

A Neuropsychological Review of Dementia

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Abstract

Dementia is a neurological disorder resulting in the loss of multiple brain functions and has been increasingly diagnosed in the elderly and often presents in the form of Alzheimer's disease. This paper provides an overview of the medical history of dementia, the general signs and symptoms of the pathology of dementia specifically in memory and intellectual functioning, and a review of major studies focused on neuropsychological evaluations, cognitive functioning, and the aging process. Lastly, future recommendations for research are discussed as well as recommendations from a health psychology perspective.

A Neuropsychological Review of Dementia

As the aging population of the United States finds that they are living longer than previous generations, the concept of cognitive health and the prevention of cognitive deterioration becomes increasingly important and popular (Centers for Disease Control and Prevention and the Alzheimer's Association, 2007). Dementia, which refers to the neurological disorder resulting in the loss of multiple brain functions, is increasingly diagnosed in the elderly and often presents in the form of Alzheimer's Disease. Individuals diagnosed with forms of dementia find they suffer a loss in cognitive functioning, especially in areas such as language, thought, memory, judgment, attention, and functional skills such as hygiene or ability to drive a car (Centers for Disease Control and Prevention and the Alzheimer's Association, 2007). This disease is progressive and affects between 5-10% of North Americans with Alzheimer's disease accounting for approximately 75% of all documented cases with over \$100 billion in costs for caring for patients each year (Souder & Chastain, 2002).

The scientific field of neuropsychology works to assess symptoms of dementia as early as possible with the goal of facilitating patient and the caregiver's ability to identify resources and medical treatment depending upon the level of progression (Miller & Neil, 2006). This process is facilitated through the analysis of neuropsychological performance in areas such as intellectual functioning and memory. Current research has been focused upon the progress and success of using neuropsychological evaluations, assessing the aging process, and understanding cognitive functioning and the role these areas have with dementia (Siedlecki, Honig, & Stern, 2008).

Background

Historical Overview

Dementia is not a relatively new phenomena and it has been over 100 years since the first recorded case of Alzheimer's was documented in 1906 by Emil Kraepelin and, from a historical perspective, dementia can be viewed as progressing through three chronological periods (Ballenger, 2006). The first period can be referred to as the clinical and pathological foundations of the disease. During this time Kraepelin described the symptoms of a patient he had who was suffering from focal signs (perceptual and behavioral impairments) as well as hallucinations and delusions. Upon a post-mortem analysis Kraepelin was able to observe bundles of neurofibrillary tangles and he passed this report on to his student, Alois Alzheimer, who published the details in 1907 (Berrios, 1990).

The second historical period of dementia can be referred to as the psychodynamic model of dementia and occurred during the 1930s through the 1970s (Ballenger, 2006). This period was markedly noted by instability in properly diagnosing dementia due to social and financial pressures to institutionalize the elderly due to the expensive costs associated with allowing them to live independently versus the decreased costs of placing them in state run hospitals (Ballenger, 2006). However, interest in researching dementia began to increase and new treatment theories, such as psychotherapy, vitamin supplementation, and hormone treatments were tested with some success.

The current historical period of dementia is defined by a focus on the biological mechanisms of dementia (Ballenger, 2006). This period is noted by the research focused

and empirical evidence driven approach to diagnosing and treating those with dementia. Dementia now is characterized by a variety of pathological symptoms that are most notably observed by changes in intellectual functioning and memory capability (Balota, Cortese, Duchek, Adams, Roediger, McDermott, & Yerys, 1999).

Memory, Prose, and Logic

General signs and symptoms of the pathology of dementia often start with changes in memory and intellectual functioning that is noticeable, often first by spouses and caregivers, in the performance of daily activities (Allaire & Willis, 2006). This change in cognitive ability typically remains stable in adults who do not have dementia until they reach their eighties; however, the Everyday Problems Test for Cognitively Challenged Elders (EPCCE) has been used successfully to identify those who are at risk for decline of the traditionally fluid intelligence levels (Allaire & Willis, 2006). This can be a predictor for identifying patients that are at risk for dementia when early symptoms present.

