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Treating anomia in semantic dementia: Improvement, maintenance, or both?

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A treatment programme for AK, an anomic patient with semantic dementia is described. The programme was based on home practice and resulted in re-learning the names of some objects AK could not name and/or comprehend prior to the treatment. The effects of treatment were still present one month post-treatment for items that AK could not name but could comprehend prior to treatment. In addition to items that AK could not name, items that she could both understand and name were also included in the programme. This allowed us to evaluate the influence of practice on the retention of words that appeared to be intact at the outset of the investigation. Results indicated that practice delayed the progression of loss. In addition, the programme was designed jointly with AK who made many important decisions related to treatment.

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INTRODUCTION

Semantic dementia (SD) represents the fluent variety of primary progressive aphasia, which is a disorder with insidious onset and a relentless dissolution of language skills that permeates all language modalities (Snowden, Neary, & Mann, 1996). Its features include impaired word comprehension and naming in the presence of effortless, fluent speech and preserved repetition. Non-semantic perceptual skills are usually well preserved, however impaired face and object recognition usually develop with disease progression. It has been established that whereas naming is impaired in SD, word repetition, orthography and phonology are remarkably spared (e.g., Hodges, Patterson, Oxbury, & Funnell, 1992; Hodges, Patterson, & Tyler, 1994; Patterson, Graham, & Hodges, 1994; Patterson & Hodges, 1992). In contrast to impaired single word comprehension, understanding of even syntactically complex sentences is intact (Breedin & Saffran, 1999; Rochon et al., 2004). Surface dysgraphia and dyslexia are writing and reading disorders that usually accompany SD (Graham, Patterson, & Hodges, 2000a; Noble, Glosser, & Grossman, 2000; Patterson & Hodges, 1992). Despite the loss of semantic knowledge (e.g., Bozeat et al., 2000; Graham et al., 2000a), individuals with SD are capable of carrying out all activities of daily living, including solving problems and making decisions (Hodges, 2001). Many SD patients can compensate for word retrieval difficulties with their fluent output and intact syntactic abilities.

Functionally, the earliest and most devastating feature of SD is a loss of word meaning. This is typically reflected in anomia and poor auditory word comprehension. Traditionally, therapy for anomia in neurogenic disorders (e.g., aphasia) has been carried out in cases where a certain degree of recovery can be predicted. Indeed, approaches to remediate anomia arising from impairments of the semantic system have proven beneficial in patients recovering from aphasia (e.g., Drew & Thompson, 1999; Hillis & Caramazza, 1994; Lowell, Beeson, & Holland, 1995; Marshall, Pound, White-Thomson, & Pring, 1990; Nettleton & Lesser, 1991).

Investigations of the effectiveness of interventions for naming deficits in semantic dementia are scarce. To date, there are two published cases by Graham and her colleagues (Graham, Patterson, Pratt, & Hodges, 1999; 2001), as well as a recent study by Snowden and Neary (2002). Graham and colleagues investigated the benefit of repeated home practice on the naming abilities of DM, an anomic patient with semantic dementia. DM had developed a system for practising words that he had difficulty producing. His system included naming words from a picture dictionary that was organised by category (e.g., sports, clothes, etc.). He also kept notebooks, both categorised and non-categorised, wherein he wrote descriptions of the words he could not name. He would then attempt to name the word according

to the descriptions. Graham et al. (1999) demonstrated that repeated practice improved both naming (Experiment 1) and category fluency tasks (Experiments 2 and 3; Graham et al., 2001), as evidenced by the fact that DM's word retrieval abilities were significantly better for practised words than for words that were not practised. DM's performance declined when practice was stopped. This finding is consistent with the suggestion that patients with temporal lobe damage are expected to show abnormally fast forgetting rates for words (Graham et al., 1999; 2001).

