

Degradation of the Mental Lexicon? A Study of Object Naming Impairment in Alzheimer's Patients

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Abstract

Alzheimer’s disease (AD), although most often associated with memory loss, causes linguistic impairment. One of the earliest symptoms of AD is decreased performance on object naming assessments, and researchers sometimes equate this with a degrading mental lexicon. However, object naming tasks are demanding in terms of executive functions such as perception and attention, and degradation of these abilities could cause object naming difficulty. This study investigated whether the object naming impairment in AD patients is the result of a degrading mental lexicon or difficulty accessing lexical items. It also explored what sorts of stimuli promote lexical access in AD patients. To answer these questions, the study recruited 5 participants with mild to moderate AD and their cognitively normal spouses to act as demographically and age-matched controls. All subjects were given an object naming task and a photograph description task; their performances on the tasks were compared. In addition, the photograph description task included semantic and phonemic clues for items that subjects were unable to name through the context of the photograph. These clues gave insight to what sorts of stimuli AD subjects need for lexical access. The results did not show increased performance on the photograph description task and were unable to determine if the mental lexicon of AD patients is intact.

1 Language Difficulties in Alzheimer’s Patients

One of the first linguistic impairments seen in Alzheimer’s disease (AD)¹ is an object naming deficit (Appell, Kertesz, and Fisman 1982). Currently, the fields of psychiatry, neurolinguistics, and neuropsychology debate over whether or not inability to name an object should be equated with lexical item loss. Some researchers argue that object naming impairments are the result of the degradation of the mental lexicon (Huff et al 1986). Others attribute the problem to lexical retrieval difficulties caused by the loss of executive functions such as attention and perception (Ober and Shenaut 1988). The current study aimed to determine whether the mental lexicon of AD patients remains intact. If it found an intact mental lexicon, it secondarily aimed to determine what sorts of stimuli facilitate object naming in AD patients. This experiment compared performance on the object naming component of the cognitive subscale of the Alzheimer’s Disease Assessment Scale (ADAS-COG) (Rosen 1984) to a photograph

¹All mentions of Alzheimer’s disease (AD) throughout this paper refer to probable AD. Because the diagnosis of AD is reliant on the presence of neurobiological markers, certain diagnosis requires an autopsy. Instead, the diagnosis of probable AD means that a patient has performed at the level expected of an AD patient on various neuropsychological assessments. Most diagnoses also include some type of imaging that suggests the presence of the neurobiological markers.

description task. It also provided increasingly specific clues during the photograph description task to determine what types of stimuli allow AD patients to access lexical items that cannot be produced during an object naming task.

2 What's Goes Wrong in AD?

Alzheimer's disease is a neuropathology thought to be caused by beta-amyloid plaques and neurofibrillary tangles that kill brain cells and create lesions (Mayo Clinic Staff 2014). Although each patient progresses differently, the path on which the disease spreads through the brain is largely the same. A basic understanding of the progression of AD and its effect on cognitive abilities as a whole informs hypotheses about linguistic deficits exhibited by AD patients.

In a "pre-Alzheimer's" stage known as mild cognitive impairment (MCI), lesions start to appear around the hippocampus, causing short-memory loss. Patients with MCI experience word finding difficulties. They also have trouble managing bills and accounts, planning and organizing, and misplacing valuable items (Northwestern University 2015). After about seven years, lesions spread to the temporal and parietal lobes and patients are diagnosed with mild AD. MCI symptoms worsen and patients have difficulty remembering new names and reading material as well as acting appropriately in social settings. They exhibit behavioral changes and become more aggressive and self-centered compared to aging normals (Rubin et al 1986). Map-making centers in the brain begin to break down and AD patients take longer and make more errors when completing trail making tests (Ashendorf et al 2008). Object naming becomes significantly impaired and is often accompanied by circumlocutions, in which patients give functional or perceptual information about an object but are unable to name it (Hodges et al 1992). For example, an AD patient asked to identify a watch might call it a "time keeper" or say that it has numbers but cannot produce the word "watch."

This changes when the lesions spread to the frontal lobe and patients enter the moderate stage of the disease; circumlocutions stop and patients simply respond “I don’t know” when asked to name objects (Hodges et al 1992). In photo description tasks, they produce empty speech (Nicholas et al 1985). Further loss of working memory results in comprehension difficulties (Small et al 2007). Additionally, moderate AD patients experience forgetfulness about their personal histories, personality and behavioral changes such as suspiciousness and compulsiveness, and changing sleep patterns (Alzheimer’s Association 2015). In its final, severe stage, AD attacks the occipital lobe, and patients experience loss of vision and motor skills. They become incapable of performing everyday tasks and require full-time care as they lose the ability to recognize their surroundings. This lack of awareness coupled with worsening speech production and comprehension makes any communication difficult. (Alzheimer’s Association 2015). Figure 1 below gives a summary of the stages of AD and their associated symptoms.

(1) Figure 1

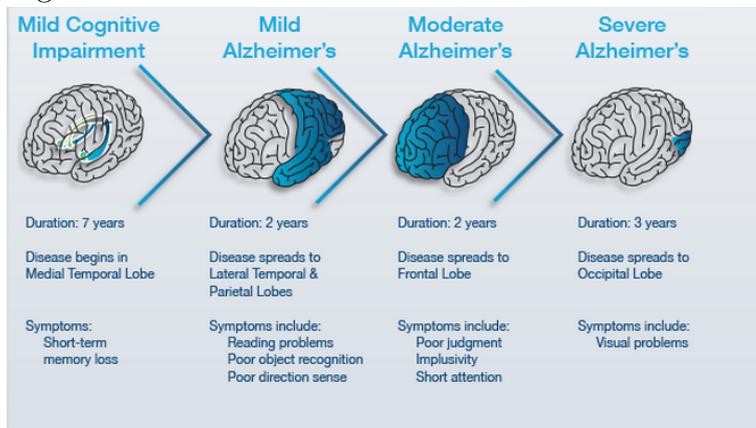


Image taken from: <https://www.mccare.com/education/alzprogression.html>

2.1 Language

The first step in forming a hypothesis about whether or not the mental lexicon of AD patients is degraded is determining what part(s) of the lexical retrieval process cannot be completed. One can imagine three levels at which lexical retrieval could be incomplete and ultimately result in an inability to produce a word - the perceptual level,

