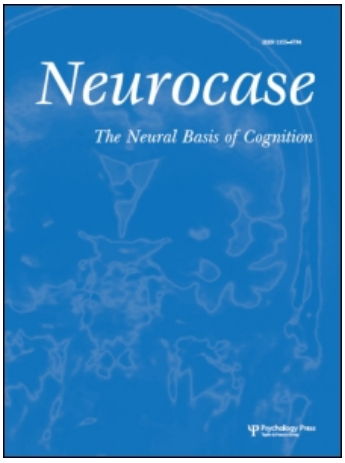
This article was downloaded by: *[Chrysikou, Evangelia]*
On: *22 January 2011*
Access details: *Access Details: [subscription number 932531594]*
Publisher *Psychology Press*
Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Neurocase
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713658146

The importance of multiple assessments of object knowledge in semantic dementia: The case of the familiar objects task

Evangelia G. Chrysikou[a]; Tania Giovannetti[b]; Denene M. Wambach[c]; Abigail C. Lyon[d]; Murray Grossman[d]; David J. Libon[b]
[a] Department of Psychology, University of Pennsylvania, Philadelphia, PA, USA [b] Department of Psychology, Temple University, Philadelphia, PA, USA [c] Department of Neurology, Drexel University, Philadelphia, PA, USA [d] Department of Neurology, Hospital of the University of Pennsylvania, Philadelphia, PA, USA

First published on: 01 September 2010

To cite this Article Chrysikou, Evangelia G. , Giovannetti, Tania , Wambach, Denene M. , Lyon, Abigail C. , Grossman, Murray and Libon, David J.(2011) 'The importance of multiple assessments of object knowledge in semantic dementia: The case of the familiar objects task', Neurocase, 17: 1, 57 — 75, First published on: 01 September 2010 (iFirst)
To link to this Article: DOI: 10.1080/13554794.2010.497156
URL: http://dx.doi.org/10.1080/13554794.2010.497156

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: http://www.informaworld.com/terms-and-conditions-of-access.pdf

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

NEUROCASE
2011, 17 (1), 57–75

Psychology Press
Taylor & Francis Group

The importance of multiple assessments of object knowledge in semantic dementia: The case of the familiar objects task

Evangelia G. Chrysikou,[1] Tania Giovannetti,[2] Denene M. Wambach,[4] Abigail C. Lyon,[3] Murray Grossman,[3] and David J. Libon[2]

[1]Department of Psychology, University of Pennsylvania, Philadelphia, PA, USA
[2]Department of Psychology, Temple University, Philadelphia, PA, USA
[3]Department of Neurology, Hospital of the University of Pennsylvania, Philadelphia, PA, USA
[4]Department of Neurology, Drexel University, Philadelphia, PA, USA

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

Semantic dementia (SD) is characterized by a dramatic loss of conceptual knowledge about the meaning of words and the identity of objects. Previous research has suggested that SD patients' knowledge is differentially influenced by the disease and may decline at different degrees depending on a patient's everyday familiarity with certain items. However, no study has examined (a) semantic knowledge deterioration and (b) the potential significance of autobiographical experience for the maintenance of object concepts in the same cohort of SD patients by using comprehensive assessments of different aspects of object knowledge across an experience-based, distributed semantic memory network. Here, we tested four SD patients and three Alzheimer's disease (AD) control patients using a range of tasks – including naming, gesture generation, and autobiographical knowledge – with personally familiar objects or perceptually similar or different object analogs. Our results showed dissociations between performance on naming relative to other assessments of object knowledge between SD and AD patients, though we did not observe a reliable familiar objects advantage. We discuss different factors that may account for these findings, as well as their implications for research on SD.

Keywords: Semantic dementia; Familiar objects; Semantic memory; Episodic memory; Object knowledge.

INTRODUCTION

Semantic dementia (SD) is a syndrome typified by profound word-finding difficulties and marked deficits in language and object comprehension. The patient's speech is fluent and syntactically intact, though it frequently appears empty of content. Patients with SD progressively lose their conceptual knowledge about the world and consequently become unable to comprehend the meaning of words or the identity of objects, regardless of input modality (Bozeat, Lambon Ralph, Patterson, Garrard, & Hodges, 2000; Hodges, Patterson, Oxbury, & Funnell, 1992; Luzzi et al., 2007; Snowden, Goulding, & Neary, 1989; Snowden, Griffiths, & Neary, 1994; Snowden, Bathgate, Blackshaw, Gibbons, & Neary, 2001). The disease is considered the temporal variant of frontotemporal dementia (FTD) because it typically affects the left temporal cortices (Grossman, 2002; Mesulam, Grossman, Hillis, Kertesz, & Weintraub, 2003; Mummery, Patterson, Hodges, & Price, 1998). Specifically with respect to neuropathology, SD is often characterized by TDP-43/

Address correspondence to Evangelia G. Chrysikou, Ph.D., Department of Psychology, Center for Cognitive Neuroscience, University of Pennsylvania, 3720 Walnut St., Solomon Lab, Room 51, Philadelphia, PA 19104-6241, USA. (E-mail: evangelg@psych.upenn.edu).

© 2010 Psychology Press, an imprint of the Taylor & Francis Group, an Informa business
http://www.psypress.com/neurocase DOI: 10.1080/13554794.2010.497156

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

ubiquitin-positive but tau-negative inclusions that result in temporal lobe atrophy (Grossman et al., 2004; Mummery et al., 1999, 2000).

In contrast to other dementias (e.g., Alzheimer's disease, AD), patients with SD seem to maintain relatively preserved episodic and autobiographical memory, and their visuospatial and executive functioning scores at the time of diagnosis are relatively less impaired (Adlam, Patterson, & Hodges, 2009; Hodges et al., 1999; Koenig, Smith, & Grossman, 2006; Rogers, Ivanoiu, Patterson, & Hodges, 2006; Simons et al., 2005), although they decline over time as a function of disease severity (e.g., Caine, Breen, & Patterson, 2009; Matuszewski et al., 2009; McKinnon et al., 2008). In fact, some patients with SD exhibit a reverse temporal gradient (or 'reverse Ribot effect') relative to patients with AD regarding the preservation of remote memories. For instance, the performance of SD patients on the Autobiographical Memory Interview (*AMI*; Kopelman, Wilson, & Baddeley, 1990) is better for recent autobiographical information relative to past events, whereas AD patients exhibit the opposite pattern, namely poor memory for recent episodic information contrary to relatively preserved memory for past life events (Snowden, Griffiths, & Neary, 1996; see also Westmacott, Black, Freedman, & Moscovitch, 2003). It has been proposed that the deterioration of hippocampal, entorhinal, and caudal perirhinal structures confines AD patients to the past and does not allow for the formation of new memories; conversely, the deterioration of temporal neocortical structures confines SD patients to the present and allows for only fragmented access to previously acquired semantic knowledge (e.g., Moss, Kopelman, Cappelletti, Davies, & Jaldow, 2003; Piolino, Belliard, Desgranges, Perron, & Eustache, 2003; see also Murray, Koenig, Antani, McCawley, & Grossman, 2007).

In accord with their preserved autobiographical memories, and contrary to their vastly impaired performance on formal naming tests (Adlam et al., 2006; Rogers et al., 2006; Snowden, Thompson, & Neary, 2004; Woollams, Cooper-Pye, Hodges, & Patterson, 2008; see also Lambon Ralph, Graham, Ellis, & Hodges, 1998), patients with mild to moderate SD have been reported to maintain some relatively-preserved vocabulary in their everyday speech for words that are related to their current experiences. In addition, even when they are unable to retrieve the correct object names, they are frequently able to use some of their personal objects appropriately in their everyday activities (Buxbaum, Schwartz, & Carew, 1997; Coccia, Bartolini, Luzzi, Provinciali, & Lambon Ralph, 2004; Graham, Lambon Ralph, & Hodges, 1997, 1999; Lauro-Grotto, Piccini, & Shallice, 1997; Rogers, Lambon Ralph, Hodges, & Patterson, 2004b; Silveri & Ciccarelli, 2009; Snowden et al., 1994). For example, Snowden et al. (1994, 1999) showed that SD patients were significantly better at identifying personal objects currently relevant to their everyday experiences, relative to personal objects they were using in the past. In addition, they were better able to recognize the faces of personal acquaintances relative to those of current celebrities, and their performance was similar for the identification of places with current relative to past personal relevance. Furthermore, results from patient KE (Snowden et al., 1994) suggested that she was more successful at identifying her own objects relative to the experimenter's, especially when those objects were placed in locations in the house that were congruent with the patient's everyday experiences (e.g., a hairbrush in the bathroom). A similar case study of patient WM showed that she could better identify items that were personally relevant and pertained to her current autobiographical experiences relative to other objects she had known before the onset of the disease (Snowden, Griffiths, & Neary, 1995). Finally, analogous results were obtained from two patients who recognized contemporary famous names and monetary concepts better than historic names and past currency (Snowden et al., 1996).

Similarly, Funnell (1995a, 1995b) reported the case of patient EP, who presented with word-finding and comprehension difficulties and focal left temporal lobe atrophy (as revealed by a CT scan) consistent with an SD diagnosis. In the early stages of her disease, EP showed frequency and familiarity effects in word recognition, exhibiting significantly better performance for highly frequent and familiar concepts. To investigate whether EP would be able to relearn concepts she once knew but had now forgotten, Funnell (1995a, 1995b) retrained the patient in naming a series of vegetables. The results of repeated exposure and practice with the test items improved the patient's identification of them, with the duration of the effect depending on the patient's degree of current experience with each object (e.g., naming of certain vegetables declined once they went out of season). Based on these findings, Funnell (2001) offered the possibility of a semantic memory system that is constantly being informed by the individual's personal experience.