Graham et al. (2001) compared the performance of DM (Graham et al., 1999) with that of AM, another patient with SD who practised naming words (Graham & Hodges, 1997). In contrast to the performance of DM, AM did not benefit from repeated practice. Although illness duration was comparable between the two patients, the illness progressed much faster in the case of AM. Therefore, any potential effects of practice may have been overridden by the unusually fast rate of progression. The authors also suggested other factors that may have been responsible for the disparity in treatment results between DM and AM. These included the degree of anomia, the status of semantic memory, and the strategy employed for organising practised words. At the outset of the study DM demonstrated better preserved semantic memory and much better naming abilities than AM who evidenced a notable semantic impairment. With regard to the organisation of practised words, AM organised his words in alphabetical order, thereby, presumably, stimulating the phonological store. DM, in contrast, organised his practice material into semantic categories, evoking both semantic and phonological representations simultaneously.

Snowden and Neary (2002) argued that DM's success in therapy was likely due to his mild impairment and the fact that he had residual semantic information available to facilitate the relearning of names. They further argued that knowledge of temporal and spatial characteristics of objects must also be preserved in order for the relearning of the corresponding words to occur. Using a repeated exposure paradigm they demonstrated that their patient KB had limited but superior relearning of items for which he had some semantic knowledge as compared to those for which his semantic knowledge was lost. In a second patient, CR, Snowden and Neary (2002) demonstrated the superiority of personal "meaningfulness" on the patient's ability to recall defining information of names she had practised. The advantage of recalling some personally meaningful items was maintained for up to 6 months after training had terminated.

Associated with the notion of meaningfulness are the role of personal experience and the significance of spared episodic memory in SD. These factors have surfaced in the literature recently with the work of Snowden and her colleagues (Snowden, Griffiths, & Neary, 1994; 1995; 1996; 1999; Snowden & Neary, 2002) and Graham and her colleagues (Graham &

Hodges, 1997; Graham, Lambon Ralph, & Hodges, 1997; Graham et al., 2000b). One of the most dramatic examples of how personal experience may influence preservation of meaning comes from Snowden et al. (1994). When asked to make a cup of tea, their patient, KE, did not recognise the examiner's kettle as a kettle, despite its close resemblance to her own that had been, unbeknownst to her, replaced. In other words, she failed to recognise the function of a particular kettle that she had not seen before. Based on this phenomenon, commonly seen in patients with semantic dementia, it has been proposed that in SD current experiences mediate the state of semantic knowledge, such that knowledge gained through personal participation is retained longer and more effectively (Snowden et al., 1995; 1996). However, Graham and her colleagues (1997) argue that what is retained in SD is not a deep generalisable semantic knowledge, but "semantic-like" knowledge—personally constrained facts encoded via the spared hippocampus. For example, they showed that their two patients' (MS and AM's) knowledge about golf and bowling (activities in which they participated prior to developing SD) was not superior to their knowledge of other sports, in which the patients did not participate. Subsequently, Snowden, Griffiths, and Neary (1999) qualified their viewpoint by stating that not *all* the previously acquired knowledge of a concept is maintained by the premorbid experience, as concepts can be quite dynamic and are continuously updated by new experiences.

It appears that the recency and personal relevance of experiences in SD are of significance to the preservation of a concept, as is the very autobiographical flavour of encoded knowledge. This may render some of the concepts expressed by semantic patients somewhat "abnormal". For example one of the patients in Snowden et al.'s study (1994) associated a pitcher with a container for holding flowers and never recognised it as a container for drinking water. This "abnormality" stems from the fact that for patients with SD semantic representations may be biased towards attributes acquired with more recent experiences with the object, without necessarily acknowledging the object's full set of semantic features.

This notion of the influence of personal experience on semantic representations has implications for the ability to recognise objects out of their usual context and its impact on object familiarity. Familiarity has been defined by Snodgrass and Vanderwart (1980) as "the degree to which one comes into contact with or thinks about a concept". This definition of familiarity has been revised with relation to SD by Snowden et al. (1994), who added the notion of "*current* experiential relevance".

