A Comparative Investigation into Knowledge of Object Attributes of Name, Unique Function and Category Membership, in Healthy Elders and Older People with Alzheimer-Type Dementia

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ABSTRACT

The progressive lexical-semantic deterioration which accompanies dementia of the Alzheimer type (DAT) has been highlighted by recent explorations of knowledge of object attributes, object naming, and recognition of object categories.

An Experimental Battery for Semantic Processing devised for this research comprised six tests examining these semantic skills in older people with probable Alzheimer-type dementia at very mild to moderate levels of severity.

An innovative set of sixty 'unique feature' or distinctive attribute cues were utilised in a recognition test of concrete nouns from fifteen common semantic categories. The recognition test, presented in both picture and written form, verified that specific attributes were more successful than semantic category in facilitating lexical comprehension in older people with DAT.

A naming test afforded the opportunity to evaluate the efficacy of the unique feature cues in facilitating name recall for the noun set. The DAT participants utilised the attribute cues to enable object naming, despite measurable deficits in cognitive and linguistic processing abilities. These findings therefore highlight the potential clinical application of semantic cueing techniques in aiding name recall with this client group.

A generative naming test further verified a residual'core' vocabulary, within each of the fifteen semantic categories, which remained resistant to disease progression in the DAT participants.

However, the finding that DAT participants were less successful in accessing broader category information contrasts with reports in the recent literature and warrants further investigation.

The performance of the Control subjects, representing healthy elders aged from 65 to 85+ years, confirmed the resistance to advancing chronological age of every lexical test in the Experimental Battery for Semantic Processing.

The Standard Measures Battery for Cognitive and Language Function, a screening battery of six cognitive and language tests also compiled for the research, verified that the DAT group were performing at levels significantly below the baseline established by the Controls on every measure. Nevertheless, the DAT participants maintained comparative levels of performance on the semantic tests after an interval of mean nine months, demonstrating the resistance of these lexical measures to advancing duration and severity of disease.

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INTRODUCTION

Alzheimer's disease (AD) is the most common form of dementia (Cummings, 1998) accounting for approximately 50 per cent of classified cases (Stokes and Holden, 1990). Alzheimer's disease is a degenerative disorder of the human central nervous system (Diesfeldt, 1989) which is identified clinically on the basis of progressive decline in two or more major areas of cognition (for example, memory, language, visual-spatial orientation, praxis) where this decline cannot be attributed to other known systemic diseases or brain disorders (Schwartz, 1990). The diagnosis of AD is confirmed by histopathologic evidence, obtained from examination of brain tissue at biopsy or autopsy, of two major hallmark lesions : the neurofibrillary tangle and the neuritic plaque, in concentrations that exceed age-graded thresholds (Damasio, Hoesen, and Hyman, 1990).

Alzheimer's disease primarily affects the elderly (Rogers and Friedhoff, 1998) The risk of developing dementia increases with age, doubling every five years after the age of 65; above the age of 80, one person in five may suffer from some degree of dementia (Royal College of Psychiatrists, 1998).

The elderly segment of the population is increasing disproportionately to other segments (Bayles and Tomoeda, 1993). The 'old' elderly' (that is, those who are 75 years old and over) in whom dementia is more prevalent, constitute the fastest-growing group (Hart and Semple, 1990). As the population ages, increasing numbers of patients will present with dementia (Kaye, 1998).

Thus dementia has been described as a “growing public health crisis” (Cummings, 1998) and a challenge to both health and social services and society in general (CSLT, 1993). The burden of dementia is borne primarily by the sufferers and secondarily by those who care for them; its cost in human terms is incalculable (Hart and Semple, 1990). Despite the advances of recent years, continued research is needed to ensure the development and refinement of therapeutic strategies which can aid in the management of this tragic disease and meet the needs of those affected by it.

Impairment in linguistic communication is an inherent component of the dementia of Alzheimer’s disease (Bayles and Tomoeda, 1993). A number of authors have documented a greater degree of impairment in dementia of the Alzheimer type (DAT) patients’ semantic abilities relative to other aspects of language, including both phonology and syntax (Bayles, 1982; Irigaray, 1973; Schwartz, Marin and Saffran, 1979). Anomia is a prominent and distinguishing feature (Hart, 1988).