In addition to the EPCCE, a memory test battery can be used to help determine early symptoms and predictors of dementia. In a study by Spann, Raaijmakers, and Jonker (2005) participants were selected from a large-scale population-based study of elderly individuals who did not have depression, any history of cerebrovascular accidents, or alternative causes for cognitive dysfunctions and they were administered a memory test battery twice with a time differential of 2 years. The test battery consisted of the 10-Word List-Learning Test, Digit Span Test, Word-Recognition Test, Paired-Associate Learning Test, Block Span Task, Word-Stem Completion Test, Category Fluency Test, Mirror-Reading Test, Perceptual Identification Test, Two-Alternative

Word-Recognition Test, and Visual Association Test with the goal of determining if there were any predictors of dementia. Upon analysis (analysis of variance with Bonferroni post hoc analyses) it was determined that the Paired-Associate Learning Test, the Perceptual Identification Task, and thirdly the Visual Association Test were predictors of the onset of dementia that presented in the group measured two years later (Spann, Raaijmakers, & Jonker, 2005). This suggests that a decline in cognitive memory functions can be a key indicator for the onset of future dementia.

Additional challenges noted in the pathology of dementia are associated with understanding events and encoding and retrieving memories. Dementia differs from age-associated memory impairment which is associated with a decline in executive function in the frontal lobes and is estimated to affect 38% of those ages 50 or older (Souder & Chastain, 2002). However, these individuals do not present with the same challenges with episodic memory recall as those with dementia. For example, events in memory and perception, which are suggested to be encoded in the functioning prefrontal cortex, were measured for individuals varying from young ($n = 24$, $M = 20.3$) to old ($n = 24$, $M = 78.0$) by presenting the groups with still pictures and measuring their temporal order capabilities by ordering events from the pictures onto a computer (Zacks, Speer, & Vettel, 2006). The analysis of variation demonstrated that older adults had substantially higher error rates with order memory, $F(1, 44) = 51.1$, $p < .001$. Adults with Alzheimer's disease have even greater demonstration of loss of order memory so these types of experiments can be used as indicators of dementia (Zacks, Speer, & Vettel, 2006).

Alzheimer's disease is not the only type of dementia that demonstrates memory challenges but it may be cited most often due to its predominance in diagnosis.

Frontotemporal dementia, which is similar to Alzheimer's disease but the degenerative changes are concentrated more in the frontal and anterior temporal lobes, results in memory encoding and retrieval issues (Glosser, Gallo, & Clark, 2002). Memory performance in frontotemporal dementia differs from Alzheimer's disease in that organizational or categorical cues, when presented to the patients, can result in greater recall performance than other dementias (Rogers, Ivanoiu, & Patterson, 2006). However, it is noted that this may be due to location of the pathology mainly residing in the anterior and lateral temporal lobes versus the medial temporal and dorsolateral frontal lobes as seen in Alzheimer's patients (Gustafson, 1987).

Additional symptoms of the onset of dementia can be documented by neuropsychologists when tests such as the Wechsler Memory Scale is administered to measure deficits in prose recall (Johnson, Storandt, & Balota, 2003). Logical memory errors are common in those with onset of dementia and this includes the lack of ability for word-for-word recall, incomplete verbatim responses when tested, and limited semantic responses. In an autopsy-confirmed research study patients suffering from Alzheimer's disease demonstrated significant impairment with distinguishing semantic categories and patients with frontotemporal dementia demonstrated significant challenges with both letter and semantic category discrimination, all which are related to verbal fluency impairment (Rascovsky, Salmon, & Hansen, 2007).

Adults with dementia have also demonstrated delayed recall when trying to reconstruct simple sentences as well as distorting the meaning of sentences (Johnson, Storandt, & Balota, 2003). Visuospatial functioning, which is the ability to copy or construct two or three dimensional pictures or figures, is also noted in

neuropsychological tests such as the Rey-Osterrieth Complex Figure as being associated with loss of functioning in the right posterior cortical area for those diagnosed with dementia (Freeman, Giovannetti, & Lamar, 2000). With this understanding of the historical development of the research associated with dementia as well as an overview of current research for identifying the pathology and symptomology associated with the onset of dementia, a more detailed literature review of current neuropsychology research is appropriate.

Literature Review

Neuropsychological Evaluations

Neuropsychological evaluations are used to work with patients and medical teams who to help screen and specify dementia and cognitive impairments. Neuropsychological evaluators do not necessarily manage the role of diagnosing a patient with dementia; rather, they are used in the function of assisting with treatment protocols as well as specification of areas of deterioration in dementia sufferers. For example, recent research has looked for rapid, systematic ways to assist with the diagnosis of dementia while eliminating age-associated memory impairment (Souder & Chastain, 2002).

Additionally, neuropsychological tests are beneficial in developing treatment strategies for dementia patients so that clinicians and families can work to plan and manage the course of the disease and the changes in care that will be required.

