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Semantic Memory in Alzheimer's Disease

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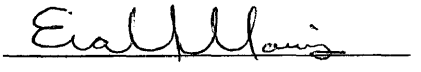

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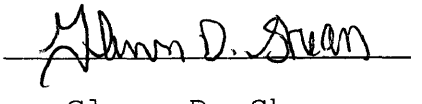

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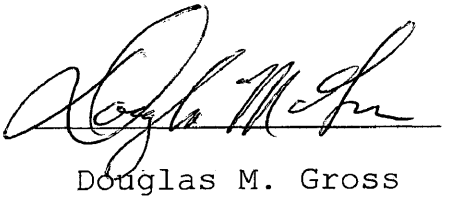

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Detection of the Nature of Semantic Memory Impairment in Patients With Alzheimer's Disease Using the Semantic Memory Test Battery

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Abstract

The purpose of this study was to examine the nature of semantic memory impairment in patients with dementia of the Alzheimer type. Seventeen normal elderly controls (NC) from the community and patients with either dementia of the Alzheimer type (DAT) (n= 7) or chronic schizophrenia (SZ) (n= 12) were recruited from a psychiatric setting and administered the Semantic Memory Test Battery. Results revealed that semantic memory is impaired in both SZ and DAT patients relative to NC. In addition, SZ patients outperformed DAT patients on naming, category comprehension, and picture sorting level 1. These data suggest that the nature of impairment in DAT is the result of a loss of knowledge. Exploratory descriptive statistics suggest that this impairment in semantic memory is preserved early in the course of Alzheimer's disease.

Detection of the Nature of Semantic Memory Impairment in Patients With Alzheimer's Disease Using the Semantic Memory Test Battery

Normal Aging

As individuals age, all organs undergo changes to some degree (Lezak, 1995). Conceptions of aging in the popular culture include the familiar stereotype of the aged individual who is hard of hearing and who has a faulty memory. Although certain deficits can be associated with aging, memory loss is not a part of the normal aging process. In early conceptions of the effect of aging on neuropsychological functioning, it was assumed that there was a general decline in skill level (Franzen & Rasmussen, 1990). Reitan (1967) ascribed this decline to be the result of a lifetime of cortical insults and injuries as the decline was not consistent across all cognitive functions assessed by the Halstead-Reitan Neuropsychological Battery (HRNB).

Catell (1963) hypothesized that human intellectual abilities could be divided into two categories. The first category included abilities that were culturally organized and dependent on the accumulation of formal and informal educational experiences over the course of a lifetime. He considered these abilities to reflect what he called

"crystallized" intelligence. The second category included abilities that reflected maturational growth and decline of neural structures. This type of intelligence is largely inherited and requires persons to manipulate new information to solve problems. He considered these abilities to reflect "fluid" intelligence. The general trend in cognitive performance throughout the lifespan begins with slight improvement occurring in early adulthood. Performance begins to level off and stabilizes during the middle years. Finally, there is a decline in performance that occurs in the later years (Horn, 1970).

There are several issues that require serious consideration in the establishment of normative data on older individuals. One example is the arbitrary cutoff age used to distinguish the "younger adult" from the "older adult" (Albert, 1981; Lezak, 1995). Some studies classify individuals as "older" if they are in their sixties or older whereas other studies include individuals in their fifties (Lindley, 1989). As individuals continue to live longer, new categories such as *old old, very old,* and *oldest old* are coming into play (La Rue, 1992). Age cutoff consistency among studies is extremely important as rapid changes in cognitive functioning occur within the 50 to 65 age range. Such a consensus for age-appropriate norms may lead to a greater consistency among studies (Lezak, 1995).

Another issue that requires serious consideration in the establishment of normative data concerns the health of the older individual (Albert, 1981; Lezak, 1995). Although most studies exclude individuals with illnesses known to impair functioning, many elderly individuals have histories of other chronic illnesses, such as heart disease, lung disease, hypertension, and diabetes, that have been found to have an effect on cognitive functioning. The issue of whether or not to include individuals with medical illness has stirred considerable debate. As a result, two different descriptions of aging have been defined: "optimal" or "healthy" aging and "typical" aging. Optimal aging refers to individuals who are free from medical illness, have no physical problems, and have no suggestion of subclinical pathology during their later years. Typical aging refers to individuals who have chronic medical conditions. An additional consideration in establishing normative data is the fact that, although some elderly individuals may appear "healthy," they may have such subtle brain disease that it cannot be detected without implementation of extensive examining procedures (Lezak, 1995).

Past research has established that for right-handed persons, the left and right hemispheres perform different cognitive functions. The left hemisphere is largely responsible for processing and storing verbal material,

whereas, the right hemisphere is responsible for processing and storing nonverbal material (Milner, 1971). This asymmetry in cognitive functioning has been found to remain stable throughout the lifespan (Hochandel & Kaplan, 1984).

Geriatric Neuropsychology

The reasons for being examined by a neuropsychologist change as we age. For the older adult, reasons would include cerebrovascular disease, central nervous system effects of medical disorders, or progressive dementias (Franzen & Rasmussen, 1990). However, this list is not all-inclusive of the many illnesses that the older adult is exposed to. As mentioned earlier, many elderly also experience other chronic illnesses. This interaction of age and disease makes diagnosis in the older patient extremely difficult (Albert, 1981). Despite these difficulties, it is important that a neuropsychological assessment of the older adult include at least five areas of investigation: attention, language, memory, visuo-spatial ability, and cognitive flexibility and abstraction (Albert, 1981).

When evaluating a patient, it is imperative that the examiner consider the fact that many causes of impairment are reversible, such as drug intoxication, depression, and infectious or metabolic disorders. For example, perceptual and psychomotor impairments reported in patients with mild

hypertension are reduced by antihypertensive medication (Albert, 1981). However, improvement is not seen in patients with impairment due to organicity, such as Alzheimer's disease. Therefore, it is necessary to make this distinction between reversible and non-reversible causes of impairment as it plays an important role in the treatment of the individual.

Understanding the role of physical aging in the performance of the elderly patient on neuropsychological tests is critical in interpreting their level of functioning. Factors such as slowing and loss of stamina can decrease the level of performance. Therefore, formal testing should be kept to a minimum (La Rue, 1992).

Another issue that deserves consideration is the recent support for a contextual perspective on the relationship between aging and cognition (Labouvie-Vief, 1985). This approach assumes that the social-environmental demands placed on older and younger adults that affect cognitive performance are different. For example, older adults are less likely to be called upon to engage in more complex tasks. This perspective also recognizes the limited value standard laboratory or intelligence tests have because of their tendency to exaggerate late-life decline. It helps to explain the variation in performance of elderly individuals, as some are deprived of the opportunity to engage in

everyday life activities that engage different types of information processing (La Rue, 1992). Investigators concerned with the validity of laboratory tests have hypothesized that elderly individuals, whose daily lives are activity-based, would perform well on natural tasks that involve recall of activities. Backman (1985) showed that free recall of simple subject-performed activities was the same for both young and old adults, demonstrating equality of performance among individuals of differing ages.

As mentioned above, memory impairment is an important area of functioning that is examined during a comprehensive neuropsychological assessment and is the most studied aspect of cognition by gerontologists (La Rue, 1992). From an information processing approach, memory can be broken down into several types. This breakdown depends on the duration and content of the memory one is examining. Sensory memory has an extremely short duration, lasting about one second. As soon as information is registered, it begins to decay. If information is not transferred to short-term memory, it is lost. Short-term memory (STM) refers to memories that last for a brief time period, about 20-30 seconds. Its capacity to store information is limited, usually to storing seven items, plus or minus two. On the other hand, the memories stored in long-term memory (LTM) last much longer. Memories in LTM are assumed to be relatively permanent.