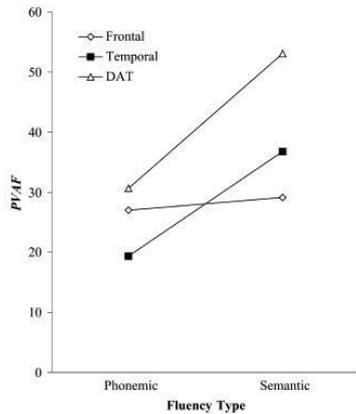
the phonological level, and the semantic level. At the perceptual level, AD patients may not be able to recognize general characteristics in objects. For example, they may not perceive the circular face and numbers on a watch, making them unable to search their mental lexicon for a word with these features. An interruption at the phonological level would be either an inability to match a semantic concept with phonological information or difficulty processing phonological information through motor areas to produce words. Finally, a semantic level failure would be an inability to use perceived information to find a semantic concept.

Studies suggest that the problem is not perceptual. As noted above, mild AD patients exhibit circumlocution (Hodges et al 1992). Patients who are shown a telephone might say that it "has numbers" (Dementia Assessment 2012) or a patient shown a cactus will say that it is a "bush that grows in the desert that is prickly" (Holmes et al 2006). Circumlocutions in the form of perceptual characteristics show that object naming impairments in AD patients are not caused by a problem at this level.

If lexical retrieval is not interrupted at the perceptual level, then problem is at the phonological or semantic level. There is evidence that the problem is not phonological; when AD subjects are given the first few phonemes of a word during an object naming task, their performance increases to that of the level of aging normals (Balthazar et al 2008). This leaves the semantic level as a possibility for lexical retrieval interruption, and previous studies have found that semantic fluency is significantly more impaired than verbal fluency in AD subjects (Thornton et al, Rosen 1980, Monsch et al 1992, Henry et al 2004). In three of these studies, subjects were given a semantic fluency test that asked them to name as many animals as possible in 60 seconds and a verbal fluency test that asked them to name as many words that started with a certain letter as possible in the same amount of time. The results showed that, although both types of fluency are significantly impaired compared to aging normals, semantic fluency was much more impaired (Thornton et al, Rosen 1980, Monsch et al 1992). Figure 2 below, taken from a meta-analysis of 153 studies, shows this. This study also compared semantic fluency in AD subjects to other cognitive measures includ-

ing psychomotor speed and verbal intelligence and found that it was also significantly impaired compared to these measures (Henry 2004).

(2) Figure 1



This figure is taken from a meta-analysis of 153 studies with over 15,000 participants. It shows the percentage of variance on semantic and verbal fluency tests (compared to aging normals) that can be attributed to dementia. AD is represented in the top line, which is labeled as DAT. The graph shows two important findings; first, AD subjects perform worse than aging normals on both verbal and semantic fluency tests. Second, it shows that within AD subjects, semantic fluency is more impaired than verbal fluency (Henry 2004).

Overall, previous studies that attempt to pinpoint lexical retrieval issues in AD patients find that they occur at the semantic level instead of the perceptual or phonological one. From here, the search turns to focus on the semantic part of lexical items; it asks whether AD patients have lost the semantic concepts that make up part of lexical items or if they have difficulty accessing these concepts.

3 Semantic Degradation or Lexical Access?

Existing research offers competing theories about why AD patients perform poorly on object naming assessments. One suggests that AD patients lose the semantic concepts that make up lexical items, and exhibit object naming deficits because they are losing parts of their mental lexicons (Hodges et al 1991, Huff et al 1986, Squire et al 1992). The other widely argued theory is that AD patients maintain their semantic memory and mental lexicon but experience difficulties in accessing it; this theory claims that

the task of object naming is too demanding on executive functions such as attention, semantic searching, and overt retrieval (Ober and Shenaut 1988, Nebes 1989). The following sections evaluate evidence for these theories and argue in favor the lexical access theory.

3.1 Abnormal but Intact Semantic Priming

Multiple studies have shown that AD patients exhibit abnormal but intact semantic priming (Ober and Shenaut 1988, Albert and Milberg 1989, Balota et al 1999, Giffard et al 2001). Though all of these studies examined lexical decision times in related and unrelated word pairs, they produced different results. One found slower reaction times in AD subjects as compared to aging normals (Albert and Milberg 1989) and another found no significant difference when making the same comparison (Ober and Shenaut 1988). Most interestingly, using the same task, two studies found hyper-priming effects in which AD subjects were actually faster than both young and old healthy controls in making these lexical decisions (Balota et al 1999, Cherkow et al 1999). Unable to arrive at a consensus, researchers began to attempt to explain these results. In 1995, Ober and Shenaut wrote a critique of using semantic priming through lexical decision as a method for studying semantic memory in AD. They claimed that these tasks required executive functions, namely attention, that are known to be degraded in AD, and thus could not produce reliable facts about semantic memory. Along with this, there was a lot of variation between subjects in the studies they evaluated. From this they concluded that priming effects in AD subjects could not be generalized because they varied significantly on an individual level. Whether or not the studies made use of semantic priming correctly, an observation across all findings was that AD subjects make fewer errors in the related prime condition of lexical decision tasks. If AD subjects are able to make these connections between words, their semantic memories and therefore their mental lexicons must be at least partially intact.

3.2 Patterns in Word Loss

Although AD follows a certain path as it spreads through different areas of the brain, it attacks neurons randomly within those areas. One would then expect that, if the semantic memory and mental lexicon are degrading, words would be lost randomly as the neurons that house them are destroyed. However, this is not case. A body of research has shown that age-of-acquisition is a good predictor of when an AD patient will lose a word on object naming tests; the loss of words follows the opposite pattern of the acquisition of them (Hirsh and Funnell 1999, Silveri et al 2002). Other factors including living versus non-living objects, frequency, and perceptual versus functional attributes show patterning in word loss (Zannino et al 2006, Rosen 1980, Duarte and Robert 2014). These observations and studies will be discussed at length in the next section.