A large number of studies of single-word production and comprehension in Alzheimer patients have established that lexical-semantic disorders occur from an early stage in DAT and are manifest as impaired object naming (Bayles and Tomoeda, 1983; Huff, Corkin and Growdon, 1986; Schwartz, Marin and Saffran, 1979), difficulty in making judgements about object attributes (Grober, Buschke, Kawas and Fuld, 1985; Martin and Fedio,1983; Nebes and Brady, 1988; Warrington, 1975) and reduced generation of words from a given semantic category within a limited time period (Chertkow and Bub, 1990; Huff, Corkin and Growdon, 1986; Martin and Fedio, 1983).

Such findings have led to the proposal that Alzheimer patients have semantic memory impairments not found in the normal old. Many investigators consider a loss of concept meaning to be the core deficit in the semantic impairment found in DAT.

Warrington (1975), Schwartz, Marin and Saffran (1979), Martin and Fedio (1983) and others have suggested breakdown of the semantic feature system, characterised by normal utilisation of broad, superordinate categorical information despite an impaired capacity for retrieval of the specific attributes such as names, physical features and functions, which differentiate between items in the same semantic category.

The central question in this area of language processing concerns the nature of the deficit (Maxim and Bryan, 1996); specifically, whether the deficit is due to an impairment in accessing semantic information, or whether this information is lost from the lexicon.

This question carries very practical implications for people with DAT and their carers (Maxim and Bryan, 1996). The possibility that semantic information about words and their meanings may be intact and accessible to directed search invites the development of therapeutic cueing strategies in aiding name recall and maintaining a core vocabulary with this client group.

This research set out to explore the lexical semantic system in a group of older people with dementia of the Alzheimer-type dementia, with reference to the above mentioned therapeutic strategies.

The Unique Features of Alzheimer-type Dementia

Dementia is an umbrella term that encompasses a number of distinct subtypes (Molloy and Lubinski, 1995). From its first clinicopathological description by Alzheimer in 1907 until recent years a diagnosis of Alzheimer's Disease was given only when dementia appeared prior to age 65. The syndrome was regarded as an exclusively pre-senile dementia and aetiologically distinct from the dementia of old age or senile dementia, the latter having an onset at or after 65 years.

However, a series of studies in the late 1970s and early 1980s documented the essential overlap between Alzheimer's disease and senile dementia with respect to both clinical presentation and neuropathological findings at autopsy, establishing senile dementia as a medical condition arising from a disease state rather than the normal accompaniment of the brain's ageing (Schwartz, 1990). The two pathologies are now held to represent a single disease entity and the term Alzheimer's Disease is therefore proper at all ages (Read, 1991).

No positive test exists for AD and the diagnosis is one of systematic exclusion of other possible causes of dementia (Arendt and Jones, 1992) and examination of behavioural, cognitive and language data (Maxim and Bryan, 1996).

The dementia of Alzheimer's disease follows an insidious and relentless course over several years, progressing from subtle impairment of memory and the higher mental abilities such as judgement and abstract thinking in the early stages, to virtual disintegration of intellectual function and personality and the development of a state of total dependency (Stokes and Holden, 1990).

Its course may be rapid or slow, from two to twenty years, with an average of ten (Pitt, 1996). There may be occasional plateaux or periods with little or no increase in functional impairment, sometimes lasting for several years (Rau, 1993).

Most patients with AD present long after the disease begins and it may be difficult to plot the early course of events, with the retrospective accounts of caregivers focusing on what they perceive to be causative or precipitating factors (Hart and Semple, 1990). Memory impairment is usually the most prominent feature throughout the course of the disease; a severe deficit in anterograde memory or difficulty in retention of new information is generally the first and most noticeable symptom.

The most broadly applied criteria for the clinical definition of AD (Cummings, Vinters, Cole and Khachaturian, 1998) were introduced by the Work Group of the National Institute of Neurological and Communicative Disorders and Stroke - Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) (McKhann, Drachman, Folstein, Katzman, Price and Stadlan, 1984). These criteria classify AD into definite, probable and possible levels of diagnostic certainty. When the diagnosis is made on the basis of clinical criteria alone, that is, without histopathologic confirmation, the patient is said to be suffering from *probable* or *possible* Alzheimer's disease (Schwartz, 1990). The diagnosis of Alzheimer's disease in life never goes beyond the level of possible or probable (Damasio et al., 1990).