Unlike STM, the capacity of LTM is unlimited. These systems differ in how the information in them is organized. Information in STM seems to be organized according to the time it entered STM, whereas material in LTM is organized by its meaning and association (MacInnes & Robbins, 1987).

Investigation of sensory memory in elderly individuals has shown age-related deficits (Cerella, Poon, & Fozard, 1982). These studies suggest that older adults need longer exposure to stimuli in order to adequately register the incoming information.

Many elderly individuals often complain of a decreased ability to remember both recent and remote events, persons names, phone numbers, dates, what they just read, or where they just put something (Bayles & Kaszniak, 1987). Although elderly individuals tend to report such subjective decline in short-term memory, some research in this area indicates otherwise (Craik, 1977). In fact, studies (Treat, Poon, & Fozard, 1981) that have involved training older individuals in using mnemonic strategies have shown substantial improvement in their performance on measures of short-term memory.

Craik (1977) has also suggested that the decline in long-term memory seen in elderly individuals can be interpreted using a depth of processing approach. This approach suggests that normal elderly individuals engage in

less extensive and less efficient processing of new material. Research by Perlmutter and Mitchell (1982) supports this notion. They indirectly encouraged different depths of processing among elderly individuals by engaging them in categorization strategies while learning new information. Their results showed that older adults benefited from categorization strategies whereas younger adults did not. They presumed that this was due to the fact that younger adults already engage in such strategies.

Although the literature suggests that some elderly individuals can benefit from training and engaging in learning strategies despite their cognitive decline, not all elderly individuals are as fortunate. Some individuals are afflicted with certain neurodegenerative disorders, such as Alzheimer's disease, that affect their ability to function, both cognitively and physically, at levels comparable to other individuals their age.

Clinical Description of Alzheimer's Disease and its Prevalence

According to the DSM-IV, Alzheimer's disease is defined as a progressive loss of cognitive function in at least two areas of functioning that are not attributable to other causes of dementia. Areas of functioning include: executive, language, memory, visuospatial ability, and motor

activity. Onset of the disease is usually slow, making it difficult to differentiate from "normal" aging. The most prominent clinical feature is the loss of recent memory, manifesting itself sometimes in the loss of normal activities. Such activities include cooking or driving. It has been observed that Alzheimer's disease is a common condition in the community when clinically diagnosed. Although Alzheimer's disease cannot be diagnosed with certainty until an autopsy is performed, with observation and assessment, it is usually possible to give a probable diagnosis before death (Roses, 1995).

Alzheimer's disease is the most common cause of dementia, comprising 70% of all cases of dementia (Kandel, Schwartz, & Jessel, 1991). Of elderly individuals living in the community aged 65 to 74 years old, 3% had probable Alzheimer's disease. Additionally, 18.7% of residents aged 75 to 84 years old and 47.2% of residents over 85 years old had probable diagnoses of Alzheimer's disease (Evans et al., 1989).

Neuropathology of Alzheimer's Disease

Pathological characteristics of Alzheimer's disease include both extracellular and intracellular markers, including neuritic plaques and neurofibrillary tangles, respectively. Neuritic plaques are extracellular fibers

with many proteins bound in them. Research has focused on these markers as causative mechanisms in the disease. The most popular theory is the "amyloid hypothesis." Amyloids are the result of the formation of beta-pleated sheets by various proteins. The amyloid found in neuritic plaques is most often due to the deposition of a 40-42 amino acid peptide fragment of a larger protein called the amyloid precursor protein (APP). This deposition is considered the central proximal cause of Alzheimer's disease (Roses, 1995).

Neuritic tangles are fibrils within neurons that distort their shape. If tau protein is phosphorylated, paried helical filaments form, resulting in neuritic tangles. Therefore, tau protein is the major compriser of neurofibrillary tangles found in Alzheimer's disease (Roses, 1995).

Neurofibrillary tangles have been found most often in temporal lobe structures of patients with AD, specifically the entorhinal cortex in layers II and IV (Hyman, Van Hoesen, Damasio, & Barnes, 1984). This finding is important because this structure is necessary for relaying information to and from the hippocampus. The subiculum, a region in the hippocampal formation which sends efferents to both cortical and subcortical regions, and the amygdala have also been shown to develop neurofibrillary tangles in patients with AD (Van Hoesen & Damasio, 1987).

AD patients have also been found to show a loss in synaptic density, neurofibrillary tangles, and neuritic plaques in the midfrontal regions of the cortex (Peavy, Salmon, and Samuel, 1999). The neuropathology found in these areas of these patients correlated moderately with scales of social inappropriateness. Not all regions of the brain, however, are as affected by neurofibrillary tangles. For example, the fact that the basal ganglia and cerebellum are less affected by neuropathology can be seen in the relatively intact motor-related skills in patients with AD (Van Hoesen & Damasio, 1987).

Another common feature of Alzheimer's disease is neuronal loss, with the greatest loss found in the temporal lobes (Rossor, 1987) and the brain stem nuclei, specifically the basal nucleus and the locus coeruleus (Terry & Katsman, 1983). This pattern of loss accounts for the prominence of memory disorders found in this disease (Damasio, Van Hoesen, & Hyman, 1990).

Neuropsychological Assesment in Alzheimer's Disease

When the lay person is asked to describe a typical person with Alzheimer's disease, the first thing that comes to mind is impairment in the individual's ability to remember the names of family members and close friends or important, autobiographical events in the individual's life.

This is considered episodic memory. Episodic memory refers to memories in LTM that are associated with a given time or place (MacInnes & Robbins, 1987). However, patients with AD not only express impairment in episodic memory, they express impairment in multiple memory-related systems.

Several paradigms have been used to study short-term memory in patients with AD. Popular paradigms include the memory span, Brown-Peterson, and free recall paradigms. The most frequently used memory span procedure is Forward Digit Span. This involves recalling an increasing number of digits correctly in a forward fashion. Although most investigators (Corkin, 1982; Kaszniak, Garron, & Fox, 1979) have found that individuals with AD are impaired on tests of Digit Span, research in this area is not consistent (Storandt, Botwinick, Danziger, Berg, & Hughes, 1984).

Additional support for short-term memory impairment in AD patients has been found using the Brown-Peterson procedure (Corkin, 1982). This procedure involves presenting three words and testing recall immediately or after a delay (1 to 18 seconds). During the delay, the person is prevented from rehearsing the words by engaging in a distractor activity. Although no differences were found in immediate recall between AD patients and normal elderly controls, Corkin found differences in recall between the two groups with increasing distraction intervals.

Even further support for impaired short-term memory in AD patients has been found in studies using free recall (Miller, 1971). Miller studied the serial position of words presented from a list of 12 or more in presenile AD patients and normal elderly controls. Results indicated that AD patients were impaired in their ability to recall words from both the beginning and the end of the list. Therefore, they did not demonstrate the expected U-shaped curve shown by the controls.

It has been established that patients with early-onset AD demonstrate a more rapid cognitive decline as well as disproportionate language and concentration impairment (Filley, Kelly, & Heaton, 1986; Koss et al., 1996). This has been easily shown in impaired primary memory or working memory (Becker, 1986). In turn, these deficits impair learning until the capacity to learn is lost.

Recent theory suggests that long-term memory is continuous rather than discrete. Therefore, memory is seen as a "process" rather than a "store" in which information is placed and retrieved. Tasks that have involved verbal list learning (McCarthy, Ferris, Clark, & Crook, 1981), paired associates (Corkin, 1982), and text recall (Danziger & Storandt, 1982) have shown a deficit in performance by AD patients. In addition, tests of long-term memory have also shown a more rapid rate of forgetting for AD patients

compared to normal elderly controls (Moss, Albert, Butters, & Payne, 1986).