3.3 Neurobiology

The neurobiology and progression of AD offers evidence in favor of the lexical access theory in mild AD patients. Semantic memory is believed to be stored mainly in the prefrontal cortex in a system that parallels the organization of the sensory and motor systems (Martin and Chao 2001). Damage to the prefrontal cortex is seen in the later stages of AD but object naming deficits are seen in the earliest stages. This suggests that semantic memory and mental lexicon degradation are not responsible for object naming deficits in mild AD patients. Furthermore, lateral temporal areas are thought to contribute to lexical retrieval (Martin and Chao 2001). These areas are lesioned during the mild stages of AD, and this would account for lexical access and object naming difficulty but not mental lexicon loss.

4 What Facilitates Object Naming?

In an attempt to explain the hyper-priming results in some of the studies described above, researchers began to look at the characteristics of word pairings and found

that different types of relatedness produced different lexical decision speeds (Giffard et al 2001, Laisney et al 2011, Rogers and Friedman 2008). These studies found that hyper-priming does exist in AD subjects but only in cases where the words are related in specific ways. The landmark study in this area is Laisney et al 2011, which tested lexical decision speed when subjects were given word pairs of two animals that were related in different ways. In one condition, the animals were distantly related and had many characteristics to differentiate them. An example stimulus is elephant:crocodile; one can think of many ways in which these animals differ. The other condition contained word pairings in which the animals differed by one distinctive attribute. For example, lion and tiger were paired because they differ in the fact that a tiger has stripes. The study found that AD subjects made lexical decisions at the same rate as aging normals in the distantly related condition and faster than both aging normals and young healthy subjects in the distinctive attribute condition.

Research about how relatedness affects semantic priming and lexical decision speed paved the way for studies about how semantic characteristics might affect performance on object naming tasks (Zannino et al 2006, Rosen 1980, Duarte and Robert 2014). The first of these studies to produce significant results found that AD subjects are better at naming non-living versus living objects (Zannino et al 2006). The study asked AD subjects to name pictures of tools and animals and found that they were significantly better at naming tools. The researchers explained this discrepancy on the basis of frequency; they claimed that AD subjects interact with non-living objects more often than living ones, and, thus, are better at naming them. This theory is in line with a previous study that found AD subjects are better at naming frequent versus infrequent objects ²(Rosen 1980).

A recent study challenged the living versus non-living paradigm and claimed that the results of Zannino et al 2006 could be explained on a perceptual versus functional level (Duarte et al 2014). The new study asked AD subjects and aging normals to

²Throughout this discussion, frequency refers to how often the subject is likely to encounter the object. This differs from the traditional linguistic view of how often they use or comprehend the word.

name pictures that varied on the levels of living versus non-living and perceptual versus functional. It replicated the results of Zannino et al 2006 and found that AD subjects perform particularly poorly when naming living objects. On top of that, it found that AD subjects were better at naming pictures that contained functional information than ones that contained perceptual information. These results are in line with previous research that has found that AD subjects commit fewer errors on action naming tests than object naming ones (Ober and Albert 1986, Robinson 1999, Druks et al 2006). All of these studies taken together suggest AD subjects have the greatest success rate at naming non-living objects with functional characteristics.

5 Current Task

The current task aims first to determine if the mental lexicon of AD subjects who present with object naming impairments is still intact and second to determine what types of stimuli beyond single object presentation allow AD subjects to access lexical items. The task first determines a baseline object naming impairment by administering the object naming component of the cognitive subscale of Alzheimer’s Disease Assessment Scale (ADAS-COG)(Rosen 1984). In this assessment, subjects are presented with twelve real objects, one at a time, and asked to name them.

The study then administers a photograph description task in which subjects are presented with a photograph depicting an object from the ADAS-COG and an action being performed with or upon that object. These pictures give both context and functional information about the object, which has previously been proven to increase object naming performance (Duarte and Robert 2014). In the event that the photograph does not facilitate lexical access, the subject is provided with increasingly specific clues to assist with object naming.

Subjects who do not name target objects from the photographs alone are given a verbal semantic clue that tells them the action in the picture along with a semantically related noun that can be seen in the picture. For example, the semantic clue for

the photograph of a girl using scissors is 'The girl is cutting paper with something.' Correct object naming at this point is interpreted as evidence that the mental lexicon is intact and accessible through the semantic pathway, but lexical access requires an overt semantic clue.

Finally, subjects who cannot name the object in the first two conditions are given a phonemic clue that consists of the first sound of the correct object and a word semantically unrelated to the target object that starts with both the same sound and letter. For example, the clue for comb is 'k' as in cake. Data that reports correct object naming at this point will be interpreted as evidence that the mental lexicon is intact but AD subjects require phonological information for access.

5.1 Innovation of the Current Study

Neither critiques of object naming nor photograph description tasks are new to the study of language in AD. However, testing the same target words under both object naming and photograph description tasks is novel. Other studies have critiqued object naming but did not use the same target words as object naming assessments to do so (Balthazar et al 2008, Giles et al 1995). Picture description tasks have also been seen in the AD literature before, but the studies focused on how much semantic information subjects could provide not if they could produce target lexical items (Giles et al 1995, Zurick et al 2011). The current study offers a new critique of object naming by attempting to elicit the same target items as the ADAS-COG, which is a widely accepted assessment in the field of neurology. It also investigates the strength of the picture description task by using it to target specific lexical items in AD subjects rather than general semantic concepts.

6 Methods

6.1 Subjects

6.1.1 AD Subjects

Five subjects previously diagnosed with AD participated in the study. They were recruited from the Yale Alzheimer's Disease Research Unit (ADRU), where they were concurrently enrolled in clinical trials. Due to their enrollment in these trials, other possible pathologies were eliminated. All subjects had normal or corrected-to-normal vision and spoke English fluently. Written informed consent, or assent in necessary cases, was obtained in accordance the standards set forth by the Yale Human Investigation Committee. Consent was obtained by a certified staff member at the Yale ADRU, and the same staff member determined cases for which assent was necessary. Each subject was paid five dollars upon completion of the study.

