [7.47]	17.53 (4.37) [10.29]
FOODS	9.82 (3.15)	11.94 (3.01)
VEGETABLES	7.41 (3.08)	8.94 (1.89)
Total over Names, Foods and Vegetables	29.06 (8.33) [24.70]	38.41 (7.53) [31.17]

Separate one way ANOVAs were conducted for the overall letter and category fluency tasks respectively (rows 4 and 8). Results indicated significant group differences for the letter fluency task (row 4), $F(1,32) = 8.41$, $p < .01$, as well as for the category fluency task (row 8), $F(1,32) = 11.78$, $p < .01$. Performance for the first 30 seconds for each letter and category were subjected to the same type of analyses, and results were consistent with the previous analysis.

To determine whether there were group differences for each of the letters and each of the categories, a 3 (type) X 2 (group) mixed model ANOVA was conducted for the letter and category fluency tasks respectively. For the letter fluency task, results indicated a significant main effect of group ($\underline{F}(1,32) = 8.41$, $\underline{p} < .01$, and a significant main effect of letter ($\underline{F}(1,32) = 8.79$, $\underline{p} < .01$). For the category fluency task, results also indicated a reliable main effect for group ($\underline{F}(1,32) = 7.47$, $\underline{p} < .05$) and a significant main effect for category ($\underline{F}(1,32) = 17.13$, $\underline{p} < .01$). The interaction effects were all non-reliable (F's < 1, ns).

In order to determine whether there were group differences between the first and last 30 seconds for the letters, as well as the Names category, a 2, period of time (first 30 seconds, last 30 seconds) X 2, group (depressed, controls) mixed model ANOVA was performed for the letters and the Names category respectively. Results indicated significant main effects for group ($\underline{F}(1,32) = 8.41$, $\underline{p} < .01$) and time period ($\underline{F}(1,32) = 104.3$, $\underline{p} < .01$) for the letter fluency task, and significant main effects for group ($\underline{F}(1,32) = 16.32$, $\underline{p} < .01$), and time period ($\underline{F}(,32) = 35.21$, $\underline{p} < .01$) for the Names category fluency task, indicating that performance for all subjects was significantly better during the first 30 s relative to the last 30 s time period. The interaction effect was not reliable.

D. Discriminant function analysis

Discriminant Function Analysis was performed to describe major differences among the groups on the set of cognitive measures which significantly differentiated the two groups, to determine the relative discriminating power for each of the measures and to classify subjects into groups on the set of measurements. It should be noted that given the small sample size/number of variables ratio, one should be cautious in interpreting the results, and the results should be considered exploratory. For the set of variables, Wilk's Lambda = 0.49, approximate Chi square (18) = 19.76, $\underline{p} < .05$. The Chi square value indicated that based on this set of variables the two groups can be significantly separated along a single dimension. In order to interpret the meaning of the discriminant function calculated in this analysis, pooled within-group correlations between the discriminant function and each of the original variables was calculated. Table 9 shows, in order of discriminating power, the measures which best discriminate between the two groups. Results indicate that the Working Memory task was the best discriminator between the two groups, followed by the Category Fluency task, the Letter Fluency task, the Sequential Movements task, the estimate of conscious control, and the perseverative response score on the Wisconsin Card Sorting task. The other scores (automaticity, difference score on free recall task and Stroop task) did not discriminate as well between the two groups.

Table 9: Pooled within group correlations between the discriminant function and each of the cognitive measures.

	Discriminant Function
Working Memory task	.70
Number of correct words: Category Fluency task	.59
Number of correct words: Letter Fluency task	.50
Sequential Movements task	.39
Estimate of conscious control	.39
Wisconsin Card Sorting task: Perseverative responses	-.37
Estimate of automaticity	-.28
Stroop task: interference score	-.07
Difference score on free recall task: high imagery words	-.03

Using this discriminant function, the classification of the subjects into the two groups was determined. The percent of "grouped" cases correctly classified was 91.1%; for the depressed group, 94.1% were correctly classified, and for the control group, 88.2% were correctly classified.

E. Correlational analyses

Relationship between severity of depression and task performance

In order to investigate the relationship between severity of depression, assessed by the Geriatric Depression Scale (GDS), and performance on cognitive tasks, Pearson correlation coefficients were calculated between the GDS score and the scores on the cognitive tasks, and these are shown on Table 10. As expected there were no significant correlations between the measure of severity of depression and task performance for the control group. Reliable negative correlations were found for the depressed group between severity of depression and the inclusion task (-.52), the estimate of automaticity (-.50), and the number of perseverative responses on the Wisconsin Card Sorting task (-.52). There were no other reliable correlations.

Table 10: Correlations between severity of depression and task performance

Row 1: normal controls
Row 2: **depressed patients**

	GDS
CONSCIOUS CONTROL	.42 **-.25**
AUTOMATIC	-.07 **-.50***
STRAT-HIGH IMAGERY	-.35 **-.47**
CARDPERSE RESPONSES	.15 **-.52***
LCOR	.25 **.10**
CCOR	.27 **-.28**
SEQ MVMT	.22 **.24**
WORKING MEMORY	.15 **.23**
STROOP	.16 **.17**

* $p < .05$, ** $p < .01$

Relationships among cognitive tasks

In order to investigate relationships between the different tasks, Pearson correlation coefficients were calculated. These are shown on Table 11. As can be seen, there are few significant correlations between tasks, and where they exist, the are mainly for the control group. For the depressed group, a significant positive correlation was found between the Letter Fluency task and the estimate of conscious control (.52), and a reliable negative correlation was found between the Letter Fluency task and the difference score for high imagery words on the free recall task.

For the control group, reliable positive correlations were found between the estimate of automaticity and the Stroop interference score (.55), the Letter Fluency task and the Sequential Movements task (.53), the Category Fluency task and the Sequential Movements task (.61), between the Working Memory task and the Category Fluency task (.63) and between the Working Memory task and the Sequential Movements task (.72). Reliable negative correlations were found between the perseverative response score on the WCST and the Working Memory task (-.52).

Table 11: correlations among cognitive variables

Row 1: normal controls
Row 2: depressed patients

	Aut	Hi ima	Wcs pr	Lett	Cat	Seq	Wm	Stroop
Con cont	-.41 **-.11**	-.28 **-.23**	-.29 **.15**	-.15 **.52***	.10 **.19**	.23 **-.29**	.41 **.07**	-.00 **-.05**
Aut		.30 **.44**	.00 **.44**	.06 **-.24**	.02 **-.20**	-.19 **-.20**	-.13 **.41**	.55* **-.25**
Hi ima			.09 **.17**	-.14 **-.71****	-.07 **-.10**	-.01 **-.00**	-.07 **-.03**	-.01 **-.39**
Wcs pr				.20 **-.11**	-.26 **-.10**	-.18 **.07**	-.52* **-.19**	-.03 **-.35**
Lett					.34 **.45**	.53* **-.26**	.33 **.23**	.27 **.39**
Cat						.61** **-.39**	.63** **-.20**	-.08 **.11**
Seq							.72** **-.16**	-.13 **.17**
WM								-.11 **.15**

* $p < .05$, ** $p < .01$

Note: Hi ima = Difference score on free recall task for high imagery words.
Lett = # correct words generated on Letter Fluency task.
Cat = # correct words generated on Category Fluency task.
Wcs pr = perseverative responses on Wisconsin Card Sorting task.
Seq = Sequential Movements task.
Stroop = Interference score on Stroop task.
WM = Working memory task.
Con cont = estimate of consciously controlled processing.
Aut = estimate of automaticity.