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

Finally, Bozeat, Lambon Ralph, Patterson, and Hodges (2002a, 2002b; see also, Bozeat, Patterson, & Hodges, 2004) presented findings from two SD patients suggesting that – despite severely impaired performance in assessments of object naming – personal familiarity with specific objects may lead to improved object use for those items. They further examined whether these effects are moderated by perceptual similarity and context by recording patients' demonstration of use for items that were perceptually similar or perceptually different relative to the patients' familiar objects. According to the results, patients performed better in this task when they were shown objects that were perceptually similar, but not perceptually different, to their own personal objects. With respect to the effects of context, performance did not seem to be influenced by situational factors, as patients' behavior did not differ between their familiar environment and the experimental laboratory. In a later study, Bozeat et al. (2004) discussed the case of patient JH who was able to relearn the use of 10 previously familiar objects after the experimenter's demonstrations, but whose performance steadily declined over time. Based on these findings, Bozeat et al. (2002a, 2004) argued that personal experience with specific objects might allow for the maintenance of some aspects of object knowledge, such as object manipulation, in semantic memory.

Overall, the above-mentioned findings would suggest that SD patients' knowledge for objects appears to be differentially influenced by the disease and may decline at different degrees depending on a patient's everyday experience with certain items. Specifically, the disease seemingly affects certain aspects of a patient's conceptual knowledge for objects, such as object names, at different rates relative to other aspects, such as knowledge of the object's function or mode of manipulation (e.g., the findings of Bozeat et al., 2002a, 2002b). Furthermore, there appears to be a dissociation between the rate of deterioration of a patient's semantic memory for objects, in general, and that for objects that are tied closer to the patient's everyday experiences, such that the preservation of semantic knowledge might be contingent upon the patient's frequency of interaction with a given object (e.g., Funnell, 1995a, 1995b; Snowden et al., 1994, 1995; see also Jefferies, Patterson, Jones, & Lambon Ralph, 2009; Patterson, Nestor, & Rogers, 2007).

These findings are consistent with distributed accounts of semantic memory for concepts, according to which knowledge about object attributes (e.g., an object's name, shape, size, or mode of manipulation) is distributed across multiple, highly interconnected sub-systems that roughly correspond to the brain regions implicated in the acquisition and representation of those attributes (see Allport, 1984; Thompson-Schill, Kan, & Oliver, 2006; Tyler & Moss, 2001). The pattern of an object's representation (i.e., how important manipulation, shape, size, etc. information is for one's interactions with it), in conjunction with the patient's current personal or autobiographical experiences, may influence the rate at which different object attributes are affected by SD (see also Damasio & Damasio, 1994; Pulvermüller, 1999; Tranel, Damasio, & Damasio, 1997). In this context, patients may perform differently across tasks that require access to different object attributes (e.g., to name an object one may need to access different aspects of an object's representation than those activated when demonstrating its use). Importantly, these earlier findings would suggest that certain aspects of a patient's object knowledge may be amenable to rehabilitation interventions, which could facilitate the maintenance of certain aspects of patients' personally salient concepts until the very late stages in the progression of the disease.

Although earlier research using the patients' familiar objects has offered some insights into which aspects of object knowledge are more susceptible to SD, as well as explored whether autobiographical experience may support the maintenance of certain object attributes, each of these studies examined only one aspect of the patients' semantic knowledge – specifically, the patients' ability to name an object, their ability to demonstrate the use of the object, or their autobiographical or episodic knowledge about it (for exceptions, see Coccia et al., 2004; Giovannetti et al., 2006; Magnié, Ferreira, Giuliano, & Poncet, 1999; Silveri & Ciccarelli, 2009). Examining each one of these components in isolation does not allow for an assessment of which aspects of conceptual knowledge are affected the most by SD and which may be maintained longer as supported by the patients' autobiographical experience. Even though earlier work has offered evidence that SD patients seem to be generally better at identifying and using objects that are relevant to their current personal experiences, no study, to our knowledge, has examined the degree of semantic knowledge deterioration in a uniform

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

group of SD patients by employing a combination of tasks that would allow for a more comprehensive assessment of their object knowledge within an experience-based, distributed semantic memory network. Critically, no prior study has explored the potential significance of autobiographical experience for the maintenance of various aspects of object knowledge in SD by using a range of semantic and autobiographical memory assessments.

Given these limitations of the earlier research, in this study we aimed to examine the degree of preservation of semantic knowledge for everyday objects in a group of four SD patients and in a control group of three AD patients, by employing a comprehensive set of assessments, including object naming, gesture generation for object use, knowledge of manner of manipulation, and different measures of autobiographical knowledge associated with the object. With this set of procedures our goal was to identify whether SD affects certain aspects of object knowledge more than others in the group of SD patients relative to the control group of AD patients. We further aimed to explore whether autobiographical experience may increase the likelihood that some components of object knowledge are preserved until later stages of the disease, by examining the patients' performance with their personally familiar objects as well as with analog items that were either perceptually similar or perceptually different to the patients' familiar objects (see Bozeat et al., 2002a, 2002b). Based on earlier findings mainly focusing on object naming (e.g., Woollams et al., 2008), we hypothesized that there might be a dissociation between the patients' performance on naming tasks and other assessments of their semantic memory for object concepts, such as the knowledge of an object's correct mode of manipulation. In comparison, AD patients were not expected to show this effect. Specifically, we hypothesized that SD patients' performance should be significantly impaired relative to that of AD patients on the naming task but not on the other semantic knowledge tasks. In line with past findings, we further predicted that the performance of SD (and, perhaps, AD, see Giovannetti et al., 2006) patients across tasks might depend on the patients' level of familiarity with the test items, such that they would be less impaired for objects that were personally familiar to them relative to perceptually similar or different object analogs. This possible familiar objects advantage might, hence, identify components of the patients' preserved semantic memory networks that could benefit from clinical rehabilitation interventions.

METHOD

Participants

Four SD patients ($N = 4$; 2 men, 2 women; mean age = 71.5 years) and three control AD patients ($n = 3$; 2 men, 1 woman; mean age = 83 years) all right-handed native English speakers, participated in this study. The SD patients did not differ from the AD patients in age ($Z = –1.77$, $p = .12$) or level of education ($Z = –.54$, $p = .63$). All SD patients were diagnosed with semantic dementia (SD) according to published criteria (Grossman & Ash, 2003; Neary et al., 1998). All AD patients were diagnosed with probable dementia of the Alzheimer's type (AD) according to the criteria proposed by the National Institute of Neurological and Communicative Diseases and Stroke, Alzheimer's Disease, and Related Disorders (McKhann et al., 1984; see also Rosen, Mohs, & Davis, 1984). The patients were recruited from the Department of Neurology at the Hospital of the University of Pennsylvania (UPenn) and the Institute of Successful Aging, University of Medicine and Dentistry in New Jersey (UMDNJ).

Neuropsychological assessment

Participants were screened for dementia severity with the *Mini Mental State Exam* (*MMSE*; Folstein, Folstein, & McHugh, 1975). Patients were excluded if they fulfilled the criteria for dementia attributed to other medical or psychiatric conditions according to a comprehensive medical history, a structured neurological exam, and structural imaging using MRI. None of the patients were receiving sedating medications or cognitive enhancers at the time of the study. Participants were also screened for the presence of any visual or hearing deficits that would interfere with inspecting visual stimuli or understanding verbally-presented instructions.

The background clinical neuropsychological evaluation differed slightly for patients recruited from the two clinics. All patients were administered the 15-item version of the *Boston Naming Test* (Kaplan, Goodglass, & Weintraub, 1983; see also Rosen et al., 1984) and the F-A-S test of phonemic word list generation (Mickanin, Grossman, Onishi, Auriacombe, & Clark, 1994). For individuals recruited from the University of Pennsylvania,

TABLE 1
Demographic information and neuropsychological assessment

Patient ID (diagnosis)	*JR (FTD-SD)*	*SB (FTD-SD)*	*TM (FTD-SD)*	*JB (FTD-SD)*	*LA (AD)*	*DP (AD)*	*WL (AD)*
Gender	M	F	M	F	F	M	M
Age	81	69	61	75	82	91	76
Education (years)	19	14	20	12	17	16	12
Time post-onset	*5 years*	*5 years*	*8 years*	*4 years*	*8 years*	*7 years*	*4 years*
MMSE	6	22	23	27	26	20	27
BNT (out of 15)	3	1	3	5	12	12	15
Word Naming Test (F-A-S)	18	18	2	11	48	29	53
PPT (pictures out of 52)	41	31	45	39	51		
PPT (words out of 52)	41	33	42	41	50		
Digit Span (backward)	3	3	4	5	5		
Digit Span (forward)	3	4	4	5	8		
Rey–Osterrieth Figure Copy Test (max 36)		26	36	30	5		
Clock Drawing Test- Copy Condition errors					0	3	2

Note: MMSE, Mini Mental State Examination; BNT, Boston Naming Test; PPT, Pyramids and Palm Trees Test; FTD-SD, Frontotemporal Semantic dementia; AD, Alzheimer's dementia; M, male; F, female. For the 15-item version of the *Boston Naming Test* patients' scores were compared to those of 25 age-matched healthy controls (mean age = 66.76; *SD* = 9.8); although the AD patients performed indistinguishably from the normal healthy subjects, the SD patients were significantly impaired on this task. For the *Pyramids and Palm Trees Test* (words and pictures), patients' scores were compared with those of 18 age-matched healthy controls (mean age = 70.3, *SD* = 8.0); the one AD patient for whom data were available was not impaired on this task relative to healthy control subjects, whereas the four SD patients showed impairment. Two of the three AD patients (DP & WL) were originally recruited from a different site where background testing differed slightly. SB, TM, JB, and LA were administered the Rey–Osterrieth Figure Copy Test. Scores from the three SD patients SB, TM, and JB were well within normal limits. AD patient LA obtained an impaired Rey Copy score, but made 0 errors when copying a figure of a clock and correctly named 12 of 15 objects on the BNT, suggesting that her poor Rey drawing may have been due to impaired executive planning/organization skills.