6.1.2 Controls

A total of five controls participated in the study. They were recruited from the Yale ADRU, where they were the cognitively normal study partners of AD subjects. In all cases, the controls were the spouses and full-time caregivers of the subjects in the AD condition, which provided a close demographic and age match. Subjects were free of all neuropathologies, cognitive disorders, and head injuries by self report. After a consent was signed, the Geriatric Depression Scale was administered; no subject scored in a range that was consistent with depression. All subjects had normal or corrected-to-normal vision and spoke English fluently. Written informed consent was obtained by a certified staff member at the ADRU and in accordance the standards set forth by the Yale Human Investigation Committee. Each subject was paid five dollars upon completion of the study.

6.2 Task 1 - Screening

The screening task consisted of the object naming component of the cognitive subscale Alzheimer's Disease Assessment Scale (ADAS-COG)(Rosen 1984). For subjects in the AD condition, the entire ADAS-COG was completed on the same day as the current experiment as part of the clinical trial in which the subject was enrolled. Subjects who scored less than 12/12 on the object naming were asked to participate in the current study by releasing their ADAS-COG scores and completing a second assessment. If a subject met criteria and consented to the study, his or her cognitively normal study partner was asked to participate in the healthy control condition. Subjects in the control condition did not undergo the ADAS-COG as part of a clinical trial, so they were given only the object naming component of the assessment. Task 1 did not act as screening for control subjects; they participated in Task 2 regardless of their score on this task.

In the AD condition, the ADAS-COG was administered by a rater from the Yale Alzheimer's Disease Research Unit (ADRU) who had been trained and certified in the administration of the assessment. Raters were taken from a pool of three ADRU research assistants and determined by the guidelines set forth by the clinical trials in which the subjects were participating.. Because the ADAS-COG has strict scoring methods, this variation in raters is not considered a confound. The object naming component of the ADAS-COG in the control condition was administered by the current author. Although she is not trained or certified in the administration of the assessment, she has spent over six months observing research staff perform the assessment and is highly familiar with it. For this task, subjects sat at a table directly across from the rater in a quiet room free of distractions. The rater held an object in front of them at eye level and asked the subject, "Can you tell me what this is?" If the subject responded with the target word, the rater scored the item as 1 and moved to the next object. If they did not produce the target word, the rater scored the object as 0. There were 12 objects in total, and they were presented in a random order chosen by the rater.

6.3 Task 2

If the subject qualified for the current study under the conditions listed above, he or she completed a picture description task. In this task, the subject sat at a table directly across from the rater³ in a quiet room free of distractions. The rater presented the subject with an 8 inch by 10 inch color photograph that depicted an action that makes use of an object from Task 1 and asked the subject to describe the photograph. The task began with two training photographs. For the first one, the rater presented the subject with a photograph of a girl lighting a candle and described it to the subject. She then presented the subject with a picture of a boy catching an American football⁴, which can be seen in Figure 3 below, and asked the subject to describe the photograph. If they could not, the rater provided subjects with a semantic clue that consisted of one noun and one verb that were related to the target object. For this training photograph, the semantic clue was "The athlete is catching something." If subjects were unable to produce the target item after this, they were given a phonemic clue consisting of the first phoneme of the target object and a semantically unrelated word that began with the same phoneme. For this training photograph, the phonemic clue was "It begins with 'b' as in bank."

(3) Figure 3



Image taken from: <http://galleryhip.com/catch-a-ball.html>

Because the study predicted that some participants would be unable to name target objects, it did not require subjects to successfully complete the training items. If subjects did not produce the correct word for either training photograph, the rater re-explained the task and went through the second training photograph again, this time

³Although the raters varied in the AD condition for Task 1, the current author was the only rater for both conditions in Task 2.

⁴Ball, football, and American football were all considered acceptable correct answers.

providing the correct word at the end if the subject was unable to do so. If subjects did not provide the correct word, the rater insured his or her understanding of the task by asking them what question they were answering. If subjects could answer this question correctly, they moved onto the test items. If the subjects could not answer this question, they were considered unable to understand the task and excluded from the study. After the two training photographs were presented and the rater determined that the subject understood the task, the test items, which were twelve photographs with the objects presented in Task 1 were presented in a random order as determined by an online list generator. Figure 4 below shows a list of the target objects and the semantic and phonemic clues that accompanied them. A complete collection of all the photographs with their semantic and phonemic clues along with a copy of the study protocol can be found in appendix of this paper.

(4) Figure 4

Object	Semantic Clue	Phonemic Clue
Candle	The girl is lighting [obj] with a match.	[k] as in cake
Ball	The athlete is catching a [obj].	[b] as in bank
Whistle	The referee is blowing a [obj].	[w] as in wish
Flower	The man is giving his girlfriend [obj].	[f] as in fast
Tongs	The person is grilling meat using [obj].	[t] as in toad
Mask	The girl is wearing a [obj.] on her face.	[m] as in mom
Bed	The girl in pajamas is jumping on the [obj.]	[b] as in bank
Harmonica	The man is playing a song on a [obj.]	[h] as in hall
Rattle	The baby is making noise with a [obj.]	[r] as in room
Wallet	[Obj.] is being stolen from the pants pocket.	[w] as in wish
Scissors	The girl is cutting paper with [obj.]	[s] as in soap
Pencil	The boy is writing on paper with a [obj.]	[p] as in pig
Stethoscope	The doctor is listening to the man's heart with a [obj.]	[s] as in soap
Comb	The man is styling his hair with [obj.]	[k] as in cake

(Rosen 1984)

In most cases, the delay between Task 1 and Task 2 in the AD condition was approximately 10 minutes, as that is the amount of time it took to go through the consenting process. However, this timing varied according to which clinical trial participants were enrolled in and what other procedures were completed as part of their routine visit to the ADRU that day. In the control condition, there was no delay between the tasks. The study does not view these differences in timing as a confound because none of