IV. Discussion

The primary goal of this study was to evaluate the hypothesis that depressed elderly patients exhibit impaired performance on consciously controlled processes, and are relatively unimpaired on automatic cognitive processes. A secondary goal was to investigate executive functioning in these patients. It should be noted the results of this study should be interpreted cautiously given the small sample size to number of variables ratio, as well as the number of univariate tests which were performed. There is a high possibility that a Type I error was made in the set of analyses. However, given that this was the time that some of the executive function tasks were used, and this was the first time that Jacoby's paradigm was used, with depressed patients, in addition to having a small sample, the cost of rejecting the null hypothesis warranted being more liberal so as to maximize the chances of finding group differences. Stevens (1986) discussed the importance of controlling for a Type II error, especially with a small sample size, and suggested that it may be prudent to be more liberal in this case.

I first will discuss the present findings with respect to executive functioning and their limitations. This will be followed by discussion of findings using Jacoby's (1991) process dissociation procedure which putatively isolates the contribution of cognitive processes to task performance. Relationships between the set of cognitive tasks will then be explored, followed by a discussion of the effects of severity of depression on task performance. Finally, a discussion of limitations of the present study and directions for future research will be addressed.

A. Executive function tasks

The term executive function refers to a variety of cognitive processes including sequencing, self monitoring, planning, reasoning, inhibition, initiation, maintenance and shifting of cognitive set (Baddeley, 1986; Damasio & Van Hoesen, 1983; Fuster, 1989; Lezak, 1983; Norman & Shallice, 1986; Stuss & Benson, 1986). As discussed earlier, executive function tasks are presumably more dependent on conscious control and self-initiated processes as opposed to automatic processes (Moscovitch & Winocur, 1992; Stuss, 1992). Relatively little research has been published on the effects of depression on executive function tests relative to memory performance. A sub-goal of the present study was to explore executive functioning in depressed patients. Where previous investigations have examined depression and executive functioning, results have indicated depression-related deficits in execut. .e functioning. In studies investigating executive functioning in depressed patients, only one or two executive function tasks have been used. However, as previously discussed, tasks presumably tapping executive functioning may not assess a unitary cognitive process. Because of the potential value in exploring multiple aspects of executive functioning, several executive function tasks were used in the present study. Following a discussion of the results of specific executive function tasks in the present study, I will present a discussion of the cognitive processes that appear to underlie successful performance of these tasks, and which of these were impaired or intact in the present sample of depressed patients.

Results from the present study showed that performance of depressed elderly patients was impaired relative to that of matched controls subjects on several executive function tasks. For example, significant differences between the two groups were found on a working memory task (Dobbs & Rule, 1989). The essence of this task is that there must be constant shifting between encoding, storage, retrieval, and dropping information from memory or somehow tagging it as no longer relevant. The lag 0 condition in this task serves as a control condition in that it requires all of the initial encoding and response requirements of higher lags. Perfect scores at the Lag 0 condition indicate that all subjects in the present study were able to track the digits and suggests that the change in performance observed at the higher lags was due to additional processing requirements at those lags. The task at Lags 1 through 3 requires frequent and repetitive shifts between relatively simple and well integrated processing routines. Depressed patients' performance on this task seems to imply an impaired ability to rapidly and repetitively shift between the processing routines compared to controls. Depressed patients were certainly able to encode and respond, as evidenced by perfect task performance at the Lag 0 condition. However, they were less efficient at shifting between processing routines at the higher lags. This task is one where temporal constraints are imposed. It is possible, that if the depressed patients were required to make these shifts in situations without temporal constraints, they would not have been impaired relative to control subjects. However, such a task without temporal constraints would have yielded information regarding the ability to perform processing per se, but would not have provided information regarding the efficiency with which subjects were able to accomplish shifting of processing, and it is the latter which is of greater interest in assessing executive functioning. In general, the present results show that the Dobbs and Rule (1989) Working Memory task is sensitive even to mild depression, in addition to its demonstrated sensitivity in distinguishing minor head injury, normal aging and early dementia (Dobbs & Rule 1989; Schwartzberg, Dobbs & Rule, 1992; Schwartzberg, Dobbs, Rule & Vanast, 1987).

There were also significant group differences on the Letter and Category Fluency tasks, indicating that controls generated a greater number of words overall. Findings of depression-related deficits in word generation in the present study are consistent with those reported in previous depression and cognition literature (Caine, 1981; Hart et al., 1987; King et al., 1991), although previous research has not presented a discussion of reasons for these deficits. In the present study, it was expected that on the Category Fluency task, where the set to be searched is more restricted and performance is less dependent on self initiated processing than on the Letter Fluency task, provision of a category for word generation would facilitate performance for all subjects relative to provision of a letter. It was further expected that deficits would be found for depressed patients on the letter fluency tasks, and that these deficits would be attenuated when subjects were provided with increased structure (i.e. a category). Consistent with this reasoning, provision of a category improved performance for both groups. Nevertheless, performance was still significantly different between the groups on the Category Fluency task, with the depressed patients generating less words overall. Verbal fluency tasks require initiation, maintenance and monitoring of output of words within a given time period. Successful performance is dependent on an efficient search process from long term storage, and a systematic strategy minimizes the resampling tendency that may occur during retrieval (Raaijmakers & Shiffrin, 1981). It is therefore possible that depressed patients generated less words on the fluency tasks because their strategy was less systematic. When they were provided with increased structure, the search was more restricted and hence performance improved, but not to the same extent as controls.

Times varied for word generation (i.e., 30 seconds vs 60 seconds) between the letters and some of the categories (Foods, Vegetables), and thus performance at 30 seconds for letters and categories was compared. Results were consistent when analyzing only the first 30 seconds. One interpretation of these data is that poorer performance on fluency tasks may be due to depressed subjects' inability to sustain behaviour over time To determine whether the two groups differed in their ability to sustain word generation over time, the first and last 30 second period for the letters and the Names category were compared. Results indicated greater initial output for the first part of the allotted time period (i.e. during the first 30 seconds) for all subjects. This is consistent with Diesfeldt's (1985) suggestion that the rate of retrieval of items on verbal fluency tasks decreases exponentially over time, but does not entirely explain the relative deficits of depressed patients. Although not measured, it is possible that depressed patients may have been slower at initiating output, and at developing search strategies, and this may explain their overall poorer performance on the letter and category tasks. One way to assess whether initiation of word generation differs between depressed and non-depressed subjects in future studies is to measure task performance at shorter intervals (e.g., 15 seconds).