The following clinical study represents an attempt to capitalise on the notion that personal experience and familiarity affect semantic representations in SD. We describe a treatment programme for the progressive loss of expressive vocabulary in AK, a patient who at the time of this project,

presented with a classical profile of semantic dementia. Some aspects of her naming performance were described in Jokel, Rochon, and Leonard (2002) and her sentence comprehension abilities were investigated in Rochon et al. (2004). Her language profile and self-styled approach to practising words very much resembled that of DM (Graham et al., 1999). We incorporated AK's approach to re-learning words into the design of our study that was carried out in the course of clinical practice. AK made many decisions related to the design and procedure in conjunction with the researchers, such as the selection of treatment items based on vocabulary she deemed necessary for her day-to-day functioning. For example, in addition to some commonly used objects, such as umbrella and gloves, she wanted to re-learn the names of musical instruments. Several adaptations to the clinical protocol were made to accommodate AK's needs and goals in therapy. AK determined the frequency with which she would practise and, as already noted, selected the stimuli for the treatment sets. She also decided what defining features would be described on the back of each picture (part of the treatment protocol to be described below) and which characteristic was most relevant to her experience. Also, in the choice of treatment items, in addition to words that AK *could not* name and/or understand we included words that she *could* name and understand. This allowed us to track the progression of her loss of naming ability and to evaluate the influence of practice on the retention of words that appeared to be intact at the outset of the study.

METHOD

Case history

At the time of this investigation (i.e., July, 2000), AK was a 63-year-old right-handed woman with a seven-year history of progressive changes in her ability to retrieve and comprehend single words. AK was a native speaker of English, had a university education, worked as an Arts Officer for a large municipality, was married and had two children. As an accomplished amateur musician and avid concertgoer, she was most devastated by her inability to remember the names of musical instruments.

The results of language testing on four subsequent evaluations are presented in Table 1. AK's spontaneous speech was fluent and progressively anomic at every assessment. She came to every session with a continuously growing number of pages of words she could no longer retrieve, but wished to. The words were supplemented with pictures and/or descriptions, often extracted from a dictionary. Her confrontation naming skills were consistently severely impaired, whereas responsive naming (e.g., What do we cut paper with?) was relatively intact, with some decline on the last evaluation.

TABLE 1
Results of AK's language assessments

Task/Test	*Results*			
	January 1998	*December 1999*	*December 2000*	*August 2001*
Spontaneous speech	Intact, fluent	Intact, tangential	Verbose, tangential	Tangential, empty, circumlocutory
Naming (BNT)	16/60	8/60	5/60	4/60
Responsive naming (BDAE)	10/10	10/10	9/10	7/10
Sentence repetition (BDAE)	16/16	16/16	16/16	16/16
Following commands (BDAE)	15/15	15/15	15/15	14/15
Comprehension of paragraphs (BDAE)	12/12	11/12	11/12	11/12
Reception of syntax (TROG)	20/20	20/20	18/20	19/20
Reading comprehension (GORT)	Passage score M = 4.2 Slow rate Normal accuracy Average comprehension	Passage score M = 3.4 Slow rate Normal accuracy Low comprehension	Refused	Refused
Reading (PALPA)				
Regular words	36/36	36/36	36/36	36/36
Irregular words	35/36	32/36	30/36	28/36
Narrative writing (BDAE)	Intact	Intact	Intact	Surface dysgraphia
Writing to dictation				
Regular words	20/20	19/20	34/36	31/36
Irregular words	17/24	6/24	10/36	7/36
Single word comprehension (PPVT-III)	65 %tile	7 %tile	1 %tile	1 %tile
Verbal fluency				
Semantic	8 animals	3 animals	0 animals	0 animals
Phonemic	41 FAS	36 FAS	NT	18 FAS
Semantic knowledge (PPTT-3 pictures)	NT	NT	37/52	39/52
Lexical decision (PALPA)	59/60	57/60	55/60	51/60
Synonym judgement (PALPA)	58/60	56/60	56/60	50/60
Word semantic association (PALPA)	NT	23/30	20/30	13/30

BNT = Boston Naming Test (Goodglass, Kaplan, & Weintraub, 2001a), BDAE = Boston Diagnostic Aphasia Examination (Goodglass, Kaplan, & Weintraub, 2001b), TROG = Test for the Reception of Grammar (Bishop, 1989), GORT = Gray Oral Reading Test (Bryant & Wiederholt, 1991), PPVT-III = Peabody Picture Vocabulary Test (Dunn & Dunn, 1997), PPTT = Pyramids and Palm Trees Test (Howard & Patterson, 1992), PALPA = Psycholinguistic Assessments of Language Processing in Aphasia (Kay, Lesser, & Coltheart, 1992)