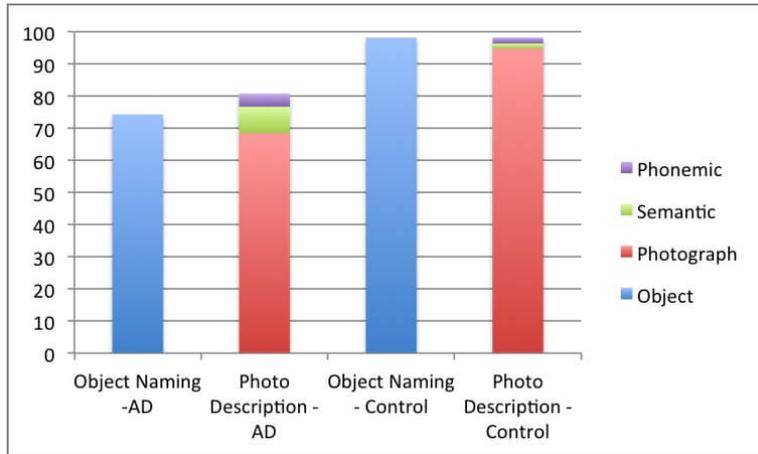
the information presented in Task 1 would have increased a subject's performance on Task 2.

7 Results

There was no significant increase in the performance of the AD subjects on photograph description task versus the object naming task. Figure 5 below shows mean scores⁵ of the five subjects in both tasks. The photograph description bars are stacked according to clues given. The red bars represent answers without clues, the green shows the percent correct with semantic, and the purple shows percent correct with phonemic clues. As the graph shows, performance did not increase in the photograph description task. AD subjects scored an average of 74.4% (SD=20.2%) on the object naming task and 72.8% (SD=29.2%) on the photograph description task after all clues had been given. Furthermore, when only pictures were presented in the photograph description task, AD subjects only scored an average of 63% (SD=30.4%). This increased to 69.6% (SD=30.4%) when semantic clues were given and then to 72.8% (SD=29.2%) after phonemic clues. The graph compares this to the performance of control subjects whose average on both the object naming and photograph description (all clues) tasks was 98.2% (SD=4%). Control picture naming without clues was 94.8% (SD=7.7%). It increased to 96.4 (SD = 5%) with semantic clues and 98.2% (SD=4%) with phonemic clues.

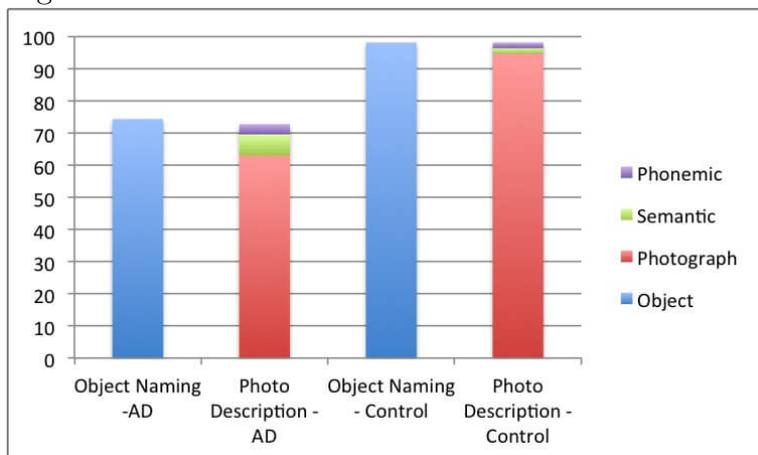
(5) Figure 5

⁵The scores are given here as percentages. One subject only completed eleven items because one item on the object naming task given in the study they were enrolled in was inconsistent with the photograph description task. Therefore, scores were calculated as percentages rather than raw number of correct responses.



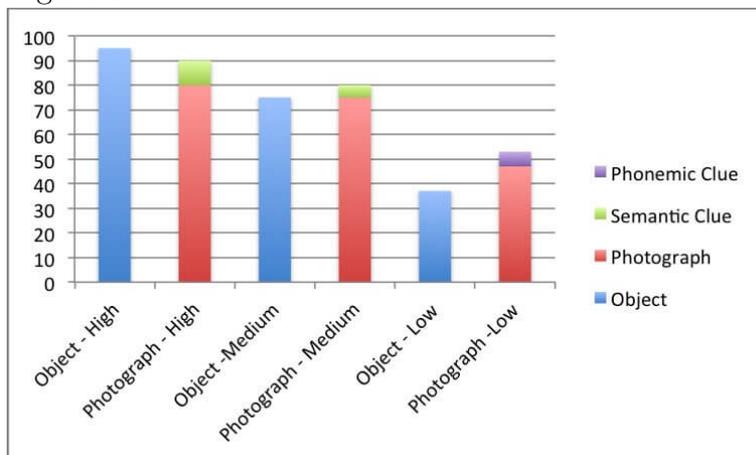
AD Subject 101 performed significantly worse on the photograph description task than the object naming task, scoring 9/12 on object naming and 5/12 on photograph description after all clues were given. Although the sample size is too small to determine outliers, this was out of line from the way other subjects performed. Two other subjects performed better and the other two had the same scores on the photograph description task. When data from this subject is removed, AD subjects scored an average of 80.8% (SD=26.8%) on the photograph description task versus 74.3% (SD=23.3%) on the object naming task. The average was 68.5% (SD = 32.1%) with only pictures, 76.8% (SD=30%) with semantic clues, and rose to the final 80.8% (SD =26.8%) when phonemic clues were given. Figure 6 below shows the same information as Figure 5 but with data from Subject 101 removed.

(6) Figure 6



The study also produced interesting results in terms of frequency. Figure 7 below shows the percentage of objects named correctly in terms of frequency⁶ As with the charts above, the blue bars show object naming and the red, green, and purple bars show the photograph description task. Red accounts for only photographs, green shows the increase in with semantic clues, and finally purple accounts for phonemic clues. There was a slight drop in high frequency level words from 95% correct in the object naming task to 90% in photograph description. This drop can be accounted for by Subject 101 who missed a high frequency word in the photograph description task that they got correct during object naming. Medium frequency responses showed similar results. Object naming was correct 75% of the time with same rate in photograph description when only the photograph was presented. This rate increased to 80% when a semantic clue was given. Finally, the difference at the low frequency level was the most significant. Object naming responses were 36% correct and the photograph only condition responses had a success rate of 47%. This jumped to 53% when phonemic clues were given; semantic clues were not helpful in the low frequency condition.