The sequential movements task requires subjects to copy, reproduce and maintain motor sequences in their correct order. Results indicated that depressed patients were also significantly disadvantaged compared to controls when tested on this executive function task. When subjects were required to copy sets of 3 or 4 sequential movements and maintain the sequence over 5 trials, depressed patients performed significantly worse than controls. Inability to reproduce motor movements per se cannot explain these results given that depressed patients were not impaired in their ability to copy single or double movements. Anecdotally, performance on this task may be aided by verbal mediation, and it is possible that the control subjects spontaneously made use of verbal mediation to help them recall and maintain the sequences. There is some evidence for this: several control subjects verbalized the movements out loud while the sequences were demonstrated. It is possible that if subjects had been provided with a verbal mediation strategy, differences between the two groups would have been minimized. Future research should investigate performance of the depressed group with and without the provision of a verbal mediation strategy to determine if group differences could be minimized when patients are provided with this type of strategy.

In order to determine whether depressed patients were impaired relative to controls in spontaneous use of a strategy for memory performance as hypothesized by Hertel and Hardin (1990), a free recall task was used with and without provision of an imagery strategy. It was expected that if depressed patients are impaired in their ability to spontaneously use strategies to encode information, then if a strategy were provided, performance should improve. Results indicated that all subjects recalled more high imagery words when provided with a strategy, and as expected, more high imagery words were recalled by all subjects. Overall, the controls recalled significantly more words than depressed patients with and without a strategy. It is possible that control subjects were spontaneously making use of an imagery strategy before it was provided, and this may explain why they recalled more words before the strategy was provided. There is at least some anecdotal evidence that this was the case with some of the control subjects, who, when provided with the imagery strategy, indicated that they had already been using such a strategy. Perhaps some depressed patients also made use of such a strategy, but they did not spontaneously report this. In future research, it may be of interest to question subjects on spontaneous use of strategies so as to determine their spontaneous use in memory testing.

Although recall of high imagery words on the latter task improved for depressed and control subjects when an encoding strategy was provided, control subjects still recalled significantly more items. Looking only at difference scores for high imagery words (with and without a strategy), the two groups benefitted approximately to the same extent by provision of a strategy. In contrast to Hertel and Hardin (1990), provision of a strategy did not eliminate group differences in this study, (depressed patients recalled fewer words even when provided with an encoding strategy), indicating that group differences cannot be solely explained by differences in initiating encoding strategy. Differences in free recall performance between depressed and control groups is thus consistent with findings from previous literature. Hertel and Hardin (1990) did not measure free recall. Rather, they provided subjects with a strategy for spelling homophones (which were presented earlier) to aid in recognition later on. In the Hertel and Hardin (1990) study, subjects received a second encoding trial via a spelling test, whereas in the present study, subjects were presented with the information only once. It may be that if subjects in the present study were presented with the to-be-remembered information on a second presentation trial, the imagery strategy may have had a more beneficial effect and may have further minimized group differences. Alternatively, although provision of an imagery strategy did not successfully eliminate group differences in this study, it is possible that provision of other types of encoding strategies may be more effective.

The present study also showed reliable group differences on the measure of perseverative responses on the Wisconsin Card Sorting task such that depressed patients made more perseverative responses. There was a similar trend for group differences on the measure of perseverative errors. No other group differences were significant. These findings are consistent with Martin et al. (1991) who found higher perseveration indices in their depressed patients. In the present study, there were no significant group differences in number of categories achieved. In this task, once a category is achieved, it is run off relatively automatically and in addition, there are no temporal constraints. It is only when participants are required to shift cognitive set that depressed subjects exhibited difficulty. Hart and his colleagues (1987) did not find any depression related deficits using the WCST, but they used Nelson's (1976) modification of this task, which alters the administration significantly (e.g., the examiner informs the participant when the category alters), and may explain Hart et al.'s null findings. Increased perseverative responses by depressed patients also have been found in other studies investigating hypothesis testing (Donnelley et al., 1980; Savard et al., 1980; Silberman et al., 1983). The present results thus suggest that depressed subjects have difficulties in shifting cognitive set in response to external feedback.

Results indicated no significant group differences on the interference score derived from the Stroop task, in contrast to previous findings of depression-related deficits (Raskin, 1986; Raskin et al., 1982). However, these findings are consistent with null findings observed by Rush and colleagues (1983). Raskin and his colleagues studied more severely depressed (older) patients, whereas in the current study, as well as the Rush et al. (1983) study, patients were more mildly depressed. Differences in severity of symptoms between the present study and the Rush et al. (1983) study on the one hand, versus Raskin's studies on the other hand, may, at least in part, account for the discrepancies in results between the studies. The essence of the Stroop task is that subjects must learn to inhibit an overlearned, automatic response (i.e. reading the word) while being required to name the colour of ink used to print the words. They are not required to shift cognitive set; rather, they are required to maintain the rule (name the colour) and inhibit any conflicting information. In the present study, the Golden (1978) version of the task was used. This version requires 45 seconds of output, and when subjects make errors they are informed of this and told to correct their errors and to continue. This allows them to regain set after errors are pointed out to them. The administration of this particular version of the task may account for null findings. In other versions of the task, for example, the original Stroop (1935) version, participants are not informed of their errors and hence may lose cognitive set without regaining it (given that errors are not corrected), and may consequently perform more poorly. Other investigators have found depression related deficits on (the non-Golden version) Stroop task (Raskin, 1986; Raskin et al. 1982), although not consistently (Rush et al., 1983). In addition to the possibility that the Stroop task may not be as sensitive to mild levels of depression as other executive function tasks, the administration of this particular version (Golden) of the task (which makes it less difficult) may have further reduced the possibility of finding group differences.

To summarize, the present study found deficits in a group of relatively mildly depressed patients on several executive function tasks that have proven sensitive to depression in the past (i.e., verbal fluency tasks, perseverative indices on the WCST and free recall tasks). Reliable group differences were also found on tasks that have not previously been used with depressed patients, including the Working Memory and Sequential Movements tasks. As noted earlier, these different executive function tasks require different types of processing for successful performance, and depressed patients were not impaired uniformly on all aspects of executive functioning. The Working Memory task requires flexible shifting between different types of processing within a time period. The Wisconsin Card Sorting task requires flexible shifting between learned concepts in response to environmental feedback, but is not temporally constrained. Verbal fluency tasks require systematic search strategies and the ability to initiate, maintain and monitor output. The Sequential Movements task requires the monitoring of output within a specific sequence, and like the WCST it is not temporally constrained.