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

semantic memory was assessed through the *Pyramids and Palm Trees Test* (words and pictures; Howard & Patterson, 1992). Span and working memory were measured with the *Digit Span Test* (forward and backward; Wechsler, 1995). Visual-spatial processing was assessed by means of the Rey–Osterrieth Figure Copy Test (UPenn; Duley et al., 1993; Osterrieth, 1944) or the Clock Drawing Test-Copy condition (UMDNJ; Libon, Malamut, Swenson, & Cloud, 1996). Table 1 presents the demographic information for all patients and their performance on each of the above-mentioned neuropsychological measures.[1]

After reviewing the patients' neuropsychological and imaging evidence, a senior behavioral neurologist (MG) at the Department of Neurology of the Hospital of the University of Pennsylvania performed the diagnosis for all patients. Patients who did not, according to the neuropsychological assessment, have the attentional capacity or cognitive skills necessary to complete an hour-long testing session and comprehend task instructions were excluded from participation in the study. To be included in the study, the participant's caregiver or residential staff person had to confirm that he or she actively participated in activities of daily living (with or without assistance) using his or her personal objects.

Materials

Familiar objects and object analogs

For each experimental task, participants were shown a total of 36 items: 12 familiar (i.e., the participants' personal) objects, 12 perceptually similar analogs, and 12 perceptually different analogs. Prior to the testing session, a telephone interview was conducted with each participant's caregiver.

[1]We note that the MMSE performance at the time of diagnosis of patient JR was lower than that of the other three patients. Although we acknowledge this difference, in the absence of any other alternative neurological diagnosis for this patient, we note that the patient's performance in all other tasks of interest was comparable to the other patients, hence we chose to include his data in the analyses we report in the present paper. To examine whether the exclusion of this patient would influence our results, we performed all analyses with and without this participant. Given that we found no differences between these analyses, in addition to the overall limited number of SD patients discussed in the literature on semantic deficits, we decided to report our results with all four patients.

TABLE 2
List of objects and average object familiarity and frequency by patient

Patient (diagnosis)	*JR (FTD-SD)*	*SB (FTD-SD)*	*TM (FTD-SD)*	*JB (FTD-SD)*	*LA (AD)*	*DP (AD)*	*WL (AD)*
	Telephone*	Glass*	Alarm clock*	Ice cream scoop	Fork*	Toothbrush	Shaving cream
	Glasses	Knife*	Broom*	Razor	Pen*	Razor	Knife*
	Mug*	Glasses	Remote control	Broom*	Key*	Hairbrush*	Glass*
	Electric razor	Hairdryer	Scissors	Fork*	Lipstick	Glass*	Scissors
	Remote control	Ice-cream Scoop	Telephone*	Key*	Spoon*	Cup*	Spoon*
	Broom*	Key*	Comb	Comb	Scissors	Fork*	Pencil*
	Toothbrush	Hairbrush*	Toothbrush	Glass*	Comb	Hat*	Comb
	Dish towel	Pan*	Electric shaver	Scissors	Pencil*	Spoon*	Pen*
	Coffee pot	Mug*	Keys*	Pen*	Knife*	Pen*	Mug*
	Comb	Lipstick	Flashlight	Spoon*	Toothbrush	Scissors	Sponge*
	Wallet*	Remote control	Fork*	Alarm clock*	Telephone*	Knife*	Remote control
	Hat*	Razor	Walkman CD player	Knife*	Cup*	Bowl*	Razor
Average item familiarity[a]	552.40	576.50	578.40	586.50	583.63	586.00	573.33
Average item frequency[b]	8.55	9.26	9.83	9.29	9.75	9.32	8.54

Note: FTD-SD, Frontotemporal Semantic dementia; AD, Alzheimer's disease. The familiarity and frequency values for each item, where available, were obtained from the Medical Research Council (MRC) Psycholinguistic database (Coltheart, 1981, http://www.psych.rl.ac.uk).

[a]Word familiarity values were obtained from the MRC norms (Coltheart, 1981; Gilhooly & Logie; 1980; Paivio, unpublished norms; Toglia & Battig, 1978). Familiarity values were scaled to a range of 100–700 ($\mu = 488$, $\sigma = 99$).

[b]A measure of word frequency was obtained for each item from a large database of hypertext frequency (Lund & Burgess, 1996) obtained from the English Lexicon Project (http://elexicon.wustl.edu; Balota et al., 2007; range = 0–17, $M = 6.16$, $SD = 2.4$). Asterisks indicate items for which both familiarity and frequency values were available in the MRC Psycholinguistic Database.

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

During the interview, the caregiver was asked to identify 12 portable household objects that the participant was currently using at least weekly. Table 2 presents a list of the items used for each patient, in addition to measures of average item familiarity and frequency by patient. Overall, these measures did not differ across patients; the measures further indicate that the objects used for each patient were of moderate-to-high familiarity and frequency (we will return to a discussion of item familiarity/frequency in a later section). The caregiver was asked to collect the personal objects for the experimenter's visit the day of the scheduled testing session. Before testing began, the experimenter prepared two laboratory analogs for each personal object: a perceptually similar analog and a perceptually different analog. Perceptual similarity between each familiar object and the laboratory analogs for that object was assessed on three parameters: (a) size, (b) shape, and (c) color. To be considered perceptually similar the laboratory analog had to be identical to the familiar object on two of the three parameters. To be considered perceptually different the laboratory analog had to differ from the familiar object on all three parameters. It should be noted that similarity was perceived on a continuum from very similar to not-at-all similar and not in absolute terms (see also Bozeat, et al., 2002a). Two experimenters jointly selected the perceptually similar and the perceptually different analogs for each object; there were no disagreements between the experimenters regarding the selection of the appropriate analogs for any of the patients' objects. For each of the experimental tasks, each object was presented to the patient either until he or she initiated a response or 30 seconds had elapsed.

Experimental tasks

Naming task

Participants were asked to name each object (familiar, perceptually similar analog, or perceptually different analog) as quickly as possible. Each object was placed behind a screen. When the participant indicated that he or she was ready for the trial, the screen was raised. Participants were allowed to approach the object if they needed to see it more clearly but they were not allowed to

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

touch the object. Two sample trials were performed before testing began, using laboratory objects that were not included in the study.

Gesture task

Participants were instructed to demonstrate the use of each object by gesturing (i.e., '*Show me with your hands how to use this object*'). Object presentation followed the procedures used in the *Naming Task*.

Personal object decision task

The aim of this task was to assess the patients' autobiographical memory for the specific object by determining whether they were able to distinguish reliably their personal objects from the laboratory objects. Participants were shown each object (familiar, perceptually similar analog, or perceptually different analog) separately, and they were asked to state whether the item belonged to them (i.e., '*Is this yours?*'). Object presentation followed the procedures used in the *Naming Task*.

Object use judgment task

Participants performed a modified version of the *Tool Use Judgment test* (Rapcsak, Ochipa, Anderson, & Poizner, 1995; see also Buxbaum et al., 1997). This task aimed to assess participants' semantic-procedural knowledge about an object through their accuracy in selecting whether the object was used correctly or not, depending on object familiarity. For one third of the items (*Orientation* condition) each object was presented being used correctly but in an inappropriate orientation (e.g., remote control up-side-down). For the second third of the items (*Semantic* condition) each object was presented being used in the correct orientation but incorrectly with respect to its normative use (e.g., a comb to turn on the TV). For the last third of the items (*Correct* condition) each object was presented being used correctly both in terms of orientation and use. The presentation of the objects across the three conditions (i.e., orientation, semantic, and correct) was randomized. Participants were asked to indicate for each trial whether the object was used correctly or not.

Semantic/script generation task

The goal of this task was to assess the patients' general semantic knowledge for the items in question. Given the open-ended nature of the questions, the task had the potential to elicit the patient's general semantic, procedural, but also autobiographical knowledge for each presented object. Participants were asked to report consecutively (a) where, (b) when, and (c) how (i.e., what are the steps involved) they would typically use each object. Objects were presented one at a time and participants were given as much time as they needed to respond to each query.

Procedure

All participants were visited at their residence. Before testing began, participants signed consent forms after receiving general instructions on the nature of the experimental tasks. Prior to the experimenters' visit, participants' caregivers had collected the 12 personal items that were identified in prior communication with the caregiver. Participants were administered all tasks in one experimental session. The order of presentation of the tasks for all patients was as follows: *Naming task*, *Gesture task*, *Personal Object Decision task*, *Object Use Judgment task*, *and Semantic/script generation task*.[2] Within each task, the presentation of all 36 objects across the three sets (familiar objects, perceptually similar analogs, perceptually different analogs) was completely randomized. Participants were allowed to take breaks if necessary. Each session lasted approximately 90 min. All sessions were videotaped with participants' consent.

RESULTS

Due to violations in the normal distribution of the data typical with small sample sizes, we employed non-parametric statistics (Wilcoxon–Mann–Whitney

[2]Our rationale for selecting a specific order of presentation of the experimental tasks relative to a random order had to do with potential fatigue effects on participants' performance toward the end of the experimental session, which might have jeopardized the validity of our findings for all tasks, given the limited number of participants included in the study. That is, we aimed to ensure that there would not be one or more participants' data that would have to be entirely excluded from one of the five tasks due to fatigue effects, which might have been the case if random task presentation was followed and which would have significantly reduced the power to detect differences within each task. We note that, with only one exception, all patients were able to complete the experimental session without interruptions, thus we do not reckon that fatigue effects differentially influenced patients' performance in any of the tasks.

two-independent-sample rank tests) to examine differences in task performance between the SD patient group and the AD patient control group. We further used a similar non-parametric statistical approach (Wicoxon signed-ranks tests for paired samples) to examine possible differences among the three object categories (familiar, perceptually similar, perceptually different) for each task, within each patient group. A significance level of $\alpha = .05$ was employed for all statistical tests.