Encoding/retrieval processes have been shown to be greatly impaired in patients with AD. Wilson and colleagues (Wilson, Bacon, Fox, & Kaszniak, 1983) found that, unlike normal elderly controls, impaired short-term memory in AD patients was correlated with impaired long-term memory on a free recall task. They also found that the size of the short-term memory deficit in AD patients increased linearly with the number of items between presentation and attempted recall.

On tests of recognition, patients with AD poorly discriminate between target items and distractor items (false alarms) with the distractor items comprising a significant proportion of their total responses (Lezak, 1995). This result has been found with both verbal and nonverbal stimuli (Miller, 1975; Wilson, Kaszniak, Bacon, Fox, & Kelly, 1982). Miller (1975) surmised that this deficit was the result of a retrieval problem because the deficit increased with an increase in the number of recognition alternatives. This deficit has also been found in normal individuals when the length of testing is comparable to dementia patients (Mayes and Meudell, 1981).

In addition to expression of poor episodic memory, AD patients also exhibit poor semantic memory. Semantic memory

is a part of long-term memory that contains the permanent representation of our knowledge of concepts, objects, and facts that add meaning to our sensory experiences. Neuropsychologically speaking, semantic memory is important for the identification and naming of objects, picture-picture and word-picture matching, and the understanding and production of written and spoken words such as generation of definitions and exemplars on category fluency tests (Hodges & Patterson, 1995). Semantic memory, unlike episodic memory, is culturally shared and not temporally specific (Hodges, Salmon, & Butters, 1992). Whether or not this impairment is seen early in the course of disease has been debated. Some studies (Filley, Kelly, & Heaton, 1986; Hodges, Salmon, & Butters, 1992) have, in fact, demonstrated semantic memory impairment in AD patients in the early course of the disease.

The nature of impaired semantic memory in patients with AD still remains uncertain. Tests of semantic memory require a person to access their fund of knowledge about a particular object. The performance of a person who has difficulty in accessing this fund should improve on tests when cues are provided that assist him/her in accessing the semantic store. However, a person who has lost the semantic store completely should not be helped by additional cues. These cues are no longer helpful in retrieving information

from the semantic store because the store no longer exists. Although some researchers have proposed that impairment on tests of semantic memory reflect impaired access to the store of semantic knowledge in long-term memory, the majority of researchers believe that impaired semantic memory is a result in the breakdown in the structure of semantic store (Hodges and Patterson, 1995).

As can be seen from the literature described above, much of early diagnosis of Alzheimer's disease involves measuring cognitive functioning in the older adult in order to differentiate early stages of Alzheimer's disease from normal aging. However, initial diagnosis of individuals with AD is simply a sign to begin treatment. In addition to the utility of the cognitive measures used in the diagnosis of Alzheimer's disease, these measures can also be used to stage the disorder in order to provide better caregiving planning. Discriminating between Alzheimer's disease and normal elderly controls has been more successful, however, than staging the disease. This is largely due to the fact that memory measures are most often used to differentiate DAT from normal aging (Storandt, Botwinick, Danziger, Berg, & Hughes, 1984; Welsh, Butters, Hughes, Mohs, & Heyman, 1992). However, recent research (Morris & Gross, 1999; Locascio, Growdon, & Corkin, 1995; Welsh et al., 1992) has shown that nonmemory measures, such as verbal fluency,

confrontational naming, and constructional praxis are useful in discriminating between patients with moderate and severe DAT.

Other issues to consider in the assessment of memory in patients with AD is the degree to which these patients are perseverative, circumstantial, and stimulus-bound in the early course of their disease (Albert & Moss, 1984). Therefore, patients responses should be evaluated with this in mind.

Cognitive Assessment in Psychiatric Settings

As individuals with Alzheimer's disease progress through the course of the disease, it becomes increasingly difficult to care for them. As a result, many elderly with Alzheimer's disease are often placed in adult homes or geriatric units of psychiatric centers where trained professionals can provide assistance to their daily needs. Also present in these alternative living environments are patients with histories of psychatric illness, such as schizophrenia and mood disorders, among others. Although these patients may have different DSM-IV diagnoses, they can still present similarly when certain cognitive functions are assessed. One such similarity is the memory impairment that is present in both patients with Alzheimer's disease and patients with schizophrenia.

Neuropsychological Impairment in Patients With Schizophrenia

It has been well established that patients with schizophrenia demonstrate cognitive impairment on neuropsychological tests. As a group, these patients have a tendency to demonstrate a general intellectual deterioration. In addition to such decline, these patients show evidence of specific cognitive deficits (Nelson et al, 1990; Saykin et al, 1991). Assessment of these deficits includes areas such as executive functioning, attention, abstraction, language, and memory.

In order to test executive functioning, Goldberg, Weinberger, Berman, Pliskin, & Podd (1987) administered the Wisconsin Card Sorting Test to chronic schizophrenics of the paranoid or undifferentiated subtype and found that these patients were unable to learn the task despite intructional techniques that were applied. Patients were able to perform the task when provided with card-by-card instruction. However, when instruction was withdrawn, performance was impaired once again, demonstrating no maintenance or transfer of learning. The authors concluded that this impairment could not be attributed to attentional deficits, as shown by normal performance with card-by-card instruction.

Not only has specific cognitive decline been noted in patients with schizophrenia as shown by poor executive functioning, but these patients also show evidence of impaired memory. Allen, Liddle, and Frith (1993) also found impaired verbal fluency in patients with chronic schizophrenia compared to normal and depressed controls. For three categories (animals, body parts, fruit) chronic schizophrenics produced fewer words, showed less clustering of words, and produced more words that did not belong to the correct category. They have suggested that these deficits can be attributed to impaired retrieval processes that underly both positive and negative speech disorders associated with schizophrenia.

Joyce, Collinson, & Crichton (1996) have shown that patients with schizophrenia also demonstrate impairment in semantic memory. Compared to normal controls, patients with schizophrenia showed poor performance on verbal fluency tasks of category and letter. In addition, cueing the patient with a subordinate category improved their category fluency. Normal functioning on the Boston Naming Test coupled with improvement in category fluency as a result of cueing provides support for the nature of semantic memory impairment seen in these patients to be reflected as a failure of access to the semantic memory store.

It has been a concern in the literature that memory impairment found in patients with schizohrenia is the result of deficient attention. However, Saykin et al. (1991) found the memory impairment in these patients to be more severe than the impairments found on auditory and visual tasks sensitive to attention. Therefore, memory impairment could not be accounted for solely by attentional deficits.

Attentional deficits have been ruled out by some investigators as a contributing factor to the poor memory performance of schizophrenic patients. However, it has been indicated that this impairment is due to inefficient learning rather than to rapid forgetting of recently learned information (McKay et al., 1996). Deficient learning can result from impaired encoding of new material. Gold, Randolph, Carpenter, Goldberg, and Weinberger (1992) administered three word lists differing in their degree of semantic organization to patients with schizophrenia and to normal controls. The random list contained 20 unrelated nouns. The unblocked list contained four categories with five exemplars in each and was constructed so that no related words were presented consecutively. In the blocked list, the five exemplars in each category were presented as a group. They found that recall for patients with schizophrenia was nearly identical for both the random and the unblocked lists. However, the patients performed better

on the blocked list. This indicated that these patients have a relatively intact underlying semantic system that requires salience of category information in order for it to be activated.