The Stroop task, which was not sensitive to depression in the present study, requires inhibition of an automatic response set, but no shifting in the rules of the task. Subjects must remember throughout <u>not to</u> do something (i.e. read the words). This differs from the WCST where the rules change throughout the task without warning. It appears that the depressed patients had most difficulty with changing concepts on the WCST. They did not differ from controls in their ability to establish categories for card sorting. Once they established a category, they were able to continue using it, and performance diminished when the rules changed as evidenced by the measure of perseverative responses.

The difficulty depressed patients demonstrated in altering responding based on external feedback (WCST perseverations), as well as problems initiating and maintaining their output (e.g fluency tasks) has potentially important implications for therapy. For example, Beck (1967) discussed depressed persons' characteristic cognitive distortions. He suggested that faulty thinking patterns may become unresponsive to external input (Beck, Rush, Shaw & Emery, 1979) and this may explain why depressed people persist in thoughts that run contradictory to external evidence (e.g. feedback). Difficulties in mental flexibility appear to underlie poorer performance on many of the executive function tasks used in the present study. These data are consistent with Beck's (1967) notion of a rigid cognitive style in depressed persons, resulting in difficulties considering alternative solutions to lifestyle patterns within the context of a therapeutic setting. This suggests that, in addition to other psychotherapeutic and pharmacologic interventions, the therapeutic process should focus on cognitive behavioral approaches to address the mechanism of cognitive inflexibility. A focus on altering thinking and behavioral patterns via teaching problem solving strategies and consideration of alternative solutions with feedback may prove beneficial to altering this rigid cognitive style.

On the basis of the data from executive function tasks, one might conclude that depressed patients are impaired on tasks requiring consciously controlled processes. However, such a conclusion must be qualified. Although executive function tasks are commonly thought to emphasize consciously controlled processes, performance is likely influenced by automatic processes as well, and it is thus difficult to unequivocally conclude which processes are impaired in depression based on executive task performance. What can be said is that depressed patients may be impaired in their efficiency to shift conceptual set, to shift between different types of processing within temporal constraints, and to initiate and maintain set, as well as to sequence to the same extent as controls. Methodologies such as Jacoby's process dissociation procedure allow for clearer separation of cognitive processes underlying executive function task performance and thus allow for clearer statements with respect to cognitive processes, not cognitive tasks.

B. Automatic and consciously controlled processes

Using Jacoby's (1991) process dissociation procedure, results from the present study show that depression significantly influenced the probability of consciously controlled processing as a basis for stem completion performance compared to controls. Stated simply, there is evidence that depression attenuates consciously controlled processing. In contrast, depression does not significantly affect the use of automatic processing as a basis for stem completion performance. The effect of depression on consciously controlled processing, along with the null effect of depression on automatic based processing is consistent with the conclusion drawn from previous investigations examining depression and cognition (e.g. Hasher & Zacks, 1979).

Most research relying on the conceptual distinction between consciously controlled and automatic processing in depressed patients have equated specific tasks with one or the other types of processing. In previous investigations, the widely proposed hypothesis that depressed patients are impaired on tasks assessing consciously controlled processing has been based on findings of deficits on tasks presumed to require conscious control (e.g. free recall tasks) with relatively intact performance on tasks presumed to depend on automatic processing for successful performance (e.g. recognition tasks). However, as this dissertation has argued, such task dissociations have not been found consistently in the literature. Some investigations have found deficits in depressed patients, while others have found intact performance, on tasks presuming to measure consciously controlled processing (e.g. free recall tasks). These inconsistencies in findings may be due to inadequate methods of investigating consciously controlled and automatic processing, and may be related to problems inherent in equating task with process (Dunn & Kirsner, 1989; Jacoby, 1991; Richardson-Klavehn & Bjork, 1988). More specifically, the lack of consistent findings across the literature may be due to the presence of both consciously controlled and automatic processes in varying proportions across tasks, precluding unequivocal conclusions with respect to the type of process affected in depression.

In conclusion, Jacoby's (1991) process dissociation procedure provided data consistent with the suggestion that depression significantly affects conscious controlled processes but not automatic memory processes. Previous investigators, on finding task dissociations between recognition and free recall tasks (with intact performance on recognition tasks and impairments on free recall tasks) have argued that depressed patients are impaired on consciously controlled tasks. However, as noted earlier, the problem with task distinctions or task dissociations is the assumption that tasks are process pure. Rather than identifying a specific type of task with a particular process, the process dissociation procedure clearly and quantitatively separates automatic and consciously controlled processes within a task.

Findings from the present study thus add to the ongoing number of experiments that have demonstrated the usefulness of the process dissociation procedure in examining conscious control and automaticity (Jacoby, 1991; Jacoby, Toth and Yonelinas, 1993; Jennings & Jacoby, 1993; Verfaellie & Treadwell, 1993). This is the first use of this procedure with depressed patients, and it proved extremely useful in quantitatively distinguishing automatic from consciously controlled processing among depressed elderly patients and non-depressed controls. Future research using this procedure is likely to yield more consistent findings across studies of depression, memory, and other cognitive processes (e.g. those underlying executive function tasks). One implication of the present research is therefore that the process dissociation procedure could be developed into a standardized paradigm that could be used to investigate deficits in automatic and consciously controlled processes in a variety of task domains (Jennings & Jacoby, 1993) with a variety of populations. The present study strongly suggests the utility of such an approach to depression.

C. Relationships among cognitive tasks

Correlational analyses yielded relatively few significant correlations between tasks. Where reliable correlations were found, the majority were within the control group. For the depressed group, there was a more restricted range of performance across tasks and this accounts for a lack of significant correlations between tasks, making it difficult to determine common cognitive processes between tasks. Given the small sample size in the present study, correlations had to be large in order to achieve statistical significance. Lack of power should be considered as a possible explanation for the lack of significant correlations, and also makes it difficult to interpret reliable correlations.

Discriminant function analysis results were consistent with the results of the ANOVAs. The resulting function indicated that the two groups could be significantly separated along a single dimension. The Working Memory task was found to have the highest correlation with the function followed by the Category Fluency, the Letter Fluency task, the Sequential Movements task and the estimate of conscious control. In interpreting this discriminant function, one commonality is that these tasks all require self monitoring of output. In the Working Memory task, subjects must be able to monitor what they must encode, store, output and drop from memory. In the fluency tasks, self monitoring is essential to avoid repetition of words as well as to contribute to a successful systematic search. Similarly, on the Sequential Movements tasks, monitoring of output is essential for successful performance. The estimate of conscious control on the stem completion task is based on the ability of subjects to use earlier presented words when they are asked to do so, and not use them when they are told not to. They must thus monitor their output in the sense of not using earlier presented words when they recall them as this would result in errors. Clearly, successful performance on this set of tasks is dependent on more than just the ability to self monitor but this may be one common component of all these tasks. As with the correlational analysis, given the small sample size to number of variables ratio, we must be cautious at making conclusions based on this analysis, and must treat this analysis as exploratory. Although the function needs to be applied to a second (larger) sample of subjects, the proportion of correct classifications obtained supports the potential utility of the these tasks in the differential classification of these two groups (depressed and controls).