Analysis by patient group, task and object type

Naming task

Scoring. Participants' responses were scored from the videorecordings on whether they correctly named each object. Participants' incorrect responses were also classified by error type. Two independent raters, blind to the experimenters' classification of the objects (i.e., familiar objects, perceptually similar or perceptually different analogs), scored participants' responses. Inter-rater reliability (Cohen's Kappa) for the naming task was .92; all differences between the raters were resolved in conference. The common scores of the raters (after consensus) were used for the analyses. The final scores reflected the percent of participants' correct responses.

The proportion of correct responses for the naming task for each patient is presented in Table 3. Average results on this task by patient group are presented in Table 4. The analysis indicated that SD patients were significantly impaired on the Naming task relative to AD patients for familiar ($Z = –2.14$, $p = .03$), perceptually similar ($Z = –2.22$, $p = .03$), and perceptually different ($Z = –2.16$, $p = .03$) objects. Although across SD patients the differences among object categories were in the expected direction, with performance for the familiar objects being superior to that for their perceptually similar and perceptually different analogs (see Table 4), the analysis did not reveal significant effects of familiarity for either patient group (all ps > .16). Specifically, in the SD group one of the four patients (SB) appeared to show such a familiar object advantage, although her performance was overall very poor. Similarly, in the AD group one of the three patients (LA) appeared to exhibit a familiar objects advantage, though her performance was rather good on this task (see Table 3). Overall, the results of the naming task showed that SD patients, in line with their SD diagnosis, were vastly impaired on this task regardless of the level of their familiarity with the stimuli (performance across object categories <20%). In contrast, AD patients did not exhibit similar impairments on this task (performance across object categories >79%).

Gesture task

Scoring. The coding for the gesture task closely resembled the procedures followed in Giovannetti et al. (2006) and Bozeat et al. (2002a). Prior to the coding, a gesture 'dictionary' was developed for each object used in the study. Five healthy control subjects were asked to perform the gesture task with all the objects used. Their performance was videotaped and it was subjected to an analysis of the gestures employed on three components: (a) number of hands used to hold the object, (b) hand posture (e.g., clench, pinch), and (c) individual movements (e.g., a semi-circular movement over the head for a hairbrush). Through this process, the normative gestures associated with the use of each object employed in the study were catalogued in the gesture 'dictionary'.

The patients' gestures while performing the gesture task were analyzed from the videorecordings on the basis of the normative gestures as presented in the gesture 'dictionary'. Gestures were scored on the previously-mentioned three components. A point was assigned for each gesture component that was executed without error. Two independent raters, blind to the experimenters' classification of the objects (i.e., familiar objects, perceptually similar or perceptually different analogs), scored participants' responses. The final scores reflected the percent of gesture components that were accurately performed out of the total number of possible correct gesture steps for each object that were included in the 'dictionary'. Inter-rater reliability (Pearson's r) for the gesture task was .75; the reliability procedures were the same as in the naming task. The common scores of the raters (after consensus) were used for the analyses.

One SD patient (JR) failed to follow consistently the instructions for the gesture task with sufficient accuracy, thus testing for gesture was not completed. Relative to AD patients, SD patients did not exhibit significant decrements in performance in this task across all object categories (all ps > .13; see Table 5). Similar to the Naming task, there was no significant effect of object type (familiar,

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

TABLE 3
Individual patient performance by object type and experimental task

Patient (diagnosis)	*JR (FTD-SD)*			*SB (FTD-SD)*			*TM (FTD-SD)*			*JB (FTD-SD)*			*LA (AD)*			*DP (AD)*			*WL (AD)*		
Object type	*F*	*S*	*D*	*F*	*S*	*D*	*F*	*S*	*D*	*F*	*S*	*D*	*F*	*S*	*D*	*F*	*S*	*D*	*F*	*S*	*D*
Task																					
Naming[a]	.08	.08	.08	.25	.08	.08	.17	.08	.17	.25	.42	.25	1.00	.83	.73	.92	.92	.92	.82	.83	.73
Gesture[a]	–	–	–	.94	.80	.77	1.00	.98	.98	.91	.91	.91	.92	.71	.80	.87	.79	.75	.82	.93	.93
Personal object Decision[a]	.67	.58	.42	.75	1.00	1.00	.92	.92	.92	.58	.92	.92	.83	.67	.58	.25	1.00	.92	.36	1.00	.82
object use judgment[a]	.83	.92	.75	1.00	.92	.92	1.00	.92	.92	1.00	1.00	1.00	.83	.92	1.00	.83	.67	.92	1.00	1.00	1.00
Script generation																					
Content words[b]	35.17	31.33	35.00	16.17	15.00	13.75	4.25	3.08	4.25	11.75	11.25	10.92	31.57	21.13	20.40	11.58	9.17	8.25	19.18	20.73	18.64
Total words	154.17	147.58	156.42	48.83	47.33	45.83	9.42	8.42	10.33	34.50	39.33	38.42	130.57	75.00	91.20	36.92	32.58	31.17	53.46	65.27	62.18
Content[b]*/Total words ratio*	.24	.25	.35	.36	.33	.30	.45	.40	.43	.35	.31	.31	.24	.31	.23	.32	.29	.51	.37	.34	.32

Note: FTD-SD, Frontotemporal Semantic dementia; AD, Alzheimer's disease; F, Familiar object; S, Perceptually similar object analog; D, Perceptually different object analog.
[a]Score reflects the proportion of correct responses by patient and object type.
[b]Content words reflect the correct-relevant content words for the objects.

TABLE 4
Mean proportion of correct responses (standard deviations) by object type and patient group for the Naming, Personal Object Decision, and Object Use Judgment Tasks

	Familiar objects	*Perceptually similar analogs*	*Perceptually different analogs*
Semantic dementia patients (n = 4)			
Naming Task	.19 (.08)	.17 (.17)	.15 (.08)
Personal Object Decision Task	.73 (.15)	.85 (.19)	.83 (.28)
Object Use Judgment Task	.96 (.09)	.94 (.04)	.90 (.11)
Alzheimer's disease patients (n = 3)			
Naming Task	.91 (.28)	.86 (.36)	.79 (.41)
Personal Object Decision Task	.49 (.51)	.89 (.32)	.77 (.43)
Object Use Judgment Task	.89 (.32)	.86 (.36)	.97 (.16)

TABLE 5
Means (standard deviations) of proportion of correct gesture steps for the Gesture Task by object type and patient group

	Object type		
	Familiar objects	*Perceptually similar analogs*	*Perceptually different analogs*
Semantic dementia patients (n = 3)	.95 (.15)	.90 (.18)	.89 (.19)
Alzheimer's disease patients (n = 3)	.89 (.26)	.81 (.35)	.83 (.32)

Note: The proportion of correct gesture steps was calculated relative to the total number of possible necessary gesture steps that were identified in the gesture 'dictionary'.

perceptually similar, perceptually different) in either patient group (all *p*s > .29; see Table 5). With respect to individual subject performance, of the four SD patients, one (SB) showed a familiar objects advantage; in fact, for this patient performance on perceptually similar and perceptually different object analogs was at least 10% lower than in the other two SD patients, who were relatively unimpaired on this task across object categories (see Table 3). None of the AD patients appeared to show a familiar objects advantage. Critically, in contrast to the discrepancy between the AD and SD participants on the naming tasks, the groups performed comparably on the gesture task. For both groups, the ability to generate gestures appropriate for the use of each object was largely unimpaired (see Tables 3 and 5). Importantly, for SD patients performance on this task, although not flawless, was dramatically better relative to their performance on the naming task.

Personal object decision task

Scoring. Participants' responses were scored from the videorecordings on whether they correctly identified each object as their own or the experimenter's. Two independent raters scored participants' responses. Inter-rater reliability (Cohen's Kappa) for the personal object decision task was .93; the reliability procedures were the same as in the previous tasks. The final scores of the raters (after consensus) reflected participants' percent of correct responses across all items by category.

SD patients did not differ in their ability to recognize whether each object was theirs or not relative to the AD patient group (all *p*s > .29), although – similar to the gesture task – there was a trend for SD patients to outperform AD patients on this task (see Tables 3 and 4). For both patient groups, the difference in performance across all object categories was not significant (all *p*s > .11). One of the four SD patients (JR) showed an advantage for familiar objects, though his performance was overall very poor (see Table 3). Interestingly, two of the four SD patients (SB, JB) showed the *reverse* familiarity effect, with better ability (>92%) to reject perceptually similar and different analogs as their own objects. A similar pattern was observed in the AD group: one of the three patients (LA) showed a familiar objects advantage, whereas the other two (DP, WL) showed a reverse familiarity effect (see Table 3). (We will return to this issue in the Discussion.) Importantly, three of the four SD patients, although not errorless, performed fairly well on this task, whereas two of the three AD patients performed very poorly, particularly for objects that were classified as familiar to them. Overall, contrary to their performance on the naming task,

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

but similar to their scores on the gesture task, SD patients were generally unimpaired in the personal object decision task.

Object use judgment task

Scoring. For each condition (orientation, semantic, and correct) participants' responses were scored from the videorecordings as properly identifying whether the object was used correctly or not. The scoring and reliability procedures were the same as in the previous tasks. Inter-rater reliability (Cohen's Kappa) for the object use judgment task was .82. The final scores of the raters (after consensus) reflected participants' percent of correct responses across all items by category.

Both patient groups performed equally well on this task for all object categories (all *p*s > .25). Across object categories there were no differences in performance for either patient group (all *p*s > .18) that would indicate deterioration from the familiar to the perceptually similar and different object analogs (see Tables 3 and 4), although there was a trend toward better performance for familiar items relative to perceptually different items in the SD group ($Z = -1.73$, $p = .08$). None of the patients in either group showed a strong familiar objects advantage for the object use judgment task. However, all four SD patients performed >75% on this task, with three of the four (SB, TM, JB) exhibiting almost perfect performance (>92%) regardless of object category (see Table 3). In contrast, two of the three AD patients (LA, DP) appeared somewhat impaired on this task, possibly due to difficulties in the organization of complex action associated with AD (see Table 3). In general, the SD patients appeared able to specify whether an object was being used correctly or not, and the level of familiarity and perceptual similarity of the object did not seem to determine good performance on this task.