Research in dementia as developed rapidly over the years and the increase in neurological testing techniques has been a major contributor to this advancement. The complexities associated with distinguishing between normal cognitive aging and damage associated with the medial temporal lobe resulting in Alzheimer's disease was the topic

of a study by Anderson, De Jager, and Iversen (2006). In their study they looked to explore whether or not a neuropsychological test called The Placing Test could measure memory loss in a manner that was sensitive enough to detect early Alzheimer's disease in the pre-dementia phase. In the study 16 patients were used who had probable Alzheimer's disease with mild dementia and they were screened using the appropriate diagnostic criteria along with an equally populated ($n = 16$) and gender based (56% female) control group. The procedure was the administration of The Placing Test to both groups of patients in a quiet room in each patient's home. The results demonstrated that The Placing Test was able to significantly detect pre-dementia phased patients using independent samples t -tests, $t = 7.07, p < 0.0005$. The placing test had 91% accuracy in detection of those diagnosed with early Alzheimer's disease without any incorrect detection rate in the control group which suggests that this is a valid prediction tool for dementia.

A second, and very popular, neuropsychological test that is used to detect dementia is the Mattis Dementia Rating Scale. This test is well established in its construct validity and reliability to the extent that it has been used as the standard in which other cognitive decline neuropsychological tests, such as the Mini-Mental State Examination, the Modified Rey's Complex Figure, The Digit Span, and the ADAS Memory Scale, are benchmarked against to measure their criterion validity (Fernandez & Scheffel, 2003). The Mattis Dementia Rating Scale has been demonstrated to be effective in both normative population samples as well as those who are known to have significantly less education compared to the test standardization (Yochim, Bank, Mast, MacNeill, & Lichtenberg, 2003). The utility of the Mattis Dementia Rating Scale was

demonstrated using a population of cognitively intact ($n = 138$) and cognitively impaired ($n = 151$) elderly patients in a medical clinic. Logistic regression was used to assess the accuracy of the variables of age, education, gender, and race in predicting impairment from dementia (Yochim et al., 2003). The results demonstrated that there was not a statistically significant difference between age, education, gender, or race with regard to the Mattis Dementia Rating Scale's ability to predict cognitive impairment.

The Mattis Dementia Rating Scale has benefited neuropsychologists in their desire to detect dementia early with the goal of creating or managing treatment plans that can begin to benefit the affected patients as early as possible. In a study by Miller and Pliskin (2006) the progression of dementia was studied using the Mattis Dementia Rating Scale to help neuropsychologists define the clinical stages of cognitive decline. In this case the participants were individuals from a Midwest neurological center who had previously been diagnosed with Alzheimer's disease using the Mattis Dementia Rating Scale in addition to medical evaluations ($n = 63$). Sixty-three of the patients were administered the test two additional time and 33 of the patients were administered a third time. A repeated measures analysis of variance was use to determine if there were any changes in the performance on the tests which were completed approximately once a year ($M = 11$, $SD = 6.45$, and $M = 12.42$, $SD = 7.89$). The results of the study demonstrated that there was a significant effect for time regarding the decline in performance (women slightly worse than men) specifically occurring between the second and the third follow up tests, $F(2, 58) = 3.01$, $p = .05$. The test results demonstrated a decline in attention, initiation and perseverance, construction, conceptualization, and memory (Miller & Pliskin, 2006). The benefit of this study is that it brought two interesting facts to light.

The first is that patients suffering from dementia experience a plateau in the progression of cognitive decline and then substantially experience decline. The second conclusion is that patients who were under the age of 70 that participated in the study had lower scores in areas such as initiation/ perseverance and construction subscales than did those that were over the age of 70 which demonstrates that age was not a determinant in decline.

The studies just discussed have a common research theme in that the effective ability to detect probable Alzheimer's disease versus aging related cognitive decline in that memory and learning tests can be predictors in the onset of the disease as well as the progression timeline. One opposing viewpoint was presented by Siedlecki, Honig, and Stern (2008) in that there was a third category introduced in addition to age related cognitive decline and early stages of Alzheimer's disease which is called questionable dementia. In this study questionable dementia (QD) was inserted as a population group to be measured in a neuropsychological battery in addition to the control group (demonstrating no signs of dementia) and the group with Alzheimer's disease. In this study the diagnosis of QD was determined when the patient had sufficient cognitive decline to be diagnosed with dementia according to the Diagnostic and Statistical Manual of Mental Disorders, yet they did not demonstrate functional impairment to qualify as having dementia. The reasons this opposing viewpoint is interesting is that if it is accepted, it changes the manner in which the disorder is classified in the prior studies.