Repetition of words and sentences was also spared, as were other aspects of expressive speech, such as syntax, phonology and prosody. AK's auditory comprehension of sentences and complex morphosyntactic structures was also relatively normal, while her comprehension of single words was severely impaired with a clearly noticeable decline over time. Oral reading was characterised by surface dyslexia. Writing single words to dictation yielded a similar pattern of surface dysgraphia. In contrast to her selective language impairments, AK's non-verbal cognitive skills were intact prior to and at the time of this investigation, as documented by successive neuropsychological assessments and subjective reports of her daily functioning.

AK had participated in another research project prior to this study, in which high-resolution structural magnetic resonance imaging (MRI) data were acquired (Kovacevic et al., 2002). AK's regional atrophy was compared to the same brain regions derived from a set of eight age-matched healthy controls (Dade et al., 2004). In keeping with the finding of semantic loss, and previous scans, quantitative analysis of regional atrophy of AK's MRI indicated the greatest atrophy over bitemporal regions, with greater left than right atrophy; greatest atrophy was over the left anterior temporal lobe. Atrophy was also noted in left ventral frontal regions, although to a lesser degree than the temporal atrophy. Dorsolateral frontal and posterior volumes were within the normal range, relative to age-matched control subjects.[1]

Stimuli

A set of 230 pictures from the Peabody Picture Collection (Dunn & Dunn, 1983) was administered to AK for naming and comprehension. The goal was to identify a set of treatment stimuli that could be further subdivided into three subsets:

1. Items that AK could name (+N) and comprehend (+C).
2. Items that AK could not name (−N) but could comprehend (+C).
3. Items that AK could not name (−N) and could not comprehend (−C).

Procedure for selection of stimuli

AK was presented with each picture individually and asked to name it. The entire set of pictures was administered twice, in two separate sessions, one week apart[2]. If AK was unable to name an item on the two attempts,

[1] The authors thank Dr. Brian Levine, Rotman Research Institute, Baycrest Centre for Geriatric Care, for sharing these data.

[2] Unfortunately, due to AK's busy schedule, we were unable to obtain repeated baseline measures three times before treatment.

the picture was considered for the Could-Not-Name (−N) category. Similarly, if AK could successfully name an item in both sessions, the picture was considered for the Could-Name (+N) category. Next, AK's comprehension of these same picture names was assessed using a word-to-picture matching task. She was presented with three pictures selected from the large array, one of which was the target item and the other two foils. Foil items were pictures that were not semantically or phonemically related to the target. AK was asked to point to the target item. Based on AK's performance on this task, pictures were further assigned to either the Could-Not-Comprehend (−C) or Could-Comprehend (+C) category. There were no items that AK could name but could not comprehend.

The choice of the final set of items to be used in the study was made by AK. She selected the semantic categories to be represented and their respective exemplars based largely on their relevance to her daily functioning and personal interests. In her decision, she considered both the tasks she performed at home and the leisure activities in which she was still participating (i.e., cultural events and social gatherings). As such, the three treatment conditions (i.e., +N + C, -N + C, −N−C) were not balanced for semantic category. The final set consisted of 180 pictures that included musical instruments (21), personal care items and accessories (20), household items (54), clothing (18), food items (60), and other (7). In the final set of treatment items, most clothing and household items were in the +N+C subset, whereas most musical instruments were in the −N−C subset. Food and personal care items were more equally distributed across all three subsets.

Each of the three subsets of treatment stimuli consisted of 60 items. Within each subset of 60 items, 30 were designated as treatment items and the remaining 30 as control items. Treatment and control items were balanced for word frequency within each of the three sets (Francis & Kucera, 1982). The mean frequencies for the treatment sets were as follows, +N + C = 224.4, −N + C = 16.8, and −N−C = 3.1. The corresponding control set mean frequencies were as follows, +N + C = 192.9, −N + C = 13.3, and −N−C = 4.4.