In 1994, Seidman et al. examined the relationship between prefrontal and temporal lobe MRI measures and neuropsychological performance in patients with chronic schizophrenia. Results showed a correlation between a smaller left dorsolateral prefrontal cortex and poor performance on the WCST as well as poor performance on Logical Memories Immediate Recall and Logical Memories Delayed Recall. Additionally, there were no correlations between neuropsychological performance and orbital frontal or temporal lobe measures. There were also no correlations found between patients' benztropine doses and neuropsychological measures or brain regions. Although Seidman (1994) found no correlation between frontal and temporal lobe volumetric measures and neuropsychological functioning, other researchers (Prohovnik, Dwork, Kaufman, & Willson, 1993) have found that, at autopsy, elderly schizophrenics who were chronically hospitalized showed Alzheimer-type neuropathology, such as neuritic plaques and tangles.

Several neuropsychological tests comprise the protocol for assessing a wide range of functioning. They include the

following: frontal lobe function- categories and perseverative response scores on the Wisconsin Card Sorting Test (WCST), the Similarities subtest of the Wechsler Adult Intelligence Scale- Revised (WAIS-R), the Auditory Continuous Performance Test (CPT), Finger Tapping, long-term memory- immediate and delayed recall scores on the Logical Memory (verbal) and Visual Reproduction (visual-constructional) subtests of the Wechsler Memory Scale-Revised (WMS-R), and learning- verbal paired associates subtest of the WMS-R.

Although administration of these tests is useful in predicting impairment in young patients with schizophrenia, they are often too difficult to administer to the older patient. It can take up to several hours to administer them, which is extremely long for elderly patients (Holden, 1988). However, several tests have been developed that are much shorter in length but still assess the same areas of cognitive functioning. One such battery that is used to assess semantic memory impairment is the Semantic Memory Battery (Hodges et al., 1992; Hodges and Patterson, 1995).

In their attempt to examine semantic memory impairment in patients with schizophrenia of varying degrees of chronicity and age of illness onset, McKay et al. (1996) administered the Semantic Memory Battery to young, chronic schizophrenics, elderly, chronic schizophrenics, young, mild

schizophrenics, and patients with Alzheimer's disease. They found that elderly patients with chronic schizophrenia demonstrated an impairment in semantic memory that was comparable to patients with Alzheimer's disease on almost of all the subtests. (Schizophrenic patients performed slightly, although not significantly, better than patients with Alzheimer's disease.) Both groups were impaired on naming, sorting, word-to-picture matching, and definitions subtests. The only subtest that was able to discriminate between the two groups was verbal fluency category of birds.

Purpose of This Study

Despite the evidence of semantic memory impairment in patients with Alzheimer's disease, there has been considerable debate over the nature of semantic memory impairment. This debate considers whether the impairment is the result of a breakdown in knowledge in the semantic system or a failure of access to knowledge (Hodges, Salmon, & Butters, 1992; Binetti et al., 1995). The purpose of this study is to examine the nature of semantic memory impairment in patients with Alzheimer's disease using the Semantic Memory Test Battery (SMTB).

It is predicted that both dementia of the Alzheimer type (DAT) patients and schizophrenic patients will show impairment on measures of semantic memory relative to normal

elderly controls. This should occur regardless of the nature of the impairment. It is also predicted that DAT patients will show greater impairment than SZ across subtests. If the impairment in semantic memory in DAT patients is the result of a loss of knowledge of the semantic store, their performance should be worse than SZ across all subtests, as exposure to each item in the stimulus set across the subtests is not helpful in retrieving information from the semantic store about that item. If, however, the impairment is the result of a failure to access the semantic store, then their performance across subtests should improve because each subtest contains the same 48-item stimulus set and should, therefore, be comparable to the SZ patients.

Method

Participants

Patients with previous Mini-mental State Exam (MMSE) scores above 9 out of a possible 30 were recruited from a psychiatric setting for this study. Most patients with scores below 9 are not testable. All patients met DSM-IV criterion for either Dementia of the Alzheimer Type (DAT) (n= 7) or Schizophrenia (SZ) (n= 12) diagnoses. All patients were English-speaking. Patients were excluded for the following reasons: (a) dementia due to other causes,

such as alcohol or stroke, (b) depression, (c) dual diagnosis as DAT and SZ according to DSM-IV criterion, and (d) history of brain injury. Seventeen Normal elderly controls (NC) were recruited from the community.

Materials

The Semantic Memory Test Battery was administered to DAT patients, patients with schizophrenia (SZ), and normal eldery controls (NC). Administration of the battery ranged from approximately 60-240 minutes. The battery consisted of six subtests, employing the same consistent set of stimulus items. In this way, input to and output from central representational knowledge was assessed using several sensory modalities. The stimulus set contained 48 items that represented three animal categories (land animals, sea creatures, and birds, all having n= 24 items) and three man-made categories (household items, vehicles, and musical instruments, all having n=24 items). All categories were matched for prototypicality and word frequency. Item administration was consistent across subjects but randomized across tests. The items used came from the corpus of line drawings by Snodgrss and Vanderwart (1980). The subtests included the following:

1. Category Fluency: The participant was given one minute to name as many objects as possible that belong to the six categories described above as well as two lower order categories (breeds of dogs and types of boats).

2. Naming: The participant was asked to name all of the 48 line drawings without cueing.

3. Naming to Description: The participant was provided with a description of 24 of the 48 items (e.g. "what do we call a small green animal which leaps around ponds?") and was asked to provide the name of the item.

4. Semantic feature questions: Eight questions were asked for the 24 items administered in the Naming to Description subtest. Half of the questions tapped knowledge of physical features (size, shape, color, etc.) and half tapped abstract attributes (habitat, ferocity, diet, uses, etc.) Half of the questions posed received "yes" responses and the other half received "no" responses. For items incorrectly named during the Naming subtest, the corresponding eight Semantic Feature questions were asked.

5. Picture sorting: Participants were asked to sort 48 cards containing the Snodgrass and Vanderwart pictures at three different levels: 1. superordiniate (living vs. manmade) 2. category (land animal vs. bird vs. water creature and musical instrument vs. household item vs. vehicle) and 3. subordinate/attributional (e.g. fierce vs.

nonfierce animal, small vs. large animal, kitchen vs. non kitchen item, and large vs. small kitchen item.) Sorting began at the superordinate level, in which the participant sorted into one pile all of the pictures that were manmade and into another pile all the pictures that were living. Next, participants were given the 24 living cards and were asked to sort them into one of the three appropriate categories (land animal vs. bird vs. water creature). Then they sorted all 12 cards containing land animals into subordinate categories according to two different binary attributes in turn (fierce vs. nonfierce and larger than a German shepherd dog vs. smaller.) The 24 manmade cards followed in which the the participant sorted according to their appropriate categories (musical instrument vs. household item vs. vehicle.) Finally, participants sorted the manmade cards at the third level (subordinate.) They sorted the 12 cards containing household items according to two different binary attributes in turn (electrical vs. non electrical and larger than a standard televison vs. smaller.)

6. Word-picture matching: Participants were presented with picture arrays consisting of eight items from the same category (e.g. land animals) and were asked to point to the item named by the examiner. Six of the items came from the originial set of 48, and two were foils not otherwise

included in the test battery. The participant viewed 48 arrays, consisting of only eight different combinations of items (one for each category such as land animals), but for each array the position of the items varied. The test sequence was consistent across participants and was arranged so that each item was followed by one from a different category.

Results

Although NCs did not differ from DAT or SZ patients in age [$F(2, 30) = 1.75$, $p = 0.191$] and gender [$F(2,30) = 0.978$, $p = 0.387$], the NCs were more educated [$F(2,30 = 12.385$, $p < 0.001$] and racially homogeneous [$F(2,30) = 17.039$, $p < 0.001$, all caucasian] than the patient groups. DAT and SZ patients did not differ in age, gender, race, or education.