D. Severity of depression

It has been suggested that severity of depression is important with respect to finding group differences in cognition. Severity was determined in the present study using the Geriatric Depression Scale (GDS), a scale designed and validated with an older population. Correlations were derived between the measure on the GDS and the cognitive measures. For the control group, as expected given the very restricted range of symptoms severity, there were no reliable relationships between the GDS measure and cognitive performance. For the depressed group, reliable negative correlations were found between severity of depression and the estimate of automaticity as well as the measure of perseverative responses. As discussed earlier, small sample size may, at least in part, explain the lack of relationship between severity of depression and cognitive performance. There is some indication from previous research that symptom severity is responsible for group differences observed in depression. Depressive deficits have more consistently been found on cognitive tests in more severely depressed patients (e.g., Kelley, 1986; Niederehe, 1986; O'Hara et al., 1986; Raskin, 1986). In the present study, the majority of depressed patients were considered to be mildly depressed, and it may be that with a sample of patients with greater variability (i.e., more moderately or severely depressed patients), severity would have influenced cognitive performance to a greater extent. In the present study, depression per se significantly discriminated the two groups on several of the cognitive measures. Future studies, with larger sample sizes and more variability in the severity of depression, should look at severity as a possible predictor of cognitive performance to more clearly determine the effects of symptom severity on cognitive performance.

E. Limitations of the present study

As discussed earlier, it is possible that diminished motivation may account for at least some of the depressive-related deficits. An attempt was made to assess motivation via use of the Incomplete Letters task. Results indicated no group differences at the first presentation trial of this task, suggesting no differences in motivational level. Despite the lack of group differences on this measure, a confounding factor of motivational effects cannot be fully eliminated. The Incomplete Letters task was administered on a second occasion within the second testing session. A significant group difference was found on this second administration, and this was interpreted as meaning that the depressed subjects demonstrated less learning relative to the control patients. An alternative explanation could be that motivation diminished over time within a session, and it may be diminished motivation, rather than diminished learning that accounted for the group difference. However, on this second trial, this measure is not as useful a measure of motivation given the potential confound of learning. Future research, using more than one test of motivation, at different points in the testing sessions, may aid in more clearly determining the contribution of motivation to task performance. The majority of depressed patients in the present study were taking anti-depressant medication, as well as anti-anxiety medication. It could thus be argued that differences in performance are due to medication effects, and not to the depression per se. It appears unlikely that medication use can account for all of the depressive deficits observed here. Firstly, most of the subjects were not taking anti-cholinergic anti-depressants (e.g. tricyclic anti-depressants), which may affect cognition, particularly memory. Most were taking newer anti-depressants, lacking the anticholinergic and sedative effects of tricyclic anti-depressants (Extein, 1989). There is evidence that anti-anxiety medications may adversely affect cognition (Curran, 1986). To explore whether use of anti-anxiety drugs was responsible for group differences, a MANOVA (fluency tasks, WCST perseverative responses, Sequential Movements task, Stroop interference score, Working Memory task, Jacoby's task and the difference score for high imagery words with and without provision of an imagery strategy), followed by univariate tests was conducted comparing patients using anti-anxiety medications with those not using these medications. Although it should be kept in mind that the sample sizes were unequal and small (n=4 not taking anti-anxiety medication vs. n= 13 taking anti-anxiety medication), results revealed no significant performance differences between those taking and not taking anti-anxiety medications ($F < 1$, n.s.); In fact, better performance was observed on some of the measures for the patients taking anti-anxiety medications. Had medication use been the sole reason for differences between the depressed and control groups, one would have expected to see more consistent impairments in performance in the depress d group across all of the tasks, particularly on tasks assessing memory and attention. This was not found. Previous findings have argued against clear medication effects on cognition. Impaired cognition has been shown in both medicated and unmedicated depressed patients across studies (see Cassens et al., 1990 for a review), and lack of differences have been shown between medicated and unmedicated patients within studies (Cassens et al., 1990; King et al., 1991). However, given that the majority of patients in the current study were taking either an anti-depressant and/or an anti-anxiety medication, we cannot fully eliminate the potential confounding facto of not capturing major depression in its purest form. It can not be definitively ruled out that medication is not responsible for at least part of the deficits found in the depressed group. Furthermore, one needs to be concerned even more about adverse effects of medication in an elderly population, given that changes in absorption, hepatic metabolism, drug distribution, renal function, brain enzyme systems and neurotransmitter alterations occur in elderly persons (Jenike, 1989b).

Previous findings of impaired cognitive performance have more consistently been found with hospitalized depressed patients, rather than community dwelling depressed patients. It could thus be argued that, in the present study, the hospitalized inpatients lowered the performance of the depressed group. The majority of depressed patients in the present study were community dwelling (n = 12). A MANOVA followed by univariate tests indicated no significant differences in cognitive task performance (fluency tasks, WCST perseverative responses, Sequential Movements task, Stroop interference score, Working Memory task, Jacoby's task and the difference score for high imagery words with and without provision of an imagery strategy) between the inpatient and outpatient depressed groups ($F < 1$, ns), thus arguing against hospitalization as a significant contributor to performance. However, as with the confound of medication use in the depressed sample, the effect of institutionalization cannot be ruled out completely. It will certainly be of great importance to replicate these findings in a sample of community dwelling patients to increase generalizability.

Although none of the depressed patients (or control subjects) had any previous or current diagnosis of an organic dementia or neurological disorder, these patients were not followed over time, and hence, one cannot definitively rule out a co-existing neurodegenerative dementing disease in the depressed patients. It is important that future investigations follow depressed elderly patients longitudinally so as to ascertain whether theirs is a deteriorating course. This would enhance the validity (due to greater diagnostic certainty). In addition, to determine whether performance differences are specific to depression, future research should compare performance of depressed patients with other psychiatric patients on these cognitive tasks.

An additional limitation of the current study concerns the group of depressed patients. Niederehe (1986) suggests that major depression is a label for a very heterogeneous category of patients. Although all the depressed patients were diagnosed with a major depression according to DSM-III-R criteria, it is possible that the depressed group was heterogeneous with respect to specific depressive symptoms. A diagnosis of major depression according to the DSM-III-R criteria requires that at least 5/9 depressive symptoms are present. However specific symptoms can vary between individuals who meet DSM-III-R criteria.

Current findings in the neuropsychological literature point to an increasing variability and heterogeneity among elderly samples (Caine et al., 1993; Cassens et al., 1990; King & Caine, submitted). Niederehe (1986) suggests that investigations be conducted to determine how memory performance varies between symptomatic subtypes of depression. King and Caine (submitted) argue that the greatest challenge for future neuropsychological investigations of depression is to better define the cognitive heterogeneity of the disorder, and consistent with Niederehe (1986), suggest that investigations be conducted to determine the relationship between neuropsychological functioning and subtypes of depression. This would increase the generalizability of results of studies investigating depression and cognitive functioning, and will aid in an understanding of the heterogeneity and variability of depressive disorders.