Semantic/script generation task

Scoring. The participants' responses were transcribed from the videorecordings by two research assistants, blind to the classification of the objects. The blind coders subsequently counted the total number of words included in each transcript. In an attempt to quantify accurate and meaningful information that the participant generated for each object, two different blind coders identified the number of 'content' words per object for each transcript. Content words were defined as all nouns, verbs, adjectives, prepositions, and adverbs that correctly referred to the target object. For instance, if in the presence of a hairdryer a participant gave the response 'Well I use it in the bedroom, in the bathroom . . . when you wash you hair and it's wet, if you want it to dry' the response would be given a score of 9 content words (*use*, *in*, *bedroom*, *bathroom*, *when*, *wash*, *hair*, *wet*, *dry*).[3] The reliability procedures were the same relative to the previous tasks. The average inter-rater reliability (Pearson's *r*) for the presence of content words was .90 (range .88 to .94). The common scores of the raters (after consensus) were used for the analyses. For each patient, the number of total words, the number of total correct-relevant content words, and the proportion of correct-relevant content words (i.e., the correct-relevant content words/total words ratio) were calculated.

Relative to AD patients, SD patients did not differ in the number of correct-relevant content and total words generated, or the correct-relevant content words/total words ratio for any of the object categories (all *p*s > .63; see Table 6). Critically, contrary to their performance on the naming task, all patients were able to generate satisfactory and appropriate responses for the objects in the script generation task, though – as expected – there was some variability in the quality of the responses, as captured by our comprehensive coding scheme for this task. Examples of task appropriate and inappropriate patient responses by patient group are presented in Table 7. None of the patients showed a strong familiar objects effect in this task (see Table 3). Nevertheless, the pairwise comparisons (Wilcoxon Signed-ranks test for related samples) suggested a possible advantage for familiar objects relative to perceptually similar analogs in the number of correct-relevant content words generated in the SD group ($Z = -1.83$, $p = .07$). No familiar objects advantage was observed in the AD group in this task (all *p*s > .11). In sum, in comparison with the AD group and despite the nature of their semantic memory deficit, SD patients were overall able to perform well on this task.

[3]Patients' content word generation for each object was given to a group of age-matched healthy control participants who verified the relevance of the generated words for the object in question. Given the length of the related analyses, those results will not be presented in detail here, as they go beyond the scope of the present paper.

TABLE 6
Means (standard deviations) of Correct-Relevant Content Words, Total Words, and their Ratio for the Semantic/Script Generation Task by object type and patient group

	Familiar objects	*Perceptually similar analogs*	*Perceptually different analogs*
Semantic dementia patients (n = 4)			
Correct-Relevant Content Words	16.83 (13.58)	15.17 (12.56)	15.98 (13.77)
Total Words	61.73 (68.49)	60.67 (69.80)	62.75 (72.96)
Correct-Relevant Content/Total Words Ratio	.35 (.13)	.32 (.14)	.32 (.12)
Alzheimer's disease patients (n = 3)			
Correct-Relevant Content Words	19.03 (8.72)	16.36 (7.74)	14.50 (6.94)
Total Words	64.83 (40.32)	55.13 (30.15)	54.07 (29.24)
Correct-Relevant Content/Total Words Ratio	.32 (.08)	.31 (.08)	.39 (.62)

TABLE 7
Examples of Appropriate and Inappropriate patient responses the Semantic/Script Generation Task by object type and patient group

	When would you use this object?	*Where would you use this object?*	*How would you use this object?*
Semantic dementia patients			
Appropriate response	[Comb] Early in the morning when your hair looks really bad.	[Hairdryer] Well I use it in the bedroom, in the bathroom . . . when you wash you hair and its wet, if you want it to dry. You hold onto that.	[Glass] Pick it up with your hand and take a drink.
Inappropriate response	[Key] That's a good question. Oh right, right. You know I can't think of it, it's funny.	[Hat] I have only done it very little.	[Pen] Well, I would be able to, uh, have like a book to have you know, and be able to, just to, you know, just so you do not have to have paper.
Alzheimer's disease patients			
Appropriate response	[Pencil] If I were writing a letter, I would use that object. If I were just sitting writing something for myself I would use that object. I would use that object whenever I wanted to write something.	[Bowl] I'd use it for dessert probably.	[Spoon] I would take the handle, I would dip it into the soup, pick it up and, very carefully, put it into my mouth.
Inappropriate response	[Fork] This is a fork; I would use it pretty much like the other things I use. You use it for baking when you need it and, um, those are the kind of things you use when you are out sometimes.	[Cup] Wherever you are when you need it.	[Lipstick] You have the um, and you have to look at the person and see what coloring they are and how they look then they have to bring in that kind of a thing.

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

Analysis across tasks

The results of the battery of semantic memory assessments that we presented above would suggest that the performance of SD patients compared to the control group of AD patients was significantly impaired on the naming task relative to the other tasks, for which performance was satisfactory albeit not flawless (see Tables 3–6). To explore more directly whether there was a significant

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

difference in performance in the naming task relative to the other tasks in the SD patient group only, we performed non-parametric pairwise comparisons (Wilcoxon Signed-ranks tests for related samples) between the naming task and the three assessments which were scored in percent correct responses by participant (i.e., gesture task, personal object decision task, and object use judgment task), for each object type separately (familiar, perceptually similar, perceptually different).

In line with our predictions, for the familiar objects, performance on the naming task in the SD group tended to be impaired relative to performance on the gesture task ($Z = –1.60$, $p = .06$, one-tailed), the personal object decision task ($Z = –1.83$, $p = .03$, one-tailed), and the object use judgment task ($Z = –1.89$, $p = .03$, one-tailed). In contrast, AD controls performed better on the naming task relative to the personal objects decision task ($Z = –1.60$, $p = .06$, one-tailed); all other comparisons for that group were not significant (all ps > .18). Similarly, SD patients' performance on the naming task for the perceptually similar objects tended to be impaired relative to performance on the gesture task ($Z = –1.60$, $p = .06$, one-tailed), the personal object decision task ($Z = –1.84$, $p = .03$, one-tailed), and the object use judgment task ($Z = –1.89$, $p = .03$, one-tailed). For the AD patient control group, in contrast, there were no differences in performance across tasks (all ps > .29). Finally, for the perceptually different objects, performance on the naming task in the SD group tended to be impaired relative to performance on the gesture task ($Z = –1.60$, $p = .06$, one-tailed), the personal object decision task ($Z = –1.84$, $p = .03$, one-tailed), and the object use judgment task ($Z = –1.84$, $p = .03$, one-tailed). In contrast, for the AD control group there were no similar task effects (all ps > .16).[4]

Overall, the results of the tasks we employed in the present study appear to support the hypothesis that a more comprehensive set of semantic memory assessments may reveal different patterns of impairment for object knowledge in SD. Specifically, our findings would suggest that – relative to a control group of AD patients – SD patients exhibited dramatic impairments in the naming task; however, as reported in the previous section, their performance was relatively unimpaired in the other assessments, which may have tapped other aspects of the patients' semantic memory for object concepts.

DISCUSSION

The primary aim of the present study was to explore whether certain aspects of an object's distributed conceptual representation, such as an object's name, might be susceptible to semantic deterioration at different rates relative to other aspects, such as knowledge of an object's function or correct mode of manipulation. In contrast to most previous studies that employed a single task to measure the degree of impairment of conceptual knowledge for objects in SD, in the present experiment we combined multiple procedures that allowed us to obtain a comprehensive assessment of the patients' object knowledge. Additionally, we investigated whether autobiographical experience and personal familiarity with specific items would modulate the effects of the disease, such that familiar objects would elicit better performance on semantic memory tasks relative to perceptually similar and different object analogs.

By employing a broader combination of procedures, we were able to demonstrate, in the same group of SD patients relative to a control group of AD patients, that although SD, predictably, leads to vastly impaired performance on naming tasks (<20% correct response rates), other aspects of the patients' knowledge for objects remained significantly well-preserved. Specifically, the patients were reliably able (a) to gesture with their hands the objects' normative function, (b) to identify whether a particular object was theirs or not, and (c) to decide on whether an object was used correctly or not. Furthermore, when asked questions referring to the context of using these items (where, when, how they would use each object), the patients were able to generate verbally meaningful scenarios regarding the objects' canonical, everyday function.

These findings are in line with distributed accounts of semantic memory (e.g., Allport, 1984; Chao, Haxby, & Martin, 1999; Damasio & Damasio, 1994; Pulvermüller, 1999; Tranel et al., 1997; Tyler & Moss, 2001) according to which knowledge for objects is encoded through multiple

[4]To explore performance across all tasks including the script generation task, we converted each participant's overall score for each task, separately for each object category, to a z score and repeated all analyses; however, due to the small number of patients for z score analyses, none of these differences reached statistical significance.

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

cortical pathways that are activated by one's multimodal experiences with a given item (e.g., visual, tactile, language-based, etc.). Brain injuries or neurodegenerative diseases may differentially influence these pathways, such that some aspects of object concepts deteriorate whereas others are preserved. In accord with this view, our findings indicate that SD may affect certain aspects of an object's conceptual representation (e.g., object name) more than others (e.g., knowledge of function or correct mode of manipulation), which may remain relatively maintained – albeit not entirely – until later stages of the disease.