Multivariate analysis of covariance was employed with the normal controls (NC), schizophrenics (SZ), and dementia of the Alzheimer type (DAT) patients as the group variable, the subtests of the Semantic Memory Test Battery as the dependent variables, and education as the covariate. Education was used as a covariate because measures of cognitive functioning are influenced by education, and the normal controls in this study were more educated than the patients. The MANCOVA revealed a highly significant overall

difference ($F = 3.618$ Pillai's Trace, $p < 0.001$). There was a significant group effect for the following subtests: naming [$F(2,28) = 4.354$, $p = 0.022$], semantic features [$F(2,28) = 7.718$, $p = 0.002$], category fluency for both living and manmade things [$F(2,28) = 24.687$, $p < 0.001$ and $F(2,28) = 22.059$, $p < 0.001$ respectively], category comprehension [$F(2,28) = 3.372$, $p = 0.048$], and picture sorting at level 1 [$F(2,28) = 4.656$, $p = 0.017$]. An alpha level of .05 was employed for all analyses.

Shown in Table 2 are the results from the pairwise comparisons. Such analyses revealed that NC performed better than SZ on semantic features and category fluency for living and manmade things. DAT patients showed greater impairment relative to NC on the following subtests: naming, naming to description, semantic features, category fluency for living and manmade things, and picture sorting at level 1. In addition, SZ outperformed DAT patients on category comprehension, naming, and picture sorting level 1. Although not significant, there were trends in the predicted direction for semantic features ($p = 0.057$) and naming to description $p = 0.095$).

Because SZ patients did not differ from DAT patients on all subtests of semantic memory as predicted, the DAT patient group was further divided into moderate DAT and severe DAT. This division was implemented because previous

work with these patients (Morris & Gross, 1999) and others (Locascio, Growdon, & Corkin, 1995; Welsh et al, 1992) suggests that severe DAT patients show greater cognitive impairment in both memory and nonmemory measures relative to moderate DAT patients. Demographic characteristics for these groups are presented in Table 1, and means from semantic memory subtests are presented in Figures 1-5. Given the small sample size, inferential statistics were not employed. However, descriptive statistics presented in these figures are suggestive that semantic memory is impaired in both SZ and severe DAT but not in moderate DAT.

Discussion

The purpose of this study was to examine the nature of semantic memory impairment in patients with dementia of the Alzheimer type. Past research has been inconsistent in reporting whether the impairment is the result of an access to the memory store or whether it is the result of a degraded loss of knowledge. Although there has been an inconsistency, most researchers have found support for the latter (Hodges, Salmon, & Butters, 1992). Results from the current study suggest that semantic memory is impaired in both patients with dementia of the Alzheimer type and elderly patients with chronic schizophrenia relative to normal elderly controls. Not only did DAT patients perform

at levels below normal controls, they also performed worse than patients with schizophrenia on naming, category comprehension, and picture sorting at level 1. Although not significant, DAT and SZ performance on naming to description and semantic features were in the predicted direction. If the nature of impairment seen in DAT patients was the result of a loss of knowledge of the semantic store, they should perform worse than normal controls and schizophrenics across subtests If, however, the nature of impairment seen in both patient groups was the result of a failure to access the semantic store, then they should perform similarly across subtests. This, however, was the case. In addition, patients with schizophrenia performed worse than normal controls on some subtests but not all, suggesting that exposure to the same stimulus set served as a cue across subtests and aided in retrieving information about the items in the patients' fund of information. Several suggestions as to the pattern of results found in this study have been provided below.

One possibility why a consistent difference was not found between DAT patients and schizophrenics is that the DAT patient group was heterogeneous, comprising of patients who were clearly moderately or severely impaired (Morris & Gross, 1999). If semantic memory is preserved early in the course of Alzheimer's disease, then patients with moderate

DAT should perform at higher levels than both severe DAT patients and patients with schizophrenia. Descriptive data from this study suggest such preservation as moderate DAT patients performed at levels similar to normal elderly controls. These data are inconsistent with Hodges and Patterson (1995) who found that semantic memory is impaired even in mild DAT.

In addition, previous research (Morris & Gross, unpublished raw data) with these patients found that the moderate DAT patients did not differ from SZ in their performance on other cognitive measures such as naming, fluency, immediate and delayed memory, and constructional praxis. If semantic memory is preserved early in the course of DAT, one would not expect to see differences in semantic memory between the groups either. Therefore, this similarity in performance might explain why no difference was found in category fluency among the two groups.

There are several caveats in this study that deserve consideration. The first is test administration. Patients with severe DAT required much greater assistance in their responding throughout test administration relative to moderate DAT patients, schizophrenics, and normal elderly controls. Without constant reminding of instructions and prompting when responses were required, it is doubtful that these patients could have initiated the proper response

required of them. This was most evident on the picture sorting subtest. During normal administration, cards indicating the categories by which to sort the stack of cards were placed in front of the participants. They were required to sort the stack into either two or three piles, depending on the difficulty level of the sort. Normal controls, schizophrenics, and moderate DAT patients could sort the stack of cards without assistance. However, patients with severe DAT needed to be reminded of the two or three categories by which they were sorting each time they were to place a card into one of the piles. In addition, they could not place the cards in the appropriate piles, as they would say that a card belonged to a particular subcategory yet they would place the card in a different pile. Therefore, the verbal response of the category they thought the card belonged to was scored and not where they placed the card down. Still some patients did not even know what to do with the cards (sort them) when they were placed in front of them, as they would make remarks such as, "Oh, that's pretty too," and try to peel the cards apart. It is possible that the difference in test administration for the severe DAT patients contributed to the nonsignificant group effect for picture sorting at levels two and three.

A second caveat concerns the relatively small sample size used for the study. Recruitment of patients willing to

participate in the study was limited for several reasons. The number of new admissions of patients who met criteria was small. Too many new patients were cognitively impaired beyong testing capabilities. In addition, those patients who were previously recruited for other studies had deteriorated to the point where they were no longer testable. Still, some of the patients who were willing to participate dropped out partway through testing because of the time demand of the tests. Some patients needed three to four hours to complete the testing. As a result of the small number of patients involved in the study, only descriptive statistics could be employed to explore the role different stages play in semantic memory impairment in Alzheimer's disease.

If semantic memory is, in fact, preserved in moderate DAT patients and not in severe DAT patients, this difference has important implications for staff treatment. For example, if a moderate DAT patient demonstrates intact semantic memory, although they may have forgotten the path between their bed and the bathroom, a picture of the toliet at the bathroom entrance can serve as cue that they are in fact at the bathroom. However, a severe DAT patient who has not only forgotten the path from his or her bed to the bathroom has also forgotten that a picture of the toliet serves as a symbol for the bathroom. Therefore, patients

with severe DAT not only need assistance in being directed toward the bathroom, they need to be told by staff that they are, in fact, at the bathroom, as a picture of the toliet is not enough to remind them of where they are at.

Not only do the data from this study have important practical implications for the treatment of patients in different stages of Alzheimer's disease, they also provide suggestions for assessment of these patients. Because a majority of patients in geratric treatment centers have diagnoses of Alzheimer's disease or schizophrenia, it is important to distinguish between the two patient groups. Patients with moderate Alzheimer's disease and patients with schizophrenia show similiar levels of impairment on a variety of cognitive measures such as memory, language, fluency, and constructional praxis (Morris & Gross, 1998). If these two patient groups perform at comparable levels on these cognitive measures, then taking a closer look at their performance on tests of semantic memory might be useful in discriminating between these patient groups. This study suggests that patients in the moderate stage of Alzheimer's disease show intact semantic memory relative to patients with schizophrenia. Therefore, differences in performance on measures of semantic memory can assist in discriminating between these patient groups.