The pictures used in treatment were labelled on the back to provide orthographic and phonological information about the corresponding word. In addition, in an effort to evoke a stronger semantic representation of the item, a description of the pictured item as produced by AK and most relevant to her personal experience, was written on the back of each picture. For example, for the picture of a piano, the label was "Piano". The description was, "The instrument I play. It has white and black keys and a pedal. I teach (name of her grandson) how to play piano".

Based on findings from the literature (Snowden & Neary, 2002) we predicted that following therapy, items for which AK's semantic knowledge was at least partially spared (i.e., those in the −N+C category) would be

named better than those for which she presumably had no representations (i.e., −N−C). We further predicted that for words that AK could name and comprehend (i.e., +N+C words), there would be a delay in the progression of loss in the treated items relative to the untreated control items.

Treatment programme and design

Because of AK's other commitments, treatment was limited to a total of three weeks in duration, during which time she practised the treatment items at home for approximately half an hour each day. This protocol was designed and agreed upon by AK and the researchers. While no formal documentation of her practice regimen was maintained, she did sign a "practice sheet" after every home session and we are confident that it was carried out as it had been discussed. Practice involved looking at the picture, and reading aloud both the label and then the description on the back of the picture.

The first subset to be treated was the +N+C subset. These items were selected first in order to avoid any potential negative influence of the passage of time on those pictures that she could still consistently name. AK practised each of the 30 pictures, for 6 consecutive days and returned to the clinic for testing on the 7th day. Testing involved the presentation of the pictures (without the labels or descriptions) that she had practised that week, interspersed with the 30 control pictures that she had not practised. Her task was to name the picture. Responses were recorded as "correct" when she named the pictured object without any assistance from the examiner.

This procedure was repeated for each of the other two subsets of treated items. The order of presentation in treatment of these two sets was determined randomly, resulting in the (−N−C) set being the last one. As mentioned, the entire treatment protocol took three weeks. Additional follow-up testing of all treated and untreated items took place one month and six months after the completion of the last treatment set. Since AK returned all practice materials after the three-week treatment protocol was completed, to the best of our knowledge, she did not practise the treatment items during the six-month interval between the end of treatment and the last follow-up testing session.

RESULTS

The results of naming accuracy before and immediately post-treatment are shown in Table 2. The McNemar Test for comparison of two related samples was used to assess the treatment effect on naming ability. The naming scores on treated versus control items post-treatment for each subset were compared. Alpha was set at .02 using the Bonferroni adjustment

TABLE 2
Accuracy of picture naming pre- and post-treatment

	Pre-treatment		*Post-treatment*		*Treated vs. Control Post-treatment*	*Treated Pre-treatment vs. Treated Post-treatment*
	Treated	*Control*	*Treated*	*Control*	*p*-value	*p*-value
+N +C	30	30	26	22	.125	.125
−N+C	0	0	18	4	.000*	.000*
−N−C	0	0	11	1	.002*	.001*

*significant

(.05 divided by three subsets of data). A significant effect emerged for two sets of items, the −N+C ($p = .000$) and −N−C ($p = .002$). In addition, naming ability was compared on treated items alone in the pre- and post-treatment conditions. Bonferroni adjustment was again set at alpha = .02. Within the +N+C condition no significant effects emerged. AK could already name all the pictures in this category before treatment. She named fewer items post-treatment, however the difference between pre- and post-treatment performance was not significant. Naming performance on treated items improved significantly after treatment for the −N+C ($p = .000$) and the −N−C ($p = .001$) sets of stimuli. As can be seen in Table 2, there was little concomitant improvement on the control items.

Follow-up testing was also conducted on all the items at both one month and six months after the last treatment session. The data were analysed in two ways. First, all treated items from the three subsets were combined as were all untreated items and these two groups were compared to assess the longevity of the treatment effect. Results of the McNemar test indicated that correct naming of treated items was significantly greater than for untreated items at both one month and six months post-treatment ($p < .0001$). Secondly, the treated items within each subset were compared with the untreated items using the McNemar test at both one month and six months post-treatment. The Bonferroni correction was set at alpha = .008 (.05 divided by six subsets of data). The results are shown in Table 3. Significance was shown for the −N+C subset at one month post-treatment ($p = .002$). The same set of items approached significance six months later at $p = .008$.