It is important to emphasize that these patients were not simply anomic; the data from the Pyramids and Palm Trees test indicate that their knowledge for a broad range of concepts was, in fact, degraded significantly to meet the criteria for an SD diagnosis. Nevertheless, we note that in the present study we focused exclusively on artifacts. We suspect that the observed effects could follow different patterns of impairment for other categories such as natural kinds (e.g., fruits, vegetables, animals) for which tactile or functional/action information may be limited. However, we acknowledge that assessments of knowledge for animals or fruits may be necessarily restricted to expressive or receptive recognition tasks that may reveal more pronounced deficits, akin to the markedly impaired performance on the naming task we observed in the present study (e.g., Graham, Patterson, Powis, Drake, & Hodges, 2002; Rogers et al., 2004a; Rogers, Patterson, & Graham, 2007; see also Patterson et al., 2006, 2007). Whether manipulability or functional information determines knowledge preservation in SD for different object categories is an empirical question worthy of further experimental investigation.

With regards to the influence of personal familiarity and autobiographical experience on the maintenance of certain aspects of object knowledge, our findings would suggest that the effect might be idiosyncratic or determined by patient-specific factors. In particular, only one of the four SD patients (SB, see Table 3) showed better performance for her familiar objects in two of the five semantic memory assessments (i.e., naming and gesture). A different SD patient (JR), showed a similar effect, but only for the personal object decision task. For the script generation task, SD patients, overall, showed a possible trend toward the predicted direction, namely better performance on content words for familiar objects relative to perceptually similar object analogs. In the AD group, one of the three AD patients (LA) showed better performance for her familiar objects in two of the five semantic memory assessments (i.e., naming and personal object decision). No other familiar objects effects were observed in that group. Interestingly, two SD patients (SB, JB) and two AD patients (DP, WL) exhibited the reverse familiarity effect in the personal object decision task; in other words, it was easier for them to reject correctly experimenter items as theirs, behavior that was possibly guided by the more 'autobiographical' nature of this task. Regarding this result, it is possible that explicit recognition of an object as one's own is especially difficult outside of the object's natural context and in a very unusual context (i.e., in the hands of the experimenter). Overall, these findings are characterized by more variability than what was reported in earlier results (e.g., Bozeat et al., 2002a; Funnel, 1995, 2001; Snowden et al., 1994). When we used a comprehensive set of assessments of object knowledge relative to the single-task procedures employed in earlier studies, the suggested advantage for the patients' familiar objects was not as pronounced as in previous experiments (Bozeat et al., 2002a, 2002b), and, critically, it did not hold consistently across all the tasks.

A number of factors may have contributed to these differences with earlier work. One possibility is that our SD patients may have had experience with multiple exemplars of the examined objects, which may have allowed them to generalize more easily across perceptually similar and perceptually different object analogs. However, from our discussions with the caregivers during the identification of the familiar objects, exposure to multiple exemplars would appear unlikely.

Furthermore, it could be argued that the analog objects were not sufficiently different perceptually relative to the patients' familiar objects. As mentioned earlier, similarity in the present study was defined in order of degree rather than in absolute terms, which may partially account for the absence of marked improvements in performance for the familiar items.

A related issue pertains to the use of color as one of the variables we manipulated to determine degree of similarity between familiar objects and their analogs. Specifically, earlier research has shown that color may be represented differently than object size and shape and, as a result, may have qualitatively different effects on object recognition (see Oliver & Thompson-Schill, 2003).

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

Moreover, color knowledge in SD appears to decline in parallel with object names (e.g., Rogers et al., 2007); hence, color may not have been an aspect of the objects to which the patients strongly attended. For these reasons, it might be that the use of color to manipulate perceptual similarity may have led to the selection of analog objects that were not as perceptually different from the patients' familiar objects as what was originally intended. Notwithstanding these possibilities, the use of shape and size for the identification of perceptually similar and different analogs, along with the high inter-rater agreement during the analog object selection, would suggest that the analogs were sufficiently different from the familiar objects to elicit the familiarity effects previously reported in the literature.

A different possible factor that may have influenced our findings is the overall frequency or familiarity in the environment of the objects we presented. Recent findings have shown significantly better performance of SD patients in semantic memory assessments involving typical or frequent versus atypical or infrequent exemplars of an item category (e.g., Caine et al., 2009; Jefferies et al., 2009; Rogers et al., 2007; Woollams et al., 2008). This would suggest that the familiar objects advantage might be the result of an interaction between a patient's personal familiarity for a given item and the degree of familiarity or frequency of that particular item category in the environment. In other words, it is possible that patients perform fairly well with objects that are, in general, more frequent in the environment (e.g., toothbrushes, spoons, keys), but they show an advantage for familiar objects that are, overall, encountered rarely (e.g., mattress inflator, candle snuffer). In the present study, we focused on the effects of personal familiarity versus perceptual similarity and did not manipulate overall item familiarity explicitly. From our evaluation of the familiarity and frequency of the items we used for each patient (see Table 2), all objects would appear to be of average-to-high familiarity and frequency for all patients in both groups. Accordingly, it is possible that our findings apply only to items of average-to-high frequency and that a more pronounced familiar objects advantage might be observed with lower-frequency items. A concurrent manipulation, thus, of personal and overall familiarity of the objects, in conjunction with comparisons involving perceptually similar and different object analogs, could address this issue in future work.

An important issue brought up by these data concerns disease severity. In interpretations of these and other findings in SD, it is essential to take into account the progressive character of the disorder and the likelihood that it does not affect the abilities of different patients in the same manner (Bright, Moss, Stamatakis, & Tyler, 2008; Silveri & Ciccarelli, 2009; see also Caine et al., 2009). Regarding the present results, the observed dissociations between naming and the remaining measures are likely associated with the mild to moderate SD diagnosis of the particular patient cohort. As the disease progresses, we would expect a decline in performance for all tasks, which would then resemble the low scores on the naming task, albeit with some heterogeneity across patients. Regarding the potential advantage for familiar objects, it is further possible that our patients were less impaired relative to those examined in earlier studies (e.g., Bozeat et al., 2002a), which could explain our less pronounced effects. For example, as the disease progresses, patients may increasingly rely on autobiographical experience for object recognition during their daily activities, thus showing a stronger familiar objects advantage. Notably, however, these effects may be idiosyncratic and determined by the patients' level of everyday activity and the degree of preservation of their autobiographical and episodic memories (Adlam et al., 2009; Matuszewski et al., 2009).

On the whole, our results complement earlier research on SD (e.g., Bozeat et al., 2002a; Funnell, 1995a, 2001; Ikeda, Patterson, Graham, Lambon-Ralph, & Hodges, 2006; Snowden et al., 1994, 1996; see also Graham, Patterson, Pratt, & Hodges, 1999) because they highlight the importance of using multiple assessments of semantic knowledge to evaluate what SD patients do and do not know about everyday objects. By using a combination of tasks that capture different aspects of the patients' object knowledge, we were able to show that significant components of semantic memory for objects are maintained relatively well. Importantly, the trends toward a familiar objects advantage we observed in some patients would appear to indicate that – in the early stages of the disease – personal, everyday experience with objects might support those components of semantic memory that remain relatively preserved.

Such a possibility may have important implications for various rehabilitation interventions for semantic dementia, which would prolong the patients' independence in activities of daily living

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

until the late stages of the disease. For example, after identifying the degree of semantic deterioration through a comprehensive set of procedures like the ones we used in the present study, patients could relearn aspects of object knowledge they have lost – such as object names – through training procedures that build on aspects of object knowledge that remain preserved – such as knowledge of an object's function or mode of manipulation. For example, Jokel, Rochon, and Leonard (2006) have shown that a comprehensive training program on items patient AK could not name but could understand prior to treatment, was associated with a significant relearning of these items. In addition, the practice program was able to delay the progression of semantic memory loss for items that were not affected prior to treatment. Moreover, a recent study has demonstrated the effectiveness of errorless learning, computer-based paradigms as treatment interventions for semantic dementia (Jokel, Rochon, & Anderson, 2010). By means of such an intervention, an SD patient (CS) was able to relearn the names of objects the he had lost but understood, in addition to maintaining the names of known items for a longer period of time during the progression of the disease (see also Dewar, Patterson, Wilson, & Graham, 2009; Heredia, Sage, Lambon Ralph, & Berthier, 2009; Kumar & Humphreys, 2008; see also Bier, Macoir, Gagnon, Van der Linden, Louveaux, & Desrosiers, 2009; Henry, Beeson, & Rapcsak, 2008). In sum, rehabilitation studies suggest that it is critical to rely on relatively preserved knowledge for effective retraining and remediation. Our data indicate that knowledge of actions and object use may serve as a relatively stable foundation on which retraining may begin in SD.

Finally, the present findings would suggest that there is an interaction between autobiographical experience involving common objects and one's semantic knowledge about the world. Although SD patients were significantly impaired in the naming task, they were able to perform reasonably well in the other assessments of semantic memory. However, their performance in these tasks was not flawless. This suggests that some degradation of semantic memory can influence behaviors involving common objects, inasmuch as these behaviors are supported by autobiographical experience. Our results could, thus, contribute to recent accounts on the role of autobiographical memory in SD (Adlam et al., 2009; Funnel, 2001; Graham, Simons, Pratt, Patterson, & Hodges, 2000; Hodges & Graham, 2001; McKinnon et al., 2008; Simons & Graham, 2000).

ACKNOWLEDGEMENTS

This work was supported by grants AG17586, AG15116, and NS44266 from the National Institutes of Health to MG. The authors would like to thank Katy Cross, Shaleigh Kwok, and Shweta Antani for their assistance in the collection of the neuropsychological assessment of the patients diagnosed at the Hospital of the University of Pennsylvania and Jamie J. Reilly and Christopher H. Ramey for valuable comments on earlier versions of this manuscript.

Original manuscript received 30 August 2009
Revised manuscript accepted 15 April 2010
First published online 1 September 2010

REFERENCES

Adlam, A.-L. R., Patterson, K., Rogers, T. T., Nestor, P. J., Salmond, C. H., Acosta-Cabronero, J., et al. (2006). Semantic dementia and fluent primary progressive aphasia: Two sides of the same coin? *Brain*, *129*, 3066–3080.