Although the data from this study are suggestive that the Semantic Memory Test Battery is useful in discriminating between patients with Alzheimer's disease and schizophrenia, administration of the test is quite lengthy, taking several hours. Adding this battery to current assessment tools would make the time of assessment necessary for each patient unreasonable. Therefore, modifications to tests currently being administered would seem most logical. One such battery currently being used in the cognitive assessment of elderly patients is the Consortium to Establish a Registry for Alzheimer's Disease (CERAD) Neuropsychological Assessment Battery. One of the subtests of the CERAD is the modified Boston Naming Test in which patients are presented with a line drawing and are asked to name the picture. If they cannot name the picture without help, phonemic and semantic cues are given in that order. Although patients with moderate Alzheimer's disease and schizophrenia do not differ in their performance on this test, introducing questions that tap their knowledge of the features and attributes of the objects might better help in discriminating between the two patient groups. Although such a modification would lengthen the time of test administration of the CERAD, the amount of testing time required would still be less than that required for administration of the Semantic Memory Test Battery. This is

the direction future research in this area should take as we examine the utility of different cognitive assessment tools to discriminate between the level and area of functioning in elderly patients with chronic schizophrenia and Alzheimer's disease.

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Table 1. Demographic Characteristics of Patients With Dementia of the Alzheimer Type, Chronic Elderly Schizophrenics, and Normal Elderly Controls

Characteristic	Age	Education	Gender		Race	
	M (SD)	M (SD)	Male	Female	Caucasian	AA
Group						
NC	74.06 (7.22)	15.41[a] (3.28)	8	9	17 [a]	0 [a]
SZ	73.29 (4.61)	9.54 (2.18)	2	12	3	11
DAT total	77.57 (5.26)	10.29 (4.72)	3	4	3	4
Moderate DAT	80.33 (6.35)	12.33 (2.08)	2	1	2	1
Severe DAT	75.50 (3.87)	8.75 (5.85)	2	2	3	1

Note. AA = African American. DAT = Dementia of the Alzheimer type; SZ = Schizophrenia; [a] = Significantly different from DAT and SZ groups, $p < 0.05$.

Table 2. Performance of Patients with Dementia of the Alzheimer Type, Chronic Schizophrenia, and Normal Controls on the Semantic Memory Test Battery

Characteristic	NC M (SD)	SZ M (SD)	DAT M (SD)
Subtest			
Naming	47.00 (1.06)	38.90 (5.92)	32.00 (16.41) [ab]
Naming to Description	22.65 (1.93)	15.80 (3.80)	12.83 (10.80) [a]
Semantic Features	94.42 (3.00)	76.42 (8.20) [a]	70.67 (17.58) [a]
Category Fluency			
Living	61.71 (12.69)	21.80 (8.89) [a]	18.67 (13.23) [a]
Manmade	61.88 (13.41)	21.20 (9.39) [a]	19.00 (11.98) [a]
Category Comprehension	47.82 (0.53)	41.00 (9.96)	36.83 (14.09) [ab]
Picture Sorting			
Level 1	47.94 (0.24)	47.09 (2.70)	45.33 (4.32) [ab]
Level 2	45.82 (2.35)	42.27 (3.41) [a]	41.00 (6.13) [a]
Level 3	45.59 (1.80)	39.82 (4.29) [a]	41.33 (6.77) [a]

Note. NC = normal elderly control; SZ = chronic schizophrenia; DAT = dementia of the Alzheimer type; [a] = Significantly different from NC, $p < 0.05$; [b] = Significantly different from SZ, $p < 0.05$.