Finally, as discussed earlier, because of the large number of univariate tests performed, the possibility of committing a Type I error is fairly high. In addition to this, given the relatively small sample size in the present study, the possibility of Type II error must also be considered. Although both of these possibilities should be considered, the pattern of findings (i.e. the consistent findings that depressed patients performed more poorly across all tasks, although not reliably so on all measures, suggests that genuine group differences exist. The findings do provide interesting directions for future research. Finding deficits on the estimate of consciously controlled processing, as well as several executive function measures (e.g. Working Memory task, verbal fluency, Sequential Movements tasks, and perseverative responses on the WCST), demonstrates the sensitivity of these measures to depression, even with a relatively mildly depressed group of community dwelling patients. It is possible that with a more severely depressed group, more severe deficits on some aspects of cognition would be found. For example, deficits in automatic processing, and aspects of executive functioning (e.g. Stroop task performance), which have been shown to be impaired in previous investigations, may become evident with more severely depressed patients. The results of this study are promising, but not conclusive. Clearly, replication of these findings with a larger sample size, and a higher sample size/number of variables ratio, would allow for more confidence in the results and would permit greater generalizability of these findings.

Use of Jacoby's process dissociation procedure provides a clearer method of investigating automatic and consciously controlled processing in depressed patients. Future research using this procedure, with larger sample sizes, and unmedicated community-dwelling patients would allow for firmer conclusions regarding the effects of depression on cognitive task performance. The present study, although limited in terms of generalizability, demonstrated interesting trends in performance and paves the way for future investigations. Given the large prevalence of depression in the elderly population, theoretically and methodologically sound procedures such as Jacoby's (1991) process dissociation procedure are essential for determining more clearly the nature of depression-related cognitive functioning.

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VI. Appendix

Word list presented for word stem completion task

slime
whale
chess
blush
probe
visit
wagon
swing
perch
delay
drift
gland
event
salad
torch
angle
resin
slump
batch
dream
guilt
clump
rebel
tumor
swamp
choir
clerk
yeast
flick
crime
heart
glory
goose
river
gouge
bully
tramp
leash
greed
thorn
alloy
sweat

WORD STEM COMPLETION-INSTRUCTIONS

This task has to parts to it. To begin, your task is to **read** a list of words and to try to remember them. Words will be presented one at a time on the computer screen at a 2 second rate. Your task is to read each word out loud and to try and remember the words.

Now, the next part of the task involves a word stem completion task. You will be presented with the first three letters of a five-letter word, and your task is to complete the word. You cannot use proper names or plurals. For each word, there will be one of two things I will ask you to do. Sometimes, I will ask you to complete the word stem with a word that you read earlier on the computer screen. However, if you cannot remember an earlier-presented word, you should complete the stem anyway-giving the first completion that comes to mind. Other times, I will ask you to complete the stem only with a new word, that is, you should not use words that you can recall as earlier read. You should treat the stems as a test of creativity by completing the stem with a word that was not presented earlier.

You will have a maximum of 20 seconds to give a response. After 20 seconds, the next stem will be presented.

So, to summarize: 3 letters will appear followed by 2 dashes. The 3 letters will always be the first 3 letters of a 5-letter word. Plurals and proper names are not allowed. Remember, when I ask you to complete the stem with an old word, I want you to try and complete it with a word that you recall as having been presented earlier. When I ask you to complete the stem with a new word, I want you to complete the stem with ta word that was not presented earlier. However, when you are not certain, guess. The idea is to complete as many stems as possible. You will have 20 seconds to give a response.

There is a practice session that we will go through so that you will be familiar with the instructions, but do you have any questions before then?

Practice session:

PSTEM1:	PSTEM2:
I: str__ (strap)	E: bel__ (belch)
E: pea__ (peace)	NE: com__ (stand)
NI: cro__	I: sta__ (stand)

After practice session is completed, and subject understands instructions, proceed to task. Tell subject "ok, now I will present some new words to you. This time, the list of words that you will see will be a lot longer. I want you to read the words out loud, and as before, once you have seen the words, we will do the word stem completion task. Do you have any questions?

SCORE SHEET-STEM COMPLETION

E	1. tra__ (tramp)	
E	2. vis__ (visit)	
I	3. wag__ (wagon)	
E N	4. tru__	
I	5. per__	(perch)
E	6. del__	(delay)
I	7. gui__	(guilt)
I N	8. chu__	
E N	9. lim__	
I	10. bat__	(batch)
I N	11. bra__	
I	12. dri__	(drift)
E	13. yea__	(yeast)
E N	14. sti__	
E	15. swi__	(swing)
I N	16. ear__	
I	17. fli__	(flick)
E	18. cri__	(crime)
E N	19. hon__	
E	20. ang__	(angle)
I	21. dre__	(dream)
I N	22. twi__	
I	23. hea__	(heart)
E	24. clu__	(clump)
I N	25. wid__	
I	26. eve__	(event)
E	27. slu__	(slump)
I N	28. sca__	
I	29. bul__	(bully)
E	30. riv__	(river)
E	31. reb__	(rebel)
I	32. gou__	(gouge)
E N	33. hav__	
I	34. cle__	(clerk)
E N	35. sna__	
E	36. glo__	(glory)
I N	37. thi__	
I N	38. lev__	
E	39. tum__	(tumor)
E N	40. arr__	
I	41. tor__	(torch)
I	42. cho__	(choir)
E	43. gla__	(gland)
I	44. swa__	(swamp)
E	45. goo__	(goose)
E	46. res__	(resin)
E N	47. vig__	
I	48. sal__	(salad)

SCORE SHEET FOR FREE RECALL TASK
(No strategy provided)

INSTRUCTIONS: *In this task, I will be showing you some words on index cards, one at a time. I would like you to read each word out loud as I show it to you. Once you have seen all the words, I will ask you to tell me as many of the words as you can remember, in any order. Do you have any questions?*

STORM
TRUTH
CHURCH
MOMENT
BIRD
AMOUNT
HORSE
ARMY
HOPE
IDEA
DOCTOR
EVENT
PAPER
EFFORT

(Imagery strategy provided)

This time, I am going to show you another set of words. Again, I want you to read each one out loud as I show it to you. Again, I will ask you to tell me as many of the words as you have seen and read all the words. Remember, you can tell me the words in any order. This time, I want you to try something as you see each word. As you say each word, I want you to try and make a picture of what the word is in your head-this may help you to remember the words better. For some of the words, it will be easy to make a picture in your head, for example 'DUCK'- try and make a picture in your head of a duck-it isn't too hard. Now try and make a picture of 'BELIEF' in your head-that isn't quite as easy, is it? But that is the idea. Do you have any questions?