Adlam, A.-L. R., Patterson, K., & Hodges, J. R. (2009). 'I remember it as if it were yesterday': Memory for recent events in patients with semantic dementia. *Neuropsychologia*, *47*, 1344–1351.

Allport, D. A. (1985). Distributed memory, modular systems, and dysphasia. In S. K. Newman & R. Epstein (Eds.), *Current perspectives in dysphasia* (pp. 32–60). Edinburgh, UK: Churchill Livingstone.

Balota, D. A., Yap, M. J., Cortese, M. J., Hutchison, K. A., Kessler, B., Loftis, B., et al. (2007). The English Lexicon Project. *Behavior Research Methods*, *39*, 445–459.

Bier, N., Macoir, J., Gagnon, L., Van der Linden, M., Louveaux, S., & Desrosiers, J. (2009). Known, lost, and recovered: Efficacy of formal-semantic therapy and spaced retrieval method in a case of semantic dementia. *Aphasiology*, *23*, 210–235.

Bozeat, S., Lambon Ralph, M. A., Patterson, K. Garrard, P., & Hodges, J. R. (2000). Non-verbal semantic impairment in semantic dementia. *Neuropsychologia*, *38*, 1207–1215.

Bozeat, S., Lambon Ralph, M. A., Patterson, K., & Hodges, J. R. (2002a). The influence of personal familiarity and context on object use in semantic dementia. *Neurocase*, *8*, 127–134.

Bozeat, S., Lambon Ralph, M. A., Patterson, K., & Hodges, J. R. (2002b). When objects lose their meaning: What happens to their use? *Cognitive, Affective, & Behavioral Neurosciences*, *2*, 236–251.

Bozeat, S., Patterson, K., & Hodges, J. R. (2004). Relearning object use in semantic dementia. *Neuropsychological Rehabilitation*, *14*, 351–363.

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

Bright, P., Moss, H. E., Stamatakis, E. A., & Tyler, L. K. (2008). Longitudinal studies of semantic dementia: The relationship between structural and functional changes over time. *Neuropsychologia*, *46*, 2177–2188.

Buxbaum, L. J., Schwartz, M. F., & Carew, T. G. (1997). The role of semantic memory in object use. *Cognitive Neuropsychology*, *14*, 219–254.

Caine, D., Breen, N., & Patterson, K. (2009). Emergence and progression of 'non-semantic' deficits in semantic dementia. *Cortex*, *45*, 483–494.

Chao, L. L., Haxby, J. V., & Martin, A. (1999) Attribute-based neural substrates in temporal cortex for perceiving and knowing about objects. *Nature Neuroscience*, *2*, 913–919.

Coccia, M., Bartolini, M., Luzzi, S., Provincialli, L., & Lambon Ralph, M. A. (2004). Semantic memory as an amodal, dynamic system: Evidence from the interaction of naming and object use in semantic dementia. *Cognitive Neuropsychology*, *21*, 513–527.

Coltheart, M. (1981). The MRC Psycholinguistic database. *Quarterly Journal of Experimental Psychology*, *33A,* 497–505.

Damasio, A. R., & Damasio, H. (1994). Cortical systems underlying knowledge retrieval. In C. Koch (Ed.), *Large-scale neuronal theories o the brain* (pp. 61–74). Cambridge, MA: MIT Press.

Dewar, B. K., Patterson, K., Wilson, B. A., & Graham, K. S. (2009). Re-acquisition of person knowledge in semantic memory disorders. *Neuropsychological Rehabilitation*, *19*, 383–421.

Duley, J. F., Wilkins, J., Hamby, S., Hopkins, D., Burwell, R., & Barry, N. (1993). Explicit scoring criteria for the Rey-Osterrieth and Taylor complex figures. *The Clinical Neuropsychologist*, *7*, 29–38.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). 'Mini mental state': A practical method for grading the mental state of patients for the clinician. *Journal of Psychiatric Research*, *12*, 189–198.

Funnell, E. (1995a). A case of forgotten knowledge. In R. Campbell & M. A. Conway (Eds.), *Broken memories* (pp. 225–236). Oxford: Blackwell Publishers.

Funnell, E. (1995b). Objects and properties: A study of the breakdown of semantic memory. *Memory*, *3*, 497–518.

Funnell, E. (2001). Evidence for scripts in semantic dementia: Implications for theories of semantic memory. *Cognitive Neuropsychology*, *18*, 323–341.

Gilhooly, K. J., & Logie, R. H. (1980). Age of acquisition, imagery, concreteness, familiarity and ambiguity measures for 1944 words. *Behavior Research Methods and Instrumentation*, *12*, 395–427.

Giovannetti, T., Sestito, N., Libon, D. J., Schmit, K., Gallo, J. L., Gambino, M., & Chrysikou, E. G. (2006). The influence of personal familiarity on object naming, knowledge and use in dementia. *Archives of Clinical Neuropsychology*, *21*, 607–614.

Graham, K. S., Lambon Ralph, M. A., & Hodges, J. R. (1997). Determining the impact of autobiographical experience on 'meaning': New insights from investigating sports-related vocabulary and knowledge in two cases with semantic dementia. *Cognitive Neuropsychology*, *14*, 801–837.

Graham, K. S., Lambon Ralph, M. A., & Hodges, J. R. (1999). A questionable semantics: The interaction between semantic knowledge and autobiographical experience in semantic dementia. *Cognitive Neuropsychology*, *16*, 689–698.

Graham, K. S., Patterson, K., Pratt, K. H., & Hodges, J. R. (1999). Relearning and subsequent forgetting of semantic category exemplars in a case of semantic dementia. *Neuropsychology*, *13*, 359–380.

Graham, K. S., Simons, J. S., Pratt, K. H., Patterson, K., & Hodges, J. R. (2000). Insights from semantic dementia on the relationship between episodic and semantic memory. *Neuropsychologia*, *38*, 313–324.

Graham, K. S., Patterson, K., Powis, J., Drake, J., & Hodges, J. R. (2002). Multiple inputs to episodic memory: Words tell another story. *Neuropsychology*, *16*, 380–389.

Grossman, M. (2002) Frontotemporal dementia: A review. *Journal of the International Neuropsychological Society*, *8*, 566–683.

Grossman, M., & Ash, S. (2003). Primary Progressive Aphasia: A Review. *Neurocase*, *10*, 3–18.

Grossman, M., McMillan, C., Moore, P., Ding, L., Glosser, G., Work, M., & Gee, J. (2004). What's in a name: Voxel-based morphometric analyses of MRI and naming difficulty in Alzheimer's disease, frontotemporal dementia, and corticobasal degeneration. *Brain*, *127*, 628–649.

Henry, M. L., Beeson, P. M., & Rapcsak, S. Z. (2008). Treatment of anomia in semantic dementia. *Seminars in Speech and Language*, *29*, 60–70.

Heredia, C. G., Sage, K., Lambon Ralph, M. A., & Bertier, M. L. (2009). Relearning and retention of verbal labels in a case of semantic dementia. *Aphasiology*, *23*, 192–209.

Hodges, J. R., & Graham, K. S. (2001). Episodic memory: Insights from semantic dementia. *Phil. Trans. R. Soc. Lond.* B., *356*, 1423–1434.

Hodges, J. R., Patterson, K., Oxbury, S., & Funnell, E. (1992). Semantic dementia: Progressive fluent aphasia with temporal lobe atrophy. *Brain*, *115*, 1783–1806.

Hodges, J. R., Patterson, K., Ward, R., Garrard, P., Bak, T., Perry, R., & Gregory, C. (1999). The differentiation of semantic dementia and frontal lobe dementia (temporal and frontal variants of frontotemporal dementia) from early Alzheimer's disease: A comparative neuropsychological study. *Neuropsychology*, *13*, 31–40.

Howard, D., & Patterson, K. (1992). *Pyramids and palm trees: A test of semantic access from pictures and words*. Bury St. Edmunds, UK: Thames Valley Test Company.

Ikeda, M., Patterson, K., Graham, K. S., Lambon-Ralph, M., & Hodges, J. R. (2006). A horse of a different color: Do patients with semantic dementia recognize different versions of the same object as the same? *Neuropsychologia*, *44*, 566–575.

Jefferies, E., Patterson, K., Jones, R. W., & Lambon Ralph, M. A. (2009). Comprehension of concrete and abstract words in semantic dementia. *Neuropsychologia*, *23*, 492–499.

Jokel, R., Rochon, E., & Leonard, C. (2006). Treating anomia in semantic dementia: Improvement, maintenance, or both? *Neuropsychological Rehabilitation*, *16*, 241–256.

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011

Jokel, R., Rochon, E., & Anderson, N. D. (2010). Errorless learning of computer-generated words in a patient with semantic dementia. *Neuropsychological Rehabilitation*, *20*, 16–41.

Koenig, P., Smith, E. E., & Grossman, M. (2006). Semantic categorization of novel objects in frontotemporal dementia. *Cognitive Neuropsychology*, *23*, 541–562.

Kopelman, M. D., Wilson, B. A., & Baddeley, A. D. (1990). *The Autobiographical Memory Interview*. Bury St. Edmunds, UK: Thames Valley Test Company.

Kumar, V. P., & Humphreys, G. W. (2008). The role of semantic knowledge in relearning spellings: Evidence from deep dysgraphia. *Aphasiology*, *22*, 489–504.

Lambon Ralph, M. A., Graham, K. S., Ellis, A. W., & Hodges, J. R. (1998). Naming in semantic dementia: What matters ? *Neuropsychologia*, *36*, 775–784.

Lauro-Grotto, R. Piccini, C., & Shallice, T. (1997). Modality-specific operations in semantic dementia. *Cortex*, *33*, 593–622.

Libon, D. J., Malamut, B. L., Swenson, R., & Cloud B. S. (1996). Further analysis of clock drawings among demented and non-demented subjects. *Archives of Clinical Neuropsychology*, *11*, 193–211.

Lund, K., & Burgess, C. (1996). Producing high-dimensional semantic spaces from lexical co-occurrence. *Behavior Research Methods, Instruments, & Computers*, *28*, 203–208.