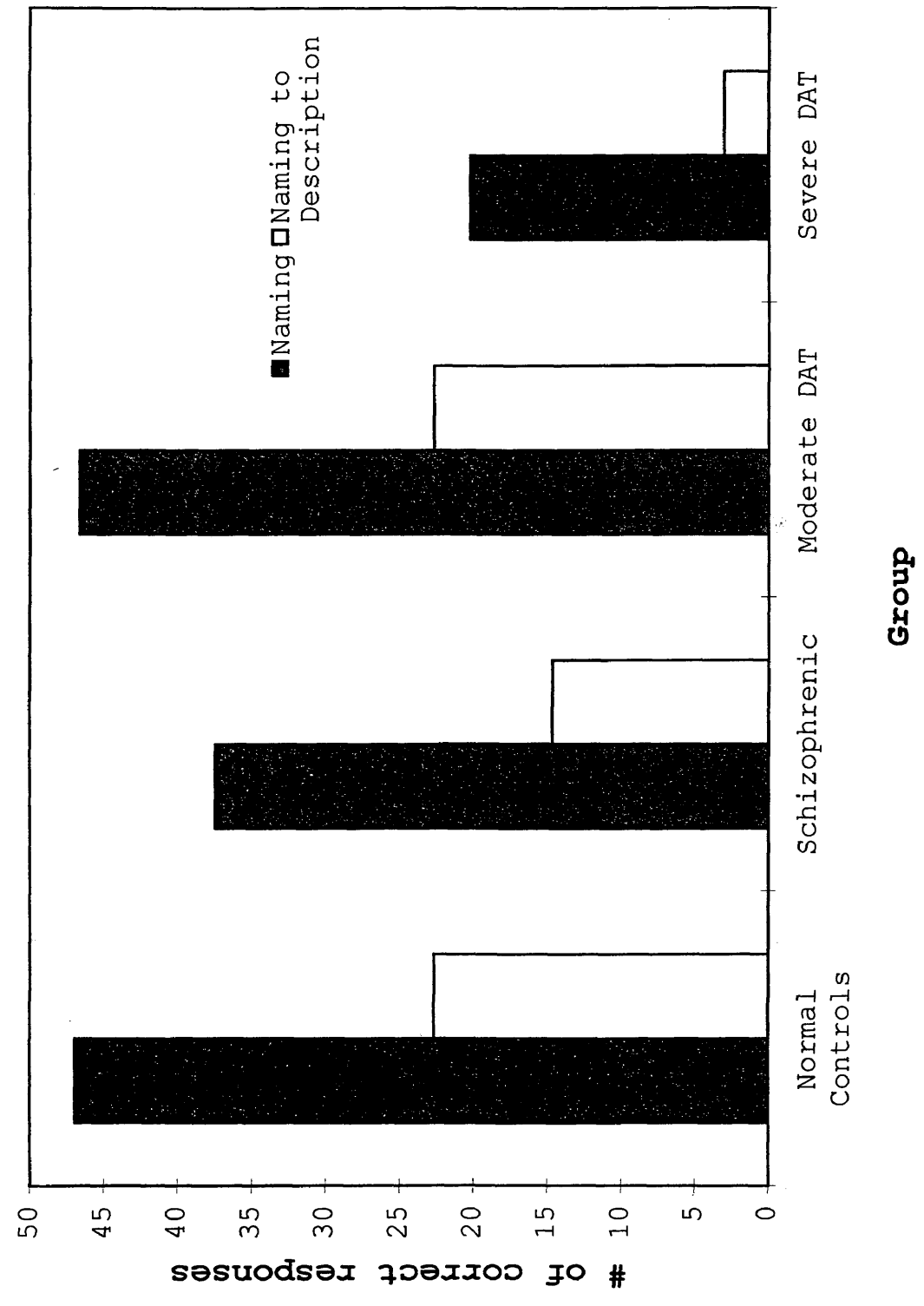

Figure 1. Performance on Naming Subtests of the Semantic Memory Test Battery

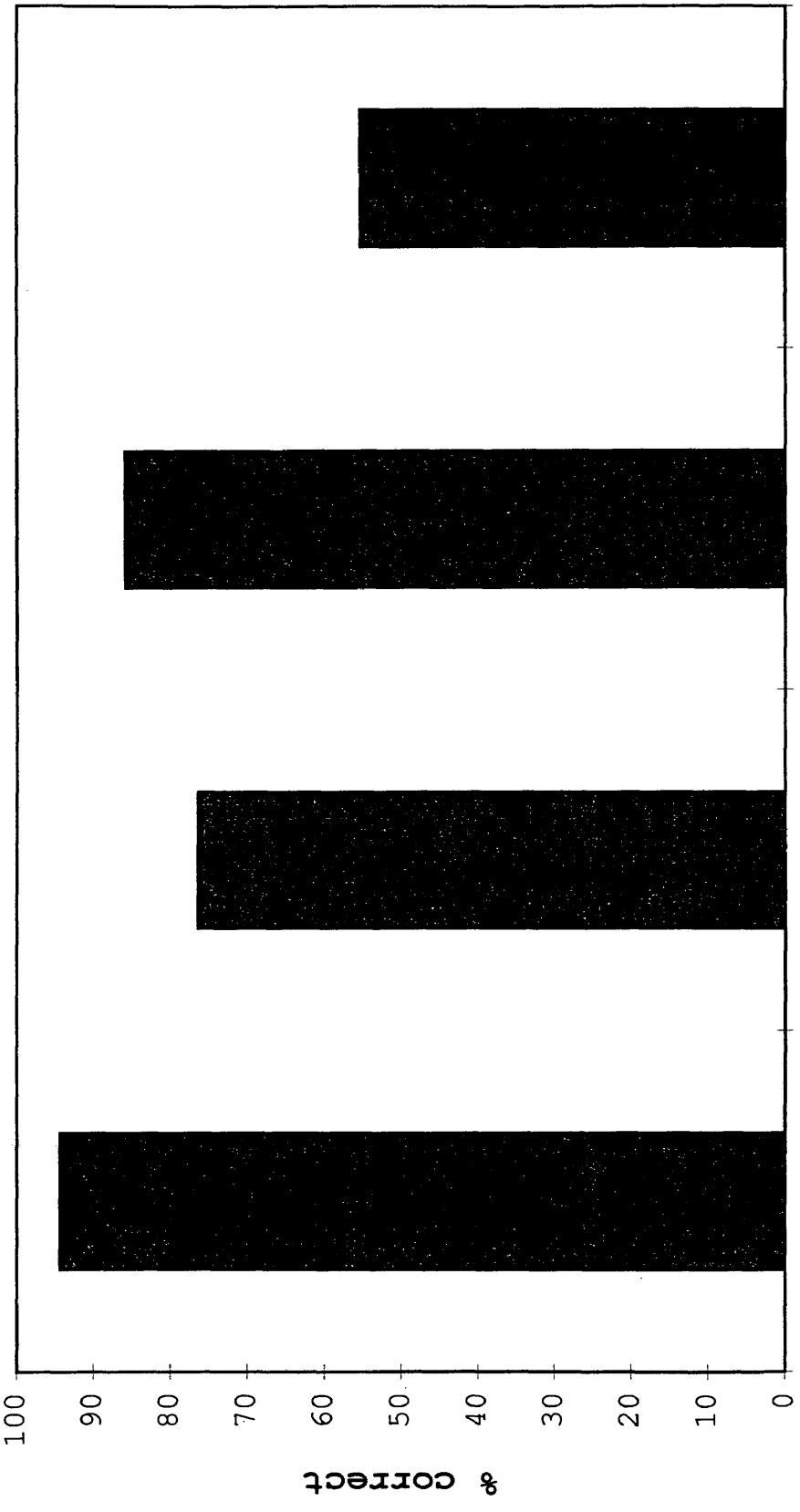

Figure 2. Performance on the Semantic Features Subtest of the Semantic Memory Test Battery.

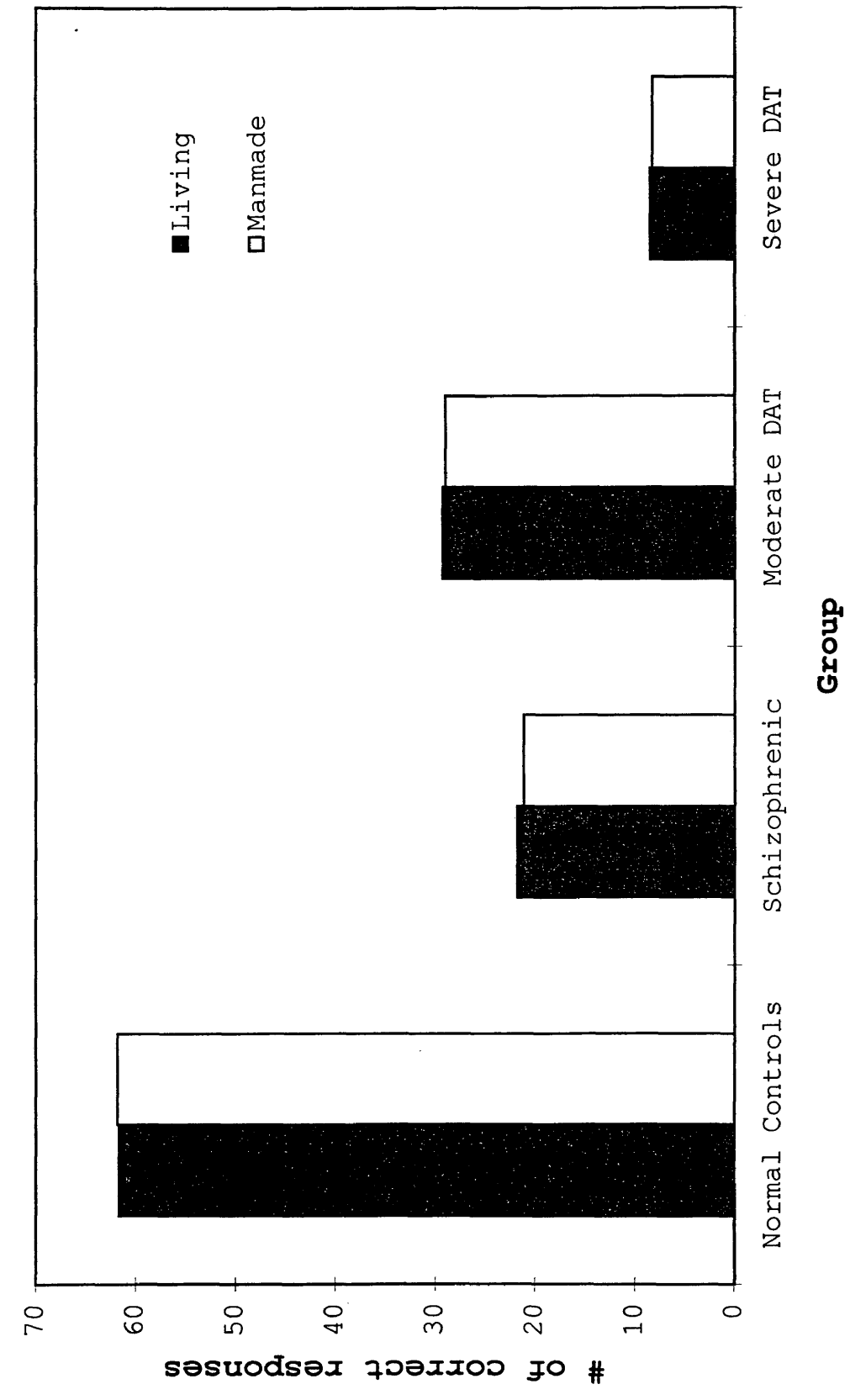

Figure 3. Performance on the Category Fluency Subtests of the Semantic Memory Test Battery.