The critical brain events associated with the clinical expression of AD are progressive neuronal dysfunction and loss of neurons in specific regions of the brain (Cummings et al., 1998). The combination of nerve cell loss and resulting neurotransmitter deficits leads to the appearance of the dementia syndrome.

There appear to be clear regional differences: the hippocampal formation and temporal lobe, and to a lesser degree the frontal lobe, are most vulnerable to atrophy and cell loss (Fraser, 1987). Primary motor and sensory cortex, cerebellum and spinal cord are usually spared (Read, 1991).

Other pathological accompaniments of AD include granulovacuolar degeneration and Hirano body formation, both found in the hippocampus (Hart and Semple, 1990).

It is becoming increasingly widely accepted that the central pathological event in the neurodegeneration of Alzheimer's disease is the aberrant synthesis of amyloid protein which, when aggregated, is neurotoxic and forms the core of neuritic plaques (Cummings et al., 1998).

In this respect Alzheimer's disease is to be contrasted with vascular or multi-infarct dementia (MID), the second most common dementia in late life, which arises from a succession of small strokes and transient ischaemic attacks (Pitt, 1996). Multi-infarct dementia typically has a more episodic course, rather than a smooth decline; its progression is often described as 'stepwise deterioration'.

Heterogeneity : A Feature of Alzheimer's Disease

Alzheimer's disease is known to be heterogeneous in its clinical presentation.

Schwartz (1990) describes the differences between Alzheimer patients as follows:

> Each patient presents a landscape of eroding cognitive and functional capacities, but the landscape contains peaks and valleys. One patient may be seen with .particularly severe visuospatial confusion and little language disturbance; another patient may show the reverse....In some patients the impairments in the domain of memory, language, perception, or action may be so well circumscribed at the outset that it is years before the presence of a dementing condition is recognised.....More typically patients show simultaneous dissolution across several domains.
>
> (1990, p.143)

Martin (1990) argues that for Alzheimer's disease (as well as for other dementing disorders) the mapping relation between neurological disease state and neuropsychological profile must be "one to many" (p.144) . In agreement with this argument Damasio et al. (1990, p. 92) state that throughout the course of the disease in most patients it is possible to recognise "a relatively selective involvement of some cognitive processes pitted against the relative sparing of others."

The heterogeneous presentation of Alzheimer-type dementia has critical implications with respect to early identification of disease onset, pharmacological intervention, the implementation of intervention strategies (for example through learning how relatively preserved abilities can be used to compensate for lost skills), and the selection of candidates to participate in group or single case studies.

Cross-sectional or group studies which describe symptom clusters and severity provide data which is particularly important in distinguishing the common core features of dementing conditions. However, although providing a profile of language and cognitive functioning at a particular stage of disease severity, one of the main problems of group studies is that they mask what individual patients can and cannot do, as well as variations amongst individual subjects.

The heterogeneity in disease presentation is superimposed on variations with respect to cognitive and linguistic performance which may arise in older adults from differences based on genetic inheritance, life history, differential vulnerability to age-associated diseases, and sensory and cognitive changes (for example, hearing and visual difficulties, decreased speed of response).

Martin (1990) states that the clinical diversity of AD and the existence of subgroups constitutes a strong case against the practice of data averaging based solely on diagnostic classification, which could yield a distorted profile of deficits and obscure qualitatively different patterns of impairment.

Chertkow and Bub (1990) state that what is required is an approach that recognises that within a heterogeneous group of DAT patients, there exist individuals with similar particular patterns of cognitive deficits, and precise studies of carefully defined small groups of DAT patients will shed light on cognitive processing in that particular domain. Single case studies of AD have helped to some extent because they can highlight specific deficits and dissociations between deficits which are unlikely to be found in group studies (Maxim and Bryan, 1996).

Funnell (1990) advocates incorporating a longitudinal element to chart the evolving nature of the disorder which characterises disease progression; a longitudinal approach, unlike cross-sectional studies, provides an opportunity to monitor the disorder over time and study the dynamics of the interacting processes as the level of performance declines.

The Language of Dementia of the Alzheimer Type

As might be expected with a progressive and degenerative process, the linguistic deficits associated with DAT change continually with disease progression and each phase of the disease is characterised by a distinct profile of language deficits (Kempler, 1995). Language is compromised in every stage of Alzheimer's disease but there may be enormous variation in deficits amongst individuals, who are almost as likely to be atypical as typical in their presentation and in the course of the disease (Maxim and Bryan, 1996).