(7) Figure 7



⁶Frequency levels were taken to be those used on the ADAS-COG. Whistle, bed, pencil, and flower are low frequency. Mask, rattle, scissors, and comb are medium frequency. Tongs, wallet, stethoscope, and harmonica are high frequency.

8 Discussion

Due to a low number of subjects and varying data across subjects, the study is unable to make a claim about whether the mental lexicon of AD patients remains intact. AD subjects actually performed worse on the photograph description task than the object naming one when only the photograph was present. Semantic and phonemic clues were helpful but not enough to make a significant difference. Though this data seems to be in line with mental lexicon degradation, the current author is hesitant to make this claim. The study failed to replicate data from Balthazar et al 2008, which found that AD subjects performed at the level of aging normals when given phonemic clues during object naming tests. Control subjects performed at an average 98.4% on the photograph description task after being given phonemic clues while AD subjects remained at 72.8%. The fact that some subjects were able to name objects in Task 1 but unable to name them in the photograph description task less than an hour later is also troubling. These issues suggest that the current data might be more evidence of confounding variables than a degraded mental lexicon. The following are possible pitfalls that likely compounded to produce insignificant data.

8.1 Possible Pitfalls

8.1.1 Fatigue

Because the study recruits AD subjects who are already enrolled in clinical trials that require at least thirty minutes cognitive assessments per visit, and the current study is completed at those visits, fatigue is a possible confound. To be allowed to perform the current tasks at the same visit as the one for the clinical trial, the current study could only occur after all of the testing for the clinical trial was completed. Emotional and psychological fatigue are also a concern; most of the subjects perform poorly on the other cognitive measures for which they are tested. AD subjects at this stage are aware of their cognitive deficits and memory loss and often find such testing emotionally taxing.

Additionally, control subjects did not experience this fatigue in the same way as the AD subjects. Although control subjects, as study partners of the AD subjects in the clinical trials, do undergo some assessments, they are in the form of answering questions about the habits and well-being of their study partners, and are much less psychologically taxing than the cognitive assessments given to AD subjects. Furthermore, assessments for the study partners are shorter with more breaks in between them, so control subjects had ample chance to recover from any fatigue. Although fatigue was a significant confound, it was also an unavoidable one.

8.1.2 Distracting Photographs

The pictures in the photograph description task may have been too complicated for some of the subjects to process and served as a distraction to the object naming goal of the task. Some subjects, particularly Subject 101 who performed worse on the photograph description task than the object naming task had difficulty focusing on the correct part of the photographs. In the photographs that depicted people, especially young children, subjects became distracted and commented on the person rather than the action that was depicted. For example, they commented that the girl using scissors looked like their grand-daughter but could not focus on her cutting paper. Additionally, Subject 103, who performed better on the photograph description task, required guidance in the form of pointing to focus on the correct part of the photograph. Overall, though they were sometimes unable to name the objects, subjects performed better or produced more circumlocution on the photographs that lacked people and in which the object the most prominently featured portion of the photograph.

8.1.3 Phonemic Clues

Phonemic cues were given in the form of the sound the object began with and a semantically unrelated word that began with the same sounds. The word was included to rule out mishearing but may have acted as a distraction from the description task. The rater noted that subjects repeated and seemed to shift focus to the word given in

the phonemic clue. This distraction might account for the current study's inconsistency with Balthazar et al 2008 which found that AD subjects perform at the level of aging normals when given phonemic clues.

8.2 Frequency

The one area in which the current study produced significant results in line with previous research was performance at the frequency level. It found a correlation between object frequency and performance on both the object naming and photograph description tasks. Furthermore, it found that the photograph description task facilitated object naming and phonemic cues were more helpful at low frequencies. These results are in line with previous research about object naming and frequency (Rosen 1980) and suggest that below the mess of potential pitfalls and confounds, functional clues in the form of photographs might facilitate object naming.

9 Further Research

Although the current study did not produce significant data, further research that eliminates the confounds and pitfalls listed above might be able to determine if the mental lexicon of AD patients remains intact. First, the sample size needs to be greatly increased. AD presents differently in each patient and a large sample will be needed to arrive at any trends or significant data. Additionally, photographs that put more focus on the target objects and less on the people using them would be helpful. A computer task that zooms in on the object after showing it with an action may maintain the functional information while eliminating the distraction of other parts of the picture. A study that expands beyond the 12 object scope of the ADAS-COG could give more data, and make finding a trend, if one exists, much easier.

Additionally, subjects who had difficulty focusing on the photographs seemed to have other cognitive deficits, such as difficulty following commands and short attention spans. A follow-up study should gather data about executive function deficits and

investigate whether they correlate with the difference in performance on the object naming and photograph description tasks. A negative correlation in which increased cognitive deficits mean less of a difference between the two tasks would offer evidence the object naming impairment is a problem with executive functions and lexical access, not a degrading mental lexicon.