STONE
CHANCE
TABLE
METHOD
CHAIR
ANSWER
OCEAN
BABY
HOUR
FACT
DOLLAR
ADVICE
FIRE
DUTY

STROOP TASK

(Allow 45 seconds for each sheet)

Total number of words read ____

Total number of colours named____

Total number of colours named on interference task ____

INSTRUCTIONS FOR THE QUICK TEST

This is kind of a picture game. I am going to show you some pictures and read you some words. I want you to point to the best picture for each word that I read. Some of the words will be very easy and some of the words will be hard. You might not know all of the words. If I read a word that you don't know, just tell me that you don't know that word, and I will go on to another word (Test only on form 1).

WORD FLUENCY TASK: LETTERS

Instructions: I want you to say as many words as you can think of that begin with the letter of the alphabet that I will give you. Don't use any proper nouns, so no names..., don't use numbers and don't use the same word with a different ending. For example, if I gave you the letter 't', you could not use the word 'tinier' and then use the word 'tiniest'. (Time limit = 1 minute per letter)

F. **A.** **S.**

Total of 3 one minute trials___

Total number of perseverations____

WORD FLUENCY TASK: CATEGORIES

Instructions: This time, I want you to say as many words as you can think of that fit into a category that I will give you.

Names (60 s) **Foods (30 s)** **Vegetables (30 s)**

Total over 3 categories ____

Total number of perseverations ___

SEQUENTIAL MOVEMENTS TASK

Instructions to subject:

(1) I am going to make a / set of / 2 / 3 / 4 / movement(s) with my right/left hand.
(2) Watch carefully. I would like you to do the same when I am finished.

<u>note:</u> F = fist, P = palm, B = back, S = side

SINGLE: R: F ___ B ___ S ___ P ___

L: F ___ B ___ S ___ P ___

(Up to three trials per movement until correct or accept subject's version for trial 3).

Three demonstrations per sequence. Demonstrate once prior to series of sequences.

DOUBLE:

R: PF _ _ _ /3 _ _ _ _ _ _ /5

L: BS _ _ _ /3 _ _ _ _ _ _ /5

TRIPLE: R: PSF _ _ _ /3 _ _ _ _ _ _ /5

L: BFS _ _ _ /3 _ _ _ _ _ _ /5

QUAD: R: SPFB _ _ _ /3 _ _ _ _ _ _ /5

L: PFBS _ _ _ /3 _ _ _ _ _ _ /5

	RIGHT	LEFT
TOTAL	___	___

WORKING MEMORY TASK-SCORE SHEET

0-LAG SCORING:

In a moment, I will be playing you a tape with some recorded numbers on it. To start with, I would like you just to repeat the numbers out loud as soon as you hear them. So, if you hear 9, you say 9 right away. If you hear 2, you say 2 right away. Do you understand? Okay. We'll begin.

TRIAL 1:

stim 8 7 1 2 1 9 5 6 3 9 **# cor to 1st error cor**
8 7 1 2 1 9 5 6 3 9 ______

resp _ _ _ _ _ _ _ _ _ _ _

TRIAL 2:

stim 9 4 1 2 7 3 6 8 5 4 **# cor to 1st error cor**
9 4 1 2 7 3 6 8 5 4 ______

resp _ _ _ _ _ _ _ _ _ _ _

1-LAG SCORING:

This time, I want you to give me the number 1 back from the one you just hear. When you hear the first number, don't say anything. When you hear the second number, say the first number. After you hear the third number, say the second number and so on. I want you to always tell me the number that came one before the number just presented. Do you understand?

IF NOT, say: Let's say the tape says 1,2,3 (show card). You are to say 1 (point) after you hear the number 2 (point). After you hear the number 3, you are to say the number 2 and so on. Do you have any questions?

Let's practice one set. You may find it helpful to close your eyes or look away to concentrate.
Are you ready? 9 2 7 5 1

Begin tape if person is able to do practice. If not, use display card pointing to the numbers as you go.

TRIAL 1:

stim 5 8 1 2 6 3 4 9 2 8 5 **# cor to 1st error cor**
5 8 1 2 6 3 4 9 2 8 5 ______

resp _ _ _ _ _ _ _ _ _ _ _ _

TRIAL 2:

stim 7 6 2 4 9 1 5 7 2 9 3 **# cor to 1st error cor**
7 6 2 4 9 1 5 7 2 9 3 ______

resp _ _ _ _ _ _ _ _ _ _ _ _

2-LAG SCORING:
This time, I want you to give me the number 2-back from the one you just heard. Say nothing when you hear the first two numbers. When you hear the third number, say the first number. When you hear the fourth number, say the second number and so on. I always want you to tell me the number that came two before the number being presented. Do you understand?

IF NOT, say: For example, if you hear the sequence 1, 2, 3, 4, 5 (point to the number card), you should wait until you hear the number 3 before you respond. After you hear the number 3, you should say the number 1. After you hear the number 4, you should say the number 2. After you hear the number 5, you should say the number 3 because the number 3 came two numbers before the number 5. Do you have any questions?

Let's practice one. Once again, you may find closing your eyes or looking away will help you to concentrate on the numbers.

Are you ready? 4 9 1 6 3 5

Begin tape if person is able to do practice; if not, use display card pointing to numbers as you go.

TRIAL 1:

stim	6	2	9	1	3	5	7	2	8	1	9	6	
cor			6	2	9	1	3	5	7	2	8	1	9 6
resp			___	___	___	___	___	___	___	___	___	___	___

\# cor to 1st error ____

TRIAL 2:

stim	1	7	6	9	3	8	2	1	6	5	7	4	
cor			1	7	6	9	3	8	2	1	6	5	7 4
resp			___	___	___	___	___	___	___	___	___	___	___

\# cor to 1st error ____

3-LAG SCORING:
This time, I would like you to give me the number 3-back from the one you just heard. When you hear the fourth number, say the first number. After you hear the fifth number, say the second number and so on. I want you to always tell me the number that came three before the number just presented. Do you understand?

<u>IF NOT</u>, say: For example, if you hear the sequence 1, 2, 3, 4, 5, 6 (point to number card), you should wait until you hear the number 4 before you respond. After you hear the number 4, you should say the number 1. After you hear the number 5, you should say the number 2. After you hear the number 6, you should say the number 3 because the number 3 came three numbers before the number 6. Do you have any questions?

Let's practice one set. Once again, you may find that closing your eyes or looking away will help you concentrate on the numbers.

Are you ready? 6 1 2 8 5 3 7 2

Begin tape if person is able to do pra tice. If not, use the display card pointing to the numbers as you go.