In summarising the linguistic breakdown which has been described in DAT, Kempler (1995) points out that Alzheimer patients have no obvious motor speech deficits; control of phonation and articulation remains intact until the latest stages; they do not exhibit phonologic disturbance or make errors in prosodic aspects of language, and the ability to arrange words into grammatical sentences appears to be relatively spared throughout the course of the disease.

The semantic system has emerged as most vulnerable to disease effects, and patients with Alzheimer-type dementia have been found to exhibit dissociation of semantic functions from those of syntax and phonology (Bayles, 1982; Schwartz, Marin and Saffran, 1979).

Whitaker (1976) described such a pattern of linguistic impairment in HCEM, a profoundly demented patient who neither comprehended nor produced propositional language, but who could echo sentences spoken by the examiner as long as eye contact had been established, and 50% of the time would correct errors of syntax and phonology without apparent conscious awareness. Whitaker described the patient as seeming to possess a grammatical filter capable of functioning independently of cognition. The same was not true for semantically anomalous material, as at no time were semantic errors corrected.

Schwartz, Marin and Saffran (1979) described a patient with progressive dementing disease who, like Whitaker's patient, exhibited the relative preservation of syntactic and phonological capacities in the face of marked semantic loss. The patient, WLP, was examined bimonthly over the course of 30 months during which time the authors observed progressive anomia and naming difficulty, although speech was rapid and well articulated. When asked to select the name of a pictured highly familiar object from among five written choices, WLP consistently selected the name of a closely semantically associated distractor. Evidence for a breakdown in semantic knowledge was not confined to picture labelling paradigms; thus, WLP was also unable to utilise semantic context in the written disambiguation of spoken homophones, but could, at the same time, use even minimal syntactic cues as the basis for correct lexical selection. When faced with a naming requirement in spontaneous speech, WLP frequently accepted inappropriate off-target suggestions by the examiner as long as they were close, semantically, to the target.

Bayles (1982) found that from a battery of five language tasks, the task based on the ability to recognise and correct semantically anomalous sentences such as "I lost John's temper" was the most discriminating between normal elderly subjects and patients with dementia at varying levels of severity. Phonology errors were rare among the dementia population. Severely affected subjects were frequently indiscriminately echolalic. The phonology of most words was correct; even in nonsense words the phonemes and their ordering did not violate the rules of sound patterning in English. Syntax, like phonology, was not grossly disrupted and word order was rarely aberrant.
What was aberrant was the meaning of some sentences. On tests of story retelling and object description, the dementia patients frequently produced bizarre and semantically inappropriate sentences which they did not acknowledge. Many utterances seemed irrelevant or empty of content. On a test of object picture naming dementia patients made semantic errors, frequently naming or describing something associated with the target item (for example, "brush" for comb; "sweeping up" for vacuum; "feathers" for bird).

Investigations into the Semantic Impairment in Alzheimer-Type Dementia

Much investigative effort has been directed towards clarifying the cause of the semantic impairment experienced by AD patients. Semantic memory (Tulving, 1983) refers to the permanent storage system within long term memory which contains an individual's knowledge of everyday concepts in the world. It is a thesaurus of organised knowledge regarding words, concepts, and their associations, as well as the rules for manipulating these symbols and concepts.

Such a knowledge base is an essential part of everyday cognitive activities like understanding the meaning of spoken words, identifying visual objects, and producing their corresponding names (Chertkow and Bub, 1990). The cardinal property of information stored in semantic memory is that it is a common pool of knowledge, stored without reference to the time and context in which it was acquired.

This is in contrast to episodic memory (Tulving, 1984) which is a temporally dated autobiographical record of unique episodes and events in an individual's experience. Episodic and semantic memory are highly interdependent systems (Bayles, 1987); patients with dementia show early and marked impairment in episodic memory, which it is hypothesised seems largely attributable to problems in the structure of, and access to, semantic memory (Bayles, 1987). The structure and organisation of semantic memory are believed to be similarly maintained from one individual to the next. Three basic elements in the structure of semantic memory which have emerged from studies in normal subjects concern its organisation by hierarchies, by categories, and in terms of semantic association between concepts (Chertkow and Bub, 1990).