To address the question about progression of loss, performance on treated items pre-treatment was compared with performance at each subsequent time point (i.e., post-treatment, one month post-, and six months post-treatment) in the +N+C set. Performance on control items at pre-treatment was also compared with performance at each subsequent time point in the +N+C set. The McNemar test was used with the Bonferroni adjustment set at alpha = .02

TABLE 3
Short- and long-term effects of naming treatment compared to the original pre-treatment performance

	Short-term (1 month)			*Long term (6 months)*		
	Treated	*Control*	*p-value*	*Treated*	*Control*	*p*-value
+N +C	30	23	.016	24	18	.031
−N +C	13	3	.002*	9	1	.008
−N−C	7	0	.016	4	0	.125

p-value = probability level, *significant

TABLE 4
Comparison of accuracy of picture naming between pre-treatment performance and other time points for treated and control items in the +N+C condition

	Pre-treatment	*Post-treatment* *p*-value		*1 month post-treatment* *p*-value		*6 months post-treatment* *p*-value	
Treated	30	26	.125	30	+	24	.031
Control	30	22	.008*	23	.016*	18	.000*

*significant; +McNemar test not possible with identical values

(.05 divided by three). As can be seen in Table 4, results indicated that for the treated items, the difference between performance pre-treatment and at the other time points never reached significance; whereas for the control items, the difference between performance pre-treatment and at the other time points emerged immediately post-treatment ($p = .008$), and this difference was maintained at the other two time points ($p = .016$ at 1 month; $p = .000$ at 6 months).

DISCUSSION

The results of this investigation suggest that improvements in word retrieval are possible, even when there is a steady progressive loss of lexical knowledge. They demonstrate, similar to the case described by Graham et al. (2001), that it is possible to re-learn items for which semantic knowledge has been partially or totally lost. Improvement in our patient's naming performance was seen immediately post-treatment for those items that she both could and could not comprehend. The manner in which AK organised and practised words may have been an important factor in this successful outcome. In AK's descriptions for the treated items, similar

to Graham et al.'s (1999) patient DM, she spontaneously included attributes that most strongly stimulated her memory, often evoking more than one source of information (e.g., phonology, orthography, semantics, olfactory, visual and/or emotional memory).

AK also appears to have demonstrated a slower rate of forgetting than DM. Two weeks after practice on his word lists was stopped, DM could no longer name approximately one third of the items from one list; six weeks after practice had stopped, he could no longer name approximately two thirds of the items from a second practice list. In contrast, AK named approximately only one third fewer items one month after treatment for two sets of words ($-N+C$; $-N-C$), compared to her immediate post-treatment performance. Six months after therapy had ended, AK was still able to name half of the items from the $-N+C$ list (and approximately one third of the words from the $-N-C$ list); DM had lost half the items on his first list by two months after practice had stopped.

There are a number of possible explanations for the purported difference in rate of forgetting. Importantly, the word production tasks were different: DM's task was a category fluency task; AK's a picture naming task. One might argue that a fluency task imposes different cognitive demands than a picture naming task, in that naming activates temporal brain regions, whereas generating words and switching between categories is related to both temporal and frontal lobe functioning (Troyer et al., 1997), presumably imposing greater demands on the retrieval process. The two patients may also have differed in the degree and extent of temporal lobe damage. For instance, the imaging data for DM suggest that he may have had a greater degree of posterior temporal lobe atrophy whereas AK's damage, while bilateral, was spread more anteriorly within the left temporal lobe. In addition, whereas our task was designed for the purpose of an intervention study, DM's performance was monitored on tasks that he had set for himself. In this respect, AK was tested precisely on what she had practised.