TRIAL 1:

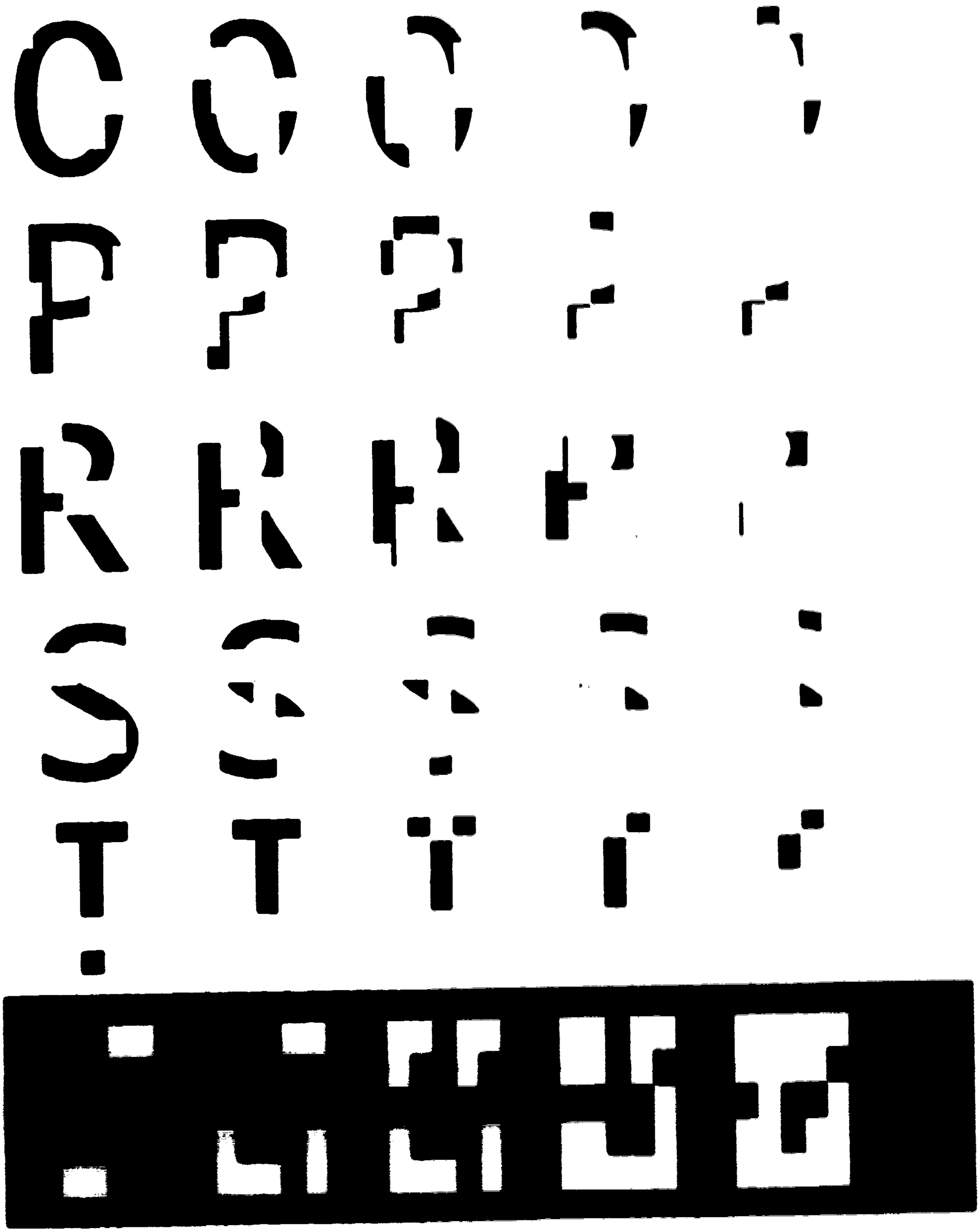
stim	8	1	9	3	2	6	4	8	5	1	9	7	4			
cor				8	1	9	3	2	6	4	8	5	1	9	7	4
resp				__	__	__	__	__	__	__	__	__	__	__	__	__

\# cor to 1st error ____

TRIAL 2:

stim	3	8	7	4	2	9	1	6	3	5	9	4	7			
cor				3	8	7	4	2	9	1	6	3	5	9	4	7
resp				__	__	__	__	__	__	__	__	__	__	__	__	__

\# cor to 1st error ____



INCOMPLETE LETTERS TASK

Instructions: I will be showing you sets of incomplete letters from the alphabet. Each letter will first be shown in its most incomplete form. I will ask you to try and identify it. If you cannot, I will then show you the next card which will have the same letter but in a more complete form. Again, I will ask you to try and identify it. If you are unable to do so, I will show you the next card which will have that letter in an even more complete form, and as before, I will ask you to identify it. You will be shown up to 5 cards until you are able to identify the letter. All letters will be printed in capital (uppercase) letters. Why don't we practice one to familiarize yourself with the task. Before we begin, do you have any questions?

Practice: *show the letter B with all 5 cards spread out to demonstrate the incomplete letters.*

	1	2	3	4	5
K					
V					

Test:

LEVEL LETTER	1	2	3	4	5
H					
A					
Z					
E					
S					
P					
U					
D					
F					
M					

Patient ____________________
I.D.# ____________________
Date ____________________
Interviewer ____________________

GERIATRIC DEPRESSION SCALE

Circle response:

1. [__] yes NO Are you basically satisfied with your life?
2. [__] no YES Have you dropped many of your activities and interests?
3. [__] no YES Do you feel that your life is empty?
4. [__] no YES Do you often get bored?
5. [__] yes NO Are you hopeful about the future?
6. [__] no YES Are you bothered by thoughts that you just cannot get out of your head?
7. [__] yes NO Are you in good spirits most of the time?
8. [__] no YES Are you afraid that something bad is going to happen to you?
9. [__] yes NO Do you feel happy most of the time?
10. [__] no YES Do you often feel helpless?
11. [__] no YES Do you often get restless and fidgety?
12. [__] no YES Do you prefer to stay home at night, rather than go out and do new things?
13. [__] no YES Do you frequently worry about the future?
14. [__] no YES Do you feel that you have more problems with memory than most?
15. [__] yes NO Do you think it is wonderful to be alive now?
16. [__] no YES Do you often feel downhearted and blue?
17. [__] no YES Do you feel pretty worthless the way you are now?
18. [__] no YES Do you worry a lot about the past?
19. [__] yes NO Do you find life very exciting?
20. [__] no YES Is it hard for you to get started on new projects?
21. [__] yes NO Do you feel full of energy?
22. [__] no YES Do you feel that your situation is hopeless?
23. [__] no YES Do you think that most people are better off than you are?
24. [__] no YES Do you frequently get upset over little things?
25. [__] no YES Do you frequently feel like crying?
26. [__] no YES Do you have trouble concentrating?
27. [__] yes NO Do you enjoy getting up in the morning?
28. [__] no YES Do you prefer to avoid social gatherings?
29. [__] yes NO Is it easy for you to make decisions?
30. [__] yes NO Is your mind as clear as it used to be?

______________TOTAL SCORE

Scoring: Count 1 point for each depressive (capitalized) answer.

A score of 0-10 = normal
11-20 = mild depression
21-30 = moderate or severe depression