Most concepts have both superordinate and subordinate categories , for example 'dog' - *animal* and *spaniel,* respectively. But at the limits of semantic knowledge (which will depend on an individual's education and experience) a concept is defined and elaborated by its unique semantic attributes, markers and associations which represent both perceptual and abstract knowledge and enable differentiation from other semantically similar concepts (for example *spaniel - terrier*).

Warrington and Shallice (Warrington and Shallice, 1979; Shallice, 1987) have suggested certain criteria which may serve to differentiate impaired lexical access from a loss of semantic knowledge. Access difficulties are reflected by inconsistency of errors for the same items from occasion to occasion, by an equal probability that general (superordinate) or specific (attribute) information is lost, by the absence of word frequency effects, and by improvement in performance after priming and slowing down of stimulus presentation. In contrast, semantic storage disorders can be supposed if there is consistency of item-specific errors, if there is a preservation of superordinate over detailed knowledge, if there are strong word frequency effects, and in the absence of effects of priming and presentation rate.

Patients with AD are hypothesised to have lost the attributes and associations that make up concept meaning. The finding of consistently preserved superordinate category knowledge in the presence of very limited ability for retrieval of specific feature knowledge has been reported in a number of different experimental paradigms with Alzheimer's disease patients (Huff, Corkin and Growdon, 1986; Martin and Fedio, 1983; Schwartz, Marin and Saffran, 1979; Warrington, 1975).

Warrington (1975) observed signs of a selective impairment of semantic knowledge in three patients with diffuse cortical atrophy who demonstrated impoverished knowledge of objects when asked to name pictures of animals, plants and inanimate objects, and then to define the auditorily presented object names. All three patients on occasion would describe the item in terms of its superordinate category (e.g. animal) but be unable to give any more precise or detailed definition; occasional semantic errors also occurred, the response being an alternative item from the same category (e.g. donkey-horse; dog-cat).

A probe technique based on yes / no questions was used in a further test of different levels of semantic knowledge (category, attribute, associative) with 40 test stimuli comprising singly presented photographs of animals, birds and household objects. Warrington found that judgements based on knowledge of categories (e.g., "Is it an animal?" or "Is it a bird?") were relatively better preserved than the ability to make judgements based on knowledge of specific physical attributes including size ("Is it bigger than a cat?") relative weight ("Is it heavier than a telephone directory?"), composition ("Is it made of metal?") and origin ("Is it foreign?").

All three subjects were at chance level in matching an animal or object picture to its corresponding name in a forced choice task in which the name was presented with a same-category item ("Is it a swan or a duck?"). A similar pattern of errors was established on a subsequent auditory presentation of this test which used yes / no probe questions and the same animal and object names.

Warrington (1975) argued that these findings supported a hierarchical organisation of semantic knowledge in both the visual and auditory modality, and that damage to the contents of semantic memory is characterised by "the relative preservation of broad category information and the relative vulnerability of specific attribute and specific associative information" (1975 p.655).

Martin, Brouwers, Cox and Fedio (1985) found similar results with Alzheimer patients, who had no difficulty sorting 18 randomly ordered photographs of equal numbers of animals, tools and foods into appropriate sets, and producing the appropriate category label. In addition, whether or not they could correctly name a particular object, they were able to correctly respond to yes/no questions concerning superordinate object knowledge. However, the patients were less accurate when probed about knowledge of specific attributes such as physical features and functions. For example, when shown a picture of a *saw*, subjects correctly indicated that it is man made as opposed to living, that it is a tool and not an animal or food, but made errors when asked "Is it used to cut things?" or "Does it have moving parts?".

It has been argued (Huff et al., 1986; Martin and Fedio, 1983; Schwartz, Marin and Saffran,1979) that such a specific pattern of breakdown in semantic knowledge, characterised by the normal utilisation of broad superordinate categorical information despite an impaired capacity for retrieval of specific attributes such as names, could be responsible for the naming and word-finding problem which is a prominent feature of the language dysfunction in dementia.

Anomia or word-finding difficulty is the earliest and most common language symptom of Alzheimer-type dementia (Kempler, 1995) and is apparent in the patient's spontaneous speech as well as on tasks requiring retrieval of a specific referent such as object confrontation naming (Barker and Lawson, 1968; Bayles, 1982; Bayles and Tomoeda, 1983; Kirshner, Webb and Kelly, 1984), and tests of generative naming (Huff et al., 1986; Martin and Fedio, 1983).