Cognitive Functioning

An equally important topic in recent literature surrounding dementia is focused on cognitive functioning and how this contributes to the diagnosis and progression of the diseases. Mild cognitive impairment is prevalent for approximately 16-25% of those

ages 65 and older in the United States and Canada (Centers for Disease Control and Prevention and the Alzheimer's Association, 2007). Although all individuals experience durable and systematic changes in their cognitive status which may result from learning or developmental changes as well as changes in health, individuals also experience more subtle changes, called intraindividual variability, in their cognitive performance (Hultsch, MacDonald, & Hunter, 2000).

A study by Hultsch, MacDonald, and Hunter (2000) decided to investigate if there was any significance in these small cognitive changes in adults with and without dementia as they noted that most literature focused upon the significant milestone changes, such as the Miller and Pliskin (2006) study described above. The study consisted of 13 individuals diagnosed with mild dementia, 17 individuals who were neurologically normal but suffered from osteoarthritis, and 15 healthy adults. Data was collected for all three groups in four separate settings by administering several neuropsychological tests including the Mini-Mental State Examination, the Wechsler Adult Intelligence Scale, the North American Adult Reading Test, and the Full Scale IQ test. Additionally, data was collected with the goals of measuring reaction time for computer based signal stimuli as well as episodic memory and then performing analyses of variation on participant groups, occasions, and tests. The results demonstrated that individuals with dementia experience greater intraindividual variability on cognitive tasks in comparison with those not experiencing neurological disturbances or those with osteoarthritis. The value of this research is that those suffering from dementia experience small changes on a frequent level which can contribute to greater behavioral variation in day to day activities.

A second important contribution to neuropsychological related dementia research is a meta-analysis study conducted by Bäckman, Wahlin, Small, Herlitz, Winblad, and Fratiglioni (2004). This comprehensive study was a review of empirical studies conducted in a community based project entitled the Kungsholmen Project which was a longitudinal study of aging and demented persons starting in the year 1987 and extending multiple years depending upon the specificity of the study. This meta-analysis came to six conclusions regarding cognitive functioning and decline which were: a) gradual age related deficits in fluid tasks continue to occur in patients with dementia as well as in normal cognitive functioning elderly, b) even the elderly in their 90s still retain the ability to improve cognitive performance in areas of the brain that are not damaged or impacted by dementia, c) individual variations such as education, sex, vitamin and nutritional consumption behaviors, or depressive symptoms do have an impact upon age-related differences in cognitive functioning, d) higher cognitive functions such as memory, visuospatial skills, and verbal abilities draw upon complex and widely neurological distributed systems resulting in similar impairments between those suffering from different forms of dementia, e) the symptoms of dementia overshadow the onset of additional age related challenges such as depression and unfortunately may be left untreated and f) detectable cognitive deficiencies present in the preclinical phase of Alzheimer's disease remain stable and long-term until a severe decline in cognitive functioning occurs (Bäckman et al., 2004). The implications of this study are substantial in that they provide stable predictors of how dementia occurs as well as raising awareness to more subtle influences on the overall cognitive performance of patients.

An opposing viewpoint regarding cognitive functioning was presented by Amieva, Lafont, Auriacombe, Le Carret, Dartigues, Orgogozo, and Colette (2002) regarding the breakdown of the inhibitory processes that occur in the early stages of dementia. The previously described studies support a theory that there is an overall decrease in inhibitory processing that is associated with the onset of dementia and that this process occurs in a graduated and possibly consistent manner, most plausibly due to an overall decline in a general inhibitory mechanism. The authors took a different perspective in testing their opposing viewpoint in that inhibitory functioning does not decline in a general manner in patients with dementia; rather, it occurs in a manner that is not consistent nor uniformly distributed (Amieva et al., 2002). A sample population of 28 patients with dementia with a mean age of 75.8 ($SD = 6.1$) were given a battery of neuropsychological tests including the Mattis Dementia Rating Scale, MMSE, Benton Visual Retention Tests, Boston Naming Test, Forward Digit Span, and Isaacs Set Test in addition to a battery of inhibitory tests including the Stroop test, Go-No Go Task, and the Stop Signal Paradigm to test the hypothesis that decline in inhibition is not consistent. Using a nonparametric Wilcoxon test ($p = .03$) the authors were able to demonstrate that the inhibitory processes in patients with dementia were not uniformly impaired. This leaves room for further research to investigate why certain inhibitory processes are affected to a greater or lesser extent as dementia progresses.