10 References

1. Appell, J., A. Kertesz, and M. Fisman. A study of language functioning in Alzheimer patients. *Brain and Language*. 17 (1982): 73-91.
2. Ahsendorf, Lee, Angela L. Jefferson, Maureen K. O'Connor, Christine Chaisson, Robert C. Green, and Robert A. Stern. Trail Making Test Errors in Normal Aging, Mild Cognitive Impairment, and Dementia. *Archives of Clinical Neuropsychology* 23.2 (2008): 129-37.
3. Balota, David A., Jason M. Watson, Janet M. Duchek, and F. Richard Ferraro. Cross-modal semantic and homograph priming in healthy young, healthy old, and in Alzheimer's disease individuals. *Journal of International Neuropsychological Society*. 5 (1999): 626-40.
4. Balthazar, Marcio Luiz Figueredo, Fernando Cendes, and Benito Pereira Damasceno. Semantic error patterns on the Boston Naming Test in normal aging, amnesic mild cognitive impairment, and mild Alzheimer's disease: is there semantic disruption? *Neuropsychology*. 22.6 (2008): 703-09.
5. Cherkow, Howard, Daniel Bub, and Mark Seidenberg. Priming and semantic memory loss in Alzheimer's disease. *Brain and Language*. 36 (1989): 420-46.
6. Dementia Assessment ACFI PAS Demo. Dementia Assessment ACFI PAS Demo. Dementia Assessment, 30 Jan. 2012. Web. 22 Mar. 2015. <https://www.youtube.com/watch?v>
7. Druks, Judit, Jackie Masterson, Michael Kopelman, Linda Clar, Anita Rose, and Gucharan Rai. Is action naming better preserved (than object naming) in Alzheimer's disease and why should we ask? *Brain and Language*. 98 (2006): 332-40.
8. Duarte, L.r., and Christelle Robert. Semantic Richness Influences Naming Pictures in Old Age and in Alzheimer's Disease. *Journal of Neurolinguistics* 31 (2014): 55-68.
9. Giffard, B., B. Desgranges, F. Nore-Mary, C. Lalevee, V. De La Sayette, F. Pasquier, et al. The nature of semantic memory deficits in Alzheimer's disease: new insights from hyperpriming effects. *Brain*. 124 (2001): 1522-32.
10. Giles, Elaine, Karalyn Patterson, and John R. Hodges. Performance on the Boston Cookie Theft Picture Description Task in Patients with Early Dementia of the Alzheimer's Type: Missing Information. *Aphasiology* 10.4 (1996): 395-408.
11. Henry, Julie D., John R. Crawford, and Louise H. Phillips. Verbal fluency performance in dementia of the Alzheimer's type: a meta-analysis. *Neuropsychologia*. 24 (2004): 1212-22.
12. Hirsh, Katherine W., and Elaine Funnell. Those Old, Familiar Things: Age of Acquisition, Familiarity and Lexical Access in Progressive Aphasia. *Journal of Neurolinguistics* 9.1 (1995): 23-32.

13. Hodges, John R., David P. Salmon, and Nelson Butters. Semantic memory impairment in Alzheimer's disease: failure of access or degraded knowledge? *Neuropsychologia*. 30.4 (1991): 301-14.
14. Holmes, Selina J., Fiona Jane Fitch, and Andrew W. Ellis. Age of Acquisition Affects Object Recognition and Naming in Patients with Alzheimer's Disease. *Journal of Clinical and Experimental Neuropsychology* 28.6 (2006): 1010-022.
15. Huff, Jacob, Suzanne Corkin, and John H. Growdon. Semantic Impairment and anomia in Alzheimer's disease. *Brain and Language*. 28.2 (1986): 235-49.
16. Laisney, M., B. Giffard, S. Belliard, V. De La Sayette, B. Desgranges, and F. Eustache. When the zebra loses its stripes: semantic priming in early Alzheimer's disease and semantic dementia. *Cortex*. 47.1 (2011): 35-46.
17. Martin, Alex and Linda Chao. Semantic memory and the brain: structure and processes. *Current Opinion in Neurobiology*. 11(2): 194-201. 2001.
18. Mayo Clinic Staff. Alzheimer's Disease. *Mayo Clinic Disease and Conditions*. Mayo Clinic, 17 June 2014. Web. 3 Apr. 2015.
19. Monsch, Andreas U., Mark W. Bondi, Nelson Butters, David Salmon, Robert Katzman, and Leon Thal. Comparisons of verbal fluency tasks in the detection of dementia of the Alzheimer's type. *Archives of neurology*. 49 (12): 1253-58. 1992.
20. Nebes, Robert D. Semantic Memory in Alzheimer's Disease. *Psychological Bulletin* 106.3 (1989): 377-94.
21. Nicholas, Marjorie, Loraine K. Ober, Martin L. Albert, and Nancy Helm-Estabrooks. Empty Speech in Alzheimer's Disease and Fluent Aphasia. *Journal of Speech, Language, and Hearing Research* 28 (1985): 405-10. JSLHR.
22. Ober, Beth and Gregory Shenaut. Lexical decision and priming in Alzheimer's disease. *Neuropsychologia*. 26(2): 273-86. 1988.
23. Ober, Beth and Gregory Shenaut. Semantic priming in Alzheimer's disease: meta-analysis and theoretical evaluation. *Advances in Psychology*. 110: 247-71. 1995
24. Ober, L.K., M.L. Albert. The action naming test. Boston VA Medical Center. 1986.
25. Robinson, K.M., M. Rossor, L. Cipolotti. Selective sparing of verb naming in a case of severe Alzheimer's disease. *Cortex*. 35 (1999): 443-50.
26. Rogers, Sean and Rhonda Friedman. The underlying mechanisms of semantic memory loss in Alzheimer's disease and semantic dementia. *Neuropsychologia*. 46.1 (2008): 12-21.
27. Rosen, Wilma G., Richard C. Mohan, and Kenneth L. Davis. A new rating scale for Alzheimer's disease. *The American Journal of Psychiatry*. (1984).

28. Rosen, Wilma G. Verbal Fluency in Aging and Dementia. *Journal of Clinical Neuropsychology*. 2.2(1980): 135-46.
29. Rubin, Eugene H., John C. Morris, Martha Storandt, and Leonard Berg. "Behavioral Changes in Patients with Mild Senile Dementia of the Alzheimer's Type." *Psychiatry Research* 21.1 (1987): 55-62.
30. Silveri, Maria C., Antonella Cappa, Paulo Mariotti, and Maria Puopolo. Naming in Patients With Alzheimer's Disease: Influence of Age of Acquisition and Categorical Effects. *Journal of Clinical and Experimental Neuropsychology* 24.6 (2002): 755-64.
31. Small, Jeff A., Susan Kemper, and Kelly Lyons. Sentence Comprehension in Alzheimer's Disease: Effects of Grammatical Complexity, Speech Rate, and Repetition. *Psychology and Aging* 12.1 (1997): 3-11.
32. Squire, Larry R. (Ed); Butters, Nelson (Ed), (1992). *Neuropsychology of memory* (2nd ed.). , (pp. 220-232). New York, NY, US: Guilford Press, xvii, 620 pp.
33. Thornton, G. Matthew, Jared F. Bengel, Paul J. Massman, and Rachel S. Doody. Phonemic and semantic fluency discrepancies: normative data and differences between MCI and AD patients.
34. What Is Mild Cognitive Impairment? Northwestern University Feinberg School of Medicine Cognitive Neurology and Alzheimer's Center. Northwestern University, n.d. Web. 12 Mar. 2015.
35. Zannino, Gian Daniele, Roberta Perri, Patrizio Pasqualetti, Carlo Caltagirone, and Giovanni A. Carlesimo. "(Category-specific) Semantic Deficit in Alzheimer's Patients: The Role of Semantic Distance." *Neuropsychologia* 44.1 (2006): 52-61.