Another intriguing observation is the apparent influence of comprehension on AK's successful naming of items. Although not systematically tested, there appeared to be a tendency for better production at all test points for the list of items that AK could initially comprehend (i.e., the $-N+C$ list). This pattern suggests that AK's ability to benefit from naming treatment was helped by her ability to comprehend the same items and, by extension, her intact semantic knowledge for those items. This suggestion is in keeping with the success of Snowden and Neary's (2002) patient KB, but contrary to the findings of Graham et al. (2001). Graham et al.'s patient, DM, demonstrated unusually high word production scores (as measured by category fluency) with a concomitant decrease in semantic knowledge (as measured by the Pyramids and Palm Trees Test, Howard & Patterson, 1992) over time. Although Graham et al. (2001) did not test DM's production

and comprehension of the same items, they nevertheless noted that DM was often unable to provide information about the words he generated in category fluency. They argued that DM's production scores benefited from rote practice, while his semantic knowledge declined over time, as would be expected in semantic dementia.

It is important to note that although we measured AK's comprehension for treated and untreated items at the outset of the study, it was not measured after treatment. Other than having constructed the three treatment sets based in part on her comprehension performance, AK's comprehension abilities were not further investigated. Variations in the degree of degradation of semantic knowledge may have contributed to AK's naming performance (Snowden & Neary, 2002). However, we can only speculate here on the likely importance of this factor to AK's performance since it was not specifically investigated in this study. The relationship between naming performance and amount of residual semantic knowledge should be further investigated in future studies. For instance, it would be beneficial to understand which aspects of semantic knowledge are most helpful in retaining the concept of a word or item in one's semantic storage (e.g., function, spatial attributes, sensory experiences with that item, etc.).

Snowden and Neary (2002) and Snowden et al. (1994) found that meaningful items were retained more successfully by their patients, CR and KE, respectively. We are unable to demonstrate the same differentiation between personally meaningful and "non-meaningful" items that Snowden and Neary (2002) did because all our items were chosen to be personally meaningful for AK. Personal familiarity of items, linked to patients' autobiographical experience, has been shown to influence remembering and/or naming (Snowden et al., 1994; 1995; 1999; Snowden & Neary, 2002), as well as object use (Bozeat, Lambon Ralph, Patterson, & Hodges, 2002; Bozeat, Patterson, & Hodges, 2004). As mentioned previously, AK was highly familiar with all treated and untreated items selected for the study. Arguably, treatment items and the practice regimen were made even more personally meaningful in that she contributed to the definition/description that was inscribed on the back of each picture. To the extent that all treatment items were personally meaningful in this way, the notion of personal familiarity cannot adequately distinguish between differences between the three subsets. However, it seems reasonable to propose that the notion of "meaningfulness", or personal familiarity may have been an important contributor to AK's overall success and slower rate of forgetting, as compared to DM and AM.

In addition, a longitudinal study by Bird, Lambon Ralph, Patterson, and Hodges (2000) found that word frequency affected the narrative production of patients with semantic dementia. It is interesting to note that in this study, the words that AK could name and comprehend (+N + C) from the

outset were higher in frequency than the other two word sets, suggesting that frequency does indeed exert an effect, whether in single word production or narrative production.

Finally, including words that AK could name and comprehend at the outset of the treatment programme allowed us to track the progression of the loss of naming ability and the results suggested that a delay in the progression of loss is possible with practice. This finding suggests that it may be beneficial in a naming treatment programme for patients with SD, to include items that are still within the patient's semantic store.

To summarise, AK's improvements and slower rate of forgetting of the practised items are encouraging with regard to the potential for managing naming deficits in SD. In addition, the positive influence of personal meaningfulness and familiarity on the success of treatment suggest that the selection of therapy items should be guided by such factors. Before concluding, some caveats are offered. The issue of degradation of knowledge needs to be incorporated in future intervention studies. It is also acknowledged that the scientific rigour of this clinical study was somewhat compromised by the personalised nature of the intervention. To this effect, appropriate controls such as more complete and sustained baseline testing as well as appropriate counterbalancing procedures of stimuli across conditions were lacking. Nevertheless, the striking difference in treated versus untreated items post-therapy provides strong evidence for the effectiveness of this therapy for naming deficits in SD and suggests that continued investigation into this area is warranted.

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