The Aging Process

A great deal of research has surrounded how neuropsychological testing has demonstrated its ability to predict and measure dementia and how a decline in cognitive processes can be measured on both macro and micro levels, but equally important is the

body of research surrounding the aging process in dementia. For example, in a study by Lövdén, Bergman, and Adolfsson (2005) looked to understand the typical paths of cognitive aging and terminal decline in patients with and without dementia while determining if any paths of decline were individually driven. Specifically, the authors felt there was a gap in research surrounding an individualistic approach to understanding cognitive decline and they preferred an approach that would investigate aging from a perspective that saw individuals as variable systems whose states are dynamic rather than stable (Lövdén, Bergman, & Adolfsson, 2005). The population sample for this study consisted of random sample of 500 adults in five age groups (60, 65, 70, 75, and 80) with 100 participants in each group. Neuropsychological tests consisting of Block Design, MMSE, and tests regarding episodic memory and semantic memory were administered and measured three times, five years apart. Upon the last testing period there were 225 participants. Using a computerized clustering statistical analysis, the experiment supported the authors' hypothesis that aging and related cognitive decline are individual in nature and not systematically defined by age.

A study conducted by Kemper, Thompson, and Marquis (2001) regarding the effects of aging on dementia presented an opposing view to the individualistic role of aging presented by Lövdén, Bergman, and Adolfsson (2005). An assessment of decline in language production in healthy older adults and older adults with dementia was conducted with the goal of determining if rates of cognitive decline were uniform across time. The participants in this longitudinal study were 30 healthy adults (determined by MMSE) ranging in age from 65 to 75 who were recruited by a newspaper solicitation. They were tested for grammatical complexity, propositional content, digit span, and

vocabulary over a 15 year period and their results were statistically analyzed using a model to indicate the relationship between aging and the outcome as well as a cubic model to depict marked declines and gradual declines associated with aging (Kemper, Thompson, & Marquis, 2001). Their results concluded that patients diagnosed with Alzheimer's disease see a marked acceleration in decline in ability for grammatical complexity and an overall decline related to age group. This suggests that there are systematic age related changes and dementia related changes associated with cognitive decline.

Conclusion

There is a great deal of research surrounding dementia in the areas of neuropsychological evaluations, assessing the aging process, and understanding cognitive functioning in association with dementia. Based upon this literature review, four areas of future research are needed to contribute to the neuropsychological understanding of dementia. Menec (2003) noted that participation in cognitively stimulating activities is can reduce cognitive decline and risk of dementia (Menec, 2003). Future studies to measure exactly what stimulating activities can reduce cognitive decline (such as determining if reading, writing, crossword puzzles, or working on hobbies, best assists in the reduction of decline) would be beneficial. A second area for future research was noted by Johnson, Storandt, and Balota (2003) regarding how the nature of errors associated with declines in prose recall with dementia has not been well studied. A third area for future research was noted by Freeman, Giovannetti, and Lamar (2000) as they found that visuospatial functioning in dementia is not well researched. A fourth area for future research would be working to understand neuropsychological identification

strategies for early markers of dementia as this can help the development of treatment strategies for both the patient and the caregiver (Marsh, Balota, & Roediger, 2005).

From a health psychology perspective, this literature review has presented several secondary topics that could benefit from additional research. For example, the relationship between the biological and neurological symptoms of dementia with the resulting behavioral changes in the patient could be investigated in further detail (Garand, Buckwalter, & Hall, 2000). The behavior of a person suffering from dementia can change rapidly, as demonstrated by the intraindividual variability in cognitive performance described prior by Hultsch, MacDonald, and Hunter (2000). This information would be value if it was worded in a manner that can prepare the caregivers for the behavioral changes they may observe.

An additional area of interest to health psychologists reducing the long term health care costs of dementia by streamlining treatment and testing procedures (Logsdon, McCurry, & Teri, 2007). This could be accomplished by gaining a better understanding of the progression of the symptoms associated with dementia and developing social support networks for patients and their families (Aalten, de Vugt, Jaspers, Jolles, & Verhey, 2005). Lastly, the Center for Disease Control in conjunction with the Alzheimer's Association has developed a program entitled the National Public Roadmap to Maintaining Cognitive Health with the purpose of raising awareness about cognitive health and cognitive decline (2007). This project should be beneficial to increase discussions between healthcare providers, patients, neuropsychologists, and caregivers with the effort of incorporating current research findings into health management plans for those suffering with dementia.

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