11 Appendix

11.1 Stimuli

11.1.1 Training Stimuli

1. Candle

Semantic Clue: The girl is lighting the obj. with a match.

Phonemic clue: 'k' as in cake.



Image taken from: <http://www.kimberleeconwayireton.net/2012/11/advents-coming>

2. Ball

Semantic Clue: The athlete is catching the obj.

Phonemic Clue: 'b' as in bank



Image taken from: <http://galleryhip.com/catch-a-ball.html>

11.1.2 Test Stimuli

1. Whistle

Semantic Clue: The referee is blowing the obj.

Phonemic Clue: 'w' as in wish



Image taken from: <http://pixgood.com/referee-blowing-whistle.html>

2. Flower(s)

Semantic Clue: The man is giving his girlfriend obj.

Phonemic Clue: 'f' as in fast.



Image taken from: <http://attractgetwomen.com/perfect-gift-for-your-new-girlfriend/flowers-for-lovely-woman/>

3. Tongs

Semantic Clue: The person is grilling meat using the obj.

Phonemic Clue: 't' as in toad



Image taken from: <http://www.webergrillsales.com/luxury-oak-barbecue-grill-tongs/>

4. Mask

Semantic Clue: The woman is wearing the obj. on her face.

Phonemic Clue: 'm' as in mom



Image taken from: <http://galleryhip.com/people-wearing-black-masquerade-masks.html>

5. Bed

Semantic Clue: The child in pajamas is jumping on the obj.

Phonemic Clue: 'b' as in bank



Image taken from: <http://kateprentiss.blogspot.com/2012/10/displaying-childrens-portraits.html>

6. Harmonica

Semantic Clue: The boy is playing a song on the obj.

Phonemic Clue: 'h' as in hall



Image taken from: <http://www.littlebabylump.com/blog/bid/219475/A-Long-Overdue-Update>

7. Rattle

Semantic Clue: The baby is making noise with the obj.

Phonemic Clue: 'r' as in room



Image taken from: <https://www.youtube.com/watch?v=n2yANOCrf80>

8. Wallet

Semantic Clue: The obj. is being stolen from the back pocket.

Phonemic Clue: 'w' as in wish



Image taken from: http://yle.fi/uutiset/pickpockets_s teal_a_w allet_e very_h our_i n_h elsinki/6236871

9. Scissors

Semantic Clue: The girl is cutting paper with the obj.

Phonemic Clue: 's' as in soap



Image taken from: <http://www.thecaterpillaryears.com/2014/04/paper-bag-puppets/>

10. Pencil

Semantic Clue: The boy is writing on the paper with the obj.

Phonemic Clue: 'p' as in pig



Image taken from:

11. Stethoscope

Semantic Clue: The doctor is listening to the man's heart with a obj.

Phonemic Clue: 's' as in soap



Image taken from: <https://blackpeopleshealth.wordpress.com/2013/01/09/why-we-dont-go-to-the-doctor/>

12. Comb

Semantic Clue: The man is styling his hair with the obj.

Phonemic Clue: 'k' as in cake



Image taken from: <http://pixgood.com/guy-combing-hair.html>

11.2 Protocol

1. I'm going to show you a picture and I want you to tell me what is happening n it. First I'll give you an example.

Present photograph of girl lighting candle.

If I showed you this picture, I would want you to tell me that the girl is lighting a candle.

1. Let's do another practice one.

Show the subject photograph of boy catching ball.

Can you tell me what is happening in this picture?

If yes, mark as correct and go to step 3. If subject gives a description that does not include the object, ask them questions such as "what are they doing that with" or point to object in picture and ask what it is without giving away semantic clues they have not already produced.

If no, go to step 2a.

- (a) Give a semantic clue.

The athlete is catching something. Can you tell me what he is catching?

If yes, mark as correct with semantic clue and got to step 2.

If no, go to step 2b.

- (b) Give a phonemic clue.

It begins with 'b' as in bank. Do you know what it is?

If yes, mark as correct with phonemic clue and go to step 2.

If no, give correct answer and move to step 2.

2. Repeat step 1 replacing the stimuli and clues with those for the test items in the table below until all test items have been presented. Refer to the scoresheet for the order of presentation.

Object	Semantic Clue	Phonemic Clue
Candle	The girl is lighting [obj] with a match.	[k] as in cake
Ball	The athlete is catching a [obj].	[b] as in bank
Whistle	The referee is blowing a [obj].	[w] as in wish
Flower	The man is giving his girlfriend [obj].	[f] as in fast
Tongs	The person is grilling meat using [obj].	[t] as in toad
Mask	The girl is wearing a [obj.] on her face.	[m] as in mom
Bed	The girl in pajamas is jumping on the [obj.]	[b] as in bank
Harmonica	The man is playing a song on a [obj.]	[h] as in hall
Rattle	The baby is making noise with a [obj.]	[r] as in room
Wallet	[Obj.] is being stolen from the pants pocket.	[w] as in wish
Scissors	The girl is cutting paper with [obj.]	[s] as in soap
Pencil	The boy is writing on paper with a [obj.]	[p] as in pig
Stethoscope	The doctor is listening to the man's heart with a [obj.]	[s] as in soap
Comb	The man is styling his hair with [obj.]	[k] as in cake