The spontaneous speech of AD patients tends to be vague, repetitive, and fairly empty of content words, instead being littered with indefinite terms (e.g., 'thing', 'stuff'), semantically related but incorrect words (e.g., calling a stool "a chair"), and circumlocutions (Nicholas, Obler, Albert and Helm-Estabrooks, 1985) which altogether convey little real information. Although initially confined to low-frequency words, the word finding impairment progresses by mid-stage to naming deficits on high frequency items. By the late stages of the disease process, noun use may be non-specific or non-existent, with perseveration on a decreasing repertoire of stereotypical utterances and the occurrence of echolalia (Maxim and Bryan, 1996).

The confrontation naming deficit of DAT is of special interest because naming ability shows almost no decline in the normal aged (Flicker, Ferris, Crook and Bartus, 1987). By contrast, patients with AD have a substantial problem naming objects, the severity of which has been found to correlate strongly with the severity of dementia (Barker and Lawson, 1968; Kirshner, Webb and Kelly, 1984).

Further evidence for this relationship was provided by Skelton-Robinson and Jones (1984) who reported correlations as high as 0.84 between the degree of naming difficulty, as measured by a confrontation naming test, and the overall severity of dementia.

A word-finding deficit in early dementia is also apparent on tests of category fluency or generative naming (Martin and Fedio, 1983) which require subjects to generate as many words as possible from a specified category (e.g. types of animal) within a given time limit, typically of 60 seconds.

Tests of generative naming tend to show a steady decline with disease progression (Nebes, 1989). High correlations have also been demonstrated between naming and fluency measures; Martin and Fedio (1983) found that naming and fluency abilities in relatively mildly impaired Alzheimer's subjects were considerably impaired relative to normal controls and highly correlated ($r = 0.80$).

Huff, Corkin and Growdon (1986) found that impaired naming of twenty pictured objects comprising clothing, tools, vehicles and vegetables was associated with difficulty listing the names of objects from the same four categories in a category fluency test in mildly and moderately impaired Alzheimer patients. This association was independent of dementia severity.

In a subsequent recognition paradigm using the same set of 20 objects and a stimulus presentation technique based on true and false pairings, the investigators found that AD patients with normal ability to discriminate visual shapes performed normally in rejecting incorrect category designations for pictured objects and their written names.

However, the patients were impaired in rejecting incorrect object names drawn from within the same category (inside-category false pairings) and erroneously selected words semantically related to the correct names. Finally, the observation that patients tended to make errors on the same items in both name recognition and confrontation naming tests led the investigators to propose that specific semantic information about objects and their names is lost in AD.

Schwartz, Marin and Saffran (1979) argued for a deterioration in semantic knowledge, manifest as difficulty in differentiating between items in the same semantic category, based on the performance of their dementing patient WLP. This patient was able to name only one (cup) of 70 colour photographs of common household objects although she consistently demonstrated recognition of the objects through precise mimes.

The objects consisted of 35 pairs of objects, each pair related through a direct superordinate (e.g., spoon-fork; apple-orange). When presented singly with the same pictures in a name recognition tests with five written choices (the target, two unrelated object names, a phonologically similar word and a semantic distractor consisting of the name of the category-mate) the overwhelming majority of WLP's errors consisted of choosing the semantic distractor (e.g., shown a fork, she chose *spoon*; shown a brush, she chose *comb*).

Comparison of error patterns at initial test and at a second test revealed that for many items (23 of the 35 object pairs) WLP was not consistent, choosing the appropriate target on one occasion and the semantic distractor on the next.

Schwartz et al. interpreted these data as indicating a more global application of word meanings such that for this subject "names no longer specified a unique referent (or class of referents) but rather a population of related referents" (1979, p.285).

The authors drew a comparison between WLP's lexical errors and the overextension errors which characterise the naming behaviour of very young children. There it has been suggested that the child's understanding of a word differs from that of the adult by the number of features or attributes associated with it (Clark, 1973 - cited by Martin and Fedio, 1983); it is assumed that the child is able to narrow down the meaning of a word as he learns more of the features which characterise its meaning, but that during the learning process the extensional domain of a verbal label may be overly broad, (e.g., overextending dog to all four-legged animals).