Luzzi, S., Snowden, J. S., Neary, D., Coccia, M., Provinciallli, L., & Lambon Ralph, M. A. (2007). Distinct patterns of olfactory impairment in Alzheimer's disse, semantic dementia, frontotemporal dementia, and corticobasal degeneration. *Neuropsychologia, 45*, 1823–1831.

Magnié, M. N., Ferreira, C. T., Giuliano, B., & Poncet, M. (1999). Category specificity in object agnosia: Preservation of sensorimotor experiences related to object. *Neuropsychologia*, *37*, 67–74.

Matuszewski, V., Piolino, P., Belliard, S., de la Sayette, V., Laisney, M., Lalevée, C., Pélerin, A., Viader. F., Eustache, F., & Desgranges, B. (2009). *Cortex*, *45*, 456–472.

McKhann, G., Drachman, D., Folstein, M., Katzman, R., Price, D., & Stadian, E. M. (1984). Clinical diagnosis of Alzheimer's disease: Report on the NINCDS-ADRDA work group under the auspices of the Department of Health and Human Services Task Force on Alzheimer's disease. *Neurology*, *34*, 939–944.

McKinnon, M. C., Nica, E. I., Sengdy, P., Kovacevic, N., Moscovitch, M., Freedman, M., Miller, B. L., Black, S. E., & Levine, B. (2008). Autobiographical memory and patterns of brain atrophy in frontotemporal lobar degeneration. *Journal of Cognitive Neuroscience*, *20*, 1839–1853.

Mesulam, M. M., Grossman, M., Hillis, A., Kertesz, A., & Weintraub, S. (2003). The core and halo of primary progressive aphasia and semantic dementia. *Annals of Neurology*, *54*, S11–S14.

Mickanin, J., Grossman, M., Onishi, K., Auriacombe, S., & Clarke, C. (1994). Verbal and non-verbal fluency in patients with probable Alzheimer's disease. *Neuropsychology*, *8*, 385–394.

Moss, H. E., Kopelman, M. D., Cappelletti, M., deMoranay Davies, P., & Jaldow, E. (2003). Lost for words or loss of memories? Autobiographical memory in semantic dementia. *Cognitive Neuropsychology*, *20*, 703–732.

Mummery, C. J., Patterson, K., Hodges, J. R., & Price, C. J. (1998). Functional neuroanatomy of the semantic system: Divisible by what? *Journal of Cognitive Neuroscience*, *10*, 766–777.

Mummery, C. J., Patterson, K., Price, C. J., Ashburner, J., Frackowiak, R. S. J., & Hodges, J. R. (2000). A voxel-based morphometry study of semantic dementia: Relationship between temporal lobe atrophy and semantic memory. *Annals of Neurology*, *47*, 36–45.

Mummery, C. J., Patterson, K., Wise, R. J. S., Vandenberg, R., Price, C. J., & Hodges, J. R. (1999). Disrupted temporal lobe connections in semantic dementia. *Brain*, *122*, 61–73.

Murray, R., Koenig, P., Antani, S., McCawley, G., & Grossman, M. (2007). Lexical acquisition in progressive aphasia and frontotemporal dementia. *Cognitive Neuropsychology*, *24*, 48–69.

Neary, D., Snowden, J. S., Gustafson, L., Passant, U., Stuss, D., Black, S., Freedman, M., Kertesz, A., Robert, P. H., Albert, M., Boone, K., Miller, B.L., Cumming, J., & Benson, D.F. (1998). Frontotemporal lobar degeneration: A consensus on clinical diagnostic criteria. *Neurology*, *51*, 1546–1554.

Oliver, R. T., & Thompson-Schill, S. L. (2003). Dorsal stream activation during retrieval of object size and shape. *Cognitive, Affective, & Behavioral Neuroscience*, *3*, 309–322.

Osterrieth, P. A. (1944). Filetest de copie d'une figure complex: Contribution a l'etude de la perception et de la memoire [The test of copying a complex figure: A contribution to the study of perception and memory]. *Archives de Psychologie*, *30*, 286–356.

Paivio, A. (1985). *Mental representations: A dual coding approach*. New York: Oxford University Press.

Patterson, K., Lambon-Ralph, M. A., Jefferies, E., Woollams, A., Jones, R., Hodges, J. R., & Rogers, T. T. (2006). 'Presemantic' cognition in semantic dementia: Six deficits in search of an explanation. *Journal of Cognitive Neuroscience*, *18*, 169–183.

Patterson, K., Nestor, P. J., & Rogers, T. T. (2007). Where do you know what you know? The representation of semantic knowledge in the human brain. *Nature Reviews Neuroscience*, *8*, 976–987.

Piolino, P., Belliard, S., Desgranges, B., Perron, M., & Eustache, F. (2003). Autobiographical memory and autonoetic consciousness in a case of semantic dementia. *Cognitive Neuropsychology*, *20*, 619–639.

Pulvermüller, F. (1999). Words in the brain's language. *Behavioral and Brain Sciences*, *22*, 253–336.

Rapcsak, S. Z., Ochipa, C., Anderson, K. C., & Poizner, H. (1995). Progressive ideomotor apraxia: Evidence for a selective impairment in the action production system. *Brain and Cognition*, *27*, 213–236.

Rogers, T. T., Lambon Ralph, M. A., Garrard, P., Bozeat, S., McClelland, J. L., Hodges, J. R., et al. (2004a). The structure and deterioration of semantic memory: A computational and neuropsychological investigation. *Psychological Review*, *11*, 205–235.

Rogers, T. T., Lambon Ralph, M. A., Hodges, J. R., & Patterson, K. (2004b). Natural selection: The impact of semantic impairment on lexical and object decision. *Cognitive Neuropsychology*, *21*, 331–352.

Rogers, T. T., Ivanoiu, A., Patterson, K., & Hodges, J. R. (2006). Semantic memory in Alzheimer's disease and the frontotemporal dementias: A longitudinal study of 236 patients. *Neuropsychology*, *20*, 319–335.

Rogers, T. T., Patterson, K., & Graham, K. (2007). Colour knowledge in semantic dementia: It is not all black and white. *Neuropsychologia*, *45*, 3285–3298.

Rosen, W. G., Mohs, R. C., & Davis, K. L. (1984). A new rating scale for Alzheimer's disease. *American Journal of Psychiatry*, *4*, 1356–1364.

Silveri, M. C., & Ciccarelli, N. (2009). Semantic memory in object use. *Neuropsychologia*, *47*, 2634–2641.

Simons, J. S., & Graham, K. S. (2000). New learning in semantic dementia: Implications for cognitive and neuroanatomical models of long-term memory. *Revue de Neuropsychologie*, *10*, 199–215.

Simons, J. S., Lee, A. C. H., Graham, K. S., Verfaellie, M., Koutstaal, W., Hodges, J. R., Schacter, D. L., & Budson, A. E. (2005). Failing to get the gist: Reduced false recognition of semantic associates in semantic dementia. *Neuropsychology*, *19*, 353–361.

Snowden, J. S., Goulding, P. J., & Neary, D. (1989). Semantic dementia: A form of circumscribed cerebral atrophy. *Behavioural Neurology*, *2*, 167–182.

Snowden, J. S., Griffiths, H. L., & Neary, D. (1994). Semantic dementia: Autobiographical contribution to preservation of meaning. *Cognitive Neuropsychology*, *11*, 265–288.

Snowden, J. S., Griffiths, H. L., & Neary, D. (1995). Autobiographical experience and word meaning. *Memory*, *3*, 225–246.

Snowden, J. S., Griffiths, H. L., & Neary, D. (1996). Semantic-episodic memory interactions in semantic dementia: Implications for retrograde memory function. *Cognitive Neuropsychology*, *13*, 1101–1137.

Snowden, J. S., Griffiths, H. L., & Neary, D. (1999). The impact of autobiographical experience on meaning: Reply to Graham, Lambon Ralph, and Hodges. *Cognitive Neuropsychology*, *11*, 673–687.

Snowden, J. S., Bathgate, D., Varma, A., Blackshaw, A., Gibbons, Z. C., & Neary, D. (2001). Distinct behavioral profiles in frontotemporal dementia and semantic dementia. *Journal of Neurology, Neurosurgery, & Psychiatry*, *70*, 323–332.

Snowden, J. S., Thompson, J. C., & Neary, D. (2004). Knowledge of famous faces and names in semantic dementia. *Brain*, *127*, 860–872.

Thompson-Schill, S. L., Kan, I. P., & Oliver, R. T. (2006). Functional neuroimaging of semantic memory. In R. Cabeza & A. Kingston (Eds.), *Handbook of functional neuroimaging of cognition* (2nd ed., pp. 149–190). Cambridge, MA: The MIT Press.

Toglia, M. P., & Battig, W. R. (1978). *Handbook of semantic word norms*. New York: Erlbaum.

Tranel, D., Damasio, H., & Damasio, A. R. (1997). A neural basis for the retrieval of conceptual knowledge. *Neuropsychologia*, *35*, 1319–1327.

Tyler, L. K., & Moss, H. E. (2001). Towards a distributed account of conceptual knowledge. *Trends in Cognitive Science*, *5*, 244–252.

Wechsler, D. A. (1995). *Wechsler Adult Intelligence Scale*. San Antonio, TX: Psychological Corporation.

Westmacott, R., Black, S. E., Freedman, M., & Moscovitch, M. (2003). The contribution of autobiographical significance to semantic memory: Evidence from Alzheimer's disease, semantic dementia, and amnesia. *Neuropsychologia*, *42*, 25–48.

Woollams, A. M., Cooper-Pye, E., Hodges, J. R., & Patterson, K. (2008). Anomia: A doubly typical signature of semantic dementia. *Neuropsychologia*, *46*, 2503–2514.

Downloaded By: [Chrysikou, Evangelia] At: 04:58 22 January 2011