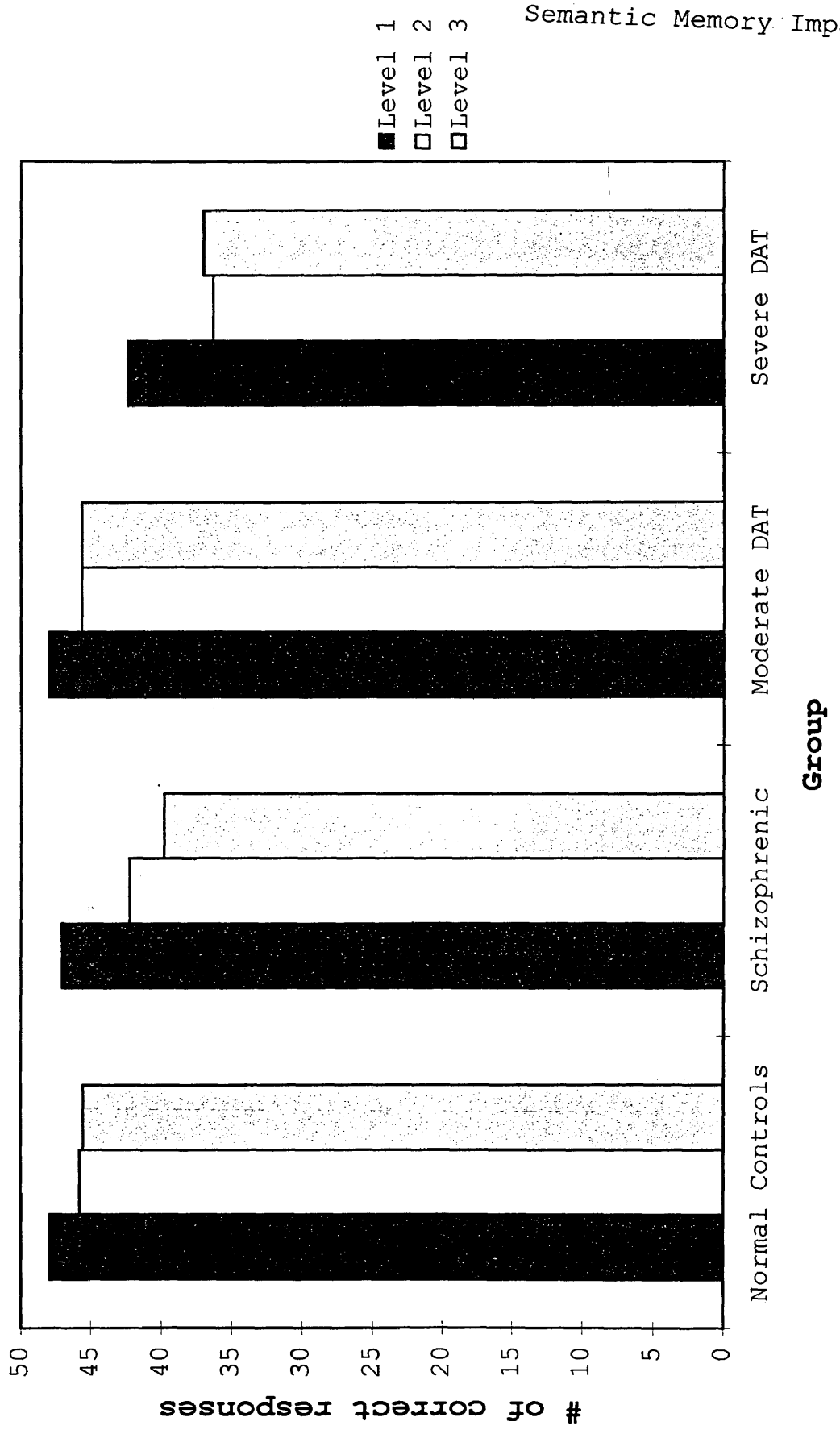

Figure 4. Performance on the Picture Sorting Subtest of the Semantic Memory Test Battery.

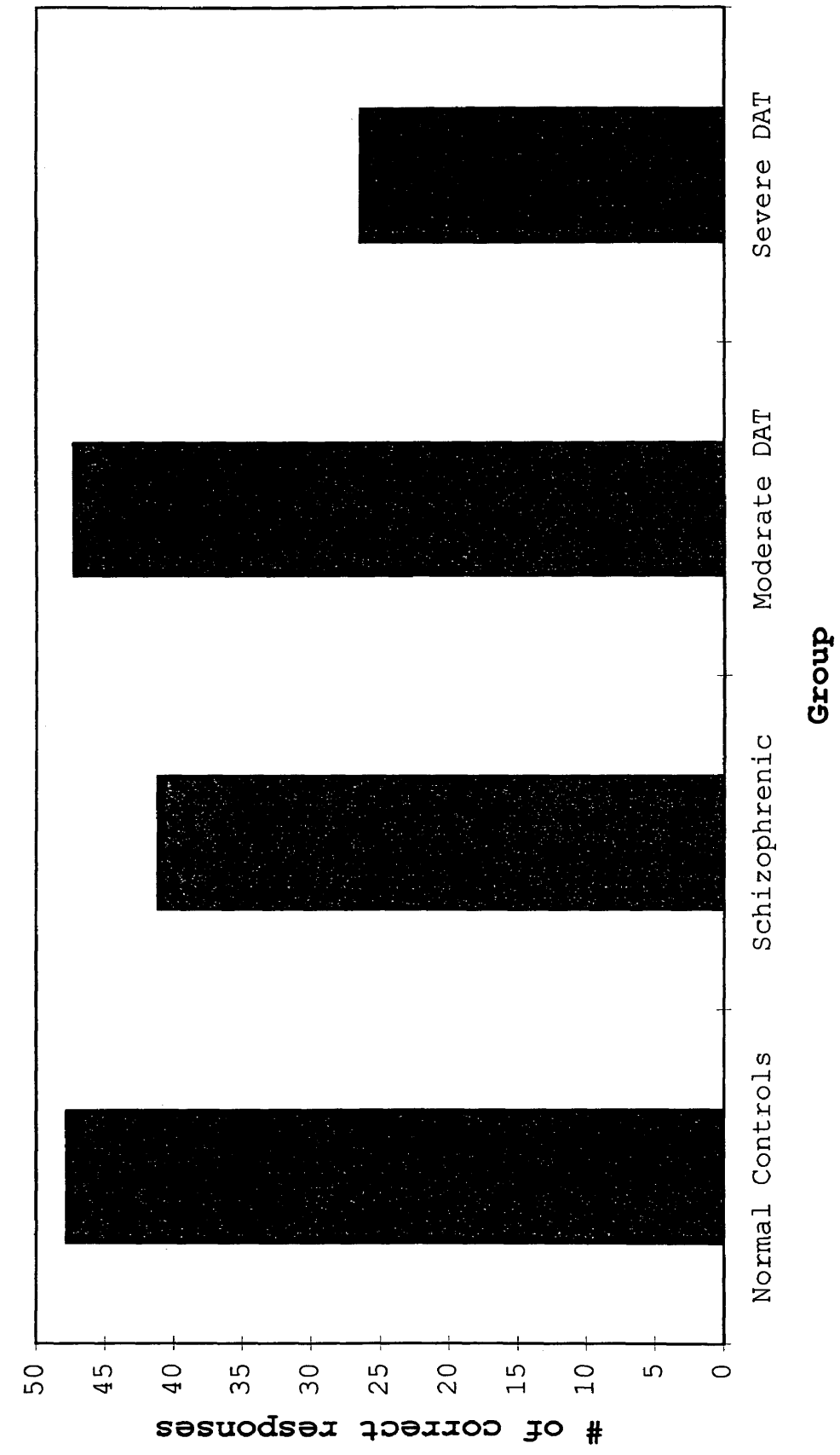

Figure 5. Performance on the Category Comprehension Subtest of the Semantic Memory Test Battery.

VITA

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