In this context the lexical loss which is observed in patients with AD is characterised by the progressive loss of the semantic features which define reference terms, with more specific distinguishing features being lost before more general ones (Schwartz et al., 1979).

Martin and Fedio (1983) administered a naming test (the Boston Naming Test) and a category fluency test (naming within 60 seconds items that could be found in a supermarket) to relatively mildly impaired patients with Alzheimer's disease. In comparison with normals, category fluency was reduced and characterised by a tendency to generate proportionally more general categorical terms; the words 'fruits', 'vegetables' and 'meats' being the most common responses, concurrent with reduced production of items within a category. In contrast, category labels were rarely produced by the normal subjects.

When confronted with line drawings of objects for naming, the majority (51%) of the DAT group naming errors were language related errors.

Responses considered to be language related errors consisted almost exclusively of adequate descriptions or synonyms (58% of the language errors) and semantic field errors (42%) consisting of the substitution of a more general, categorical term (e.g., "vegetable" for asparagus) or the name of a related object from the same category as the target item (e.g., "goat" for camel). The naming errors, then, often involved either a hierarchical relationship or a linear, within-category relationship with the target name.

Martin and Fedio concluded that their patients with dementia may have been exhibiting a specific breakdown in semantic knowledge as previously suggested in research by Warrington (1975) and Schwartz et al. (1979). Although the patients studied by these authors had more severe naming difficulties than the ones who participated in Martin and Fedio's study, Martin and Fedio concluded that there were enough similarities to suggest that their patients were exhibiting the early stages of a deterioration of meaning characterised by an inability to retrieve and properly utilise specific attributes.

Bayles (1982), Bayles and Tomoeda (1983) and Bowles, Obler and Albert (1987) have all argued for a breakdown in word meanings in Alzheimer's disease, based on the types of errors made on naming tests.

Bayles and Tomoeda (1983) reported that among a group of patients with a mild or moderate level of dementia of mixed aetiology including Alzheimer's disease only the moderate Alzheimer's disease patients were found to be significantly inferior in naming relative to normals on a confrontation naming test of 20 mixed-category pictured objects.

In all cases, regardless of dementia aetiology, when a misnaming occurred, it was most likely to be semantically related to the stimulus item. Furthermore, 71% of the Alzheimer's patients' error responses classified as visually similar to the target stimulus were also semantically associated to the stimulus.

Closer examination of the semantically related misnamings showed that the most common semantically associated error response was the naming of another member of the stimulus item's semantic class (e.g., "truck" for bus). Dementia severity affected both the frequency and nature of misnamings; increasing severity of dementia was associated with a steady rise in naming error rates and a greater probability that errors were random and unrelated to the target stimulus, for example "yes, please" for towel and "fixed open" for whistle.

Bayles (1982) also found that from a group of dementia patients rated as mildly, moderately or severely demented, the severely demented patients frequently gave naming responses that were not obviously related to the target object, such as "menu" for bathtub; "where is the baby" for matches.

Bowles, Obler and Albert (1987) administered a 63-item test of verbs (the Action Naming Test : Obler and Albert, 1979) to ten DAT patients with a mild to moderately severe level of dementia. The DAT patients were distinguished from healthy older adults by the number of semantically unrelated or irrelevant error responses given, which the authors took as evidence confirming failure at the concept identification stage. In addition, the four DAT patients who performed at a normal level in terms of number of pictures correctly named were identified by the relatively high number of unrelated errors and by the total number of responses given relative to the number of errors on initial attempt. The authors speculated that these patients were demonstrating a reduced ability to select from among possible lexical candidates.

Gewirth, Shindler and Hier (1984) studied the word associations produced by patients with mild, moderate or severe levels of dementia of mixed aetiology on a test comprising 16 stimuli of mixed grammatical class (nouns, verbs, adjectives, and adverbs) in which research participants were instructed to give the first word they thought of upon hearing each stimulus.

Dementia severity influenced the type of word associations given. The number of 'popular' responses (with reference to word association norms) fell dramatically with dementia progression, reflecting a decrease in paradigmatic associations (words related to the stimulus in meaning, and from the same grammatical class, such as synonyms, antonyms, subordinates and superordinates, and the functional contexts of nouns) and a corresponding increase in random, perseverative, echolalic, and null responses.

In contrast, the frequency of syntagmatic associations (words from a different grammatical class than that of the stimulus that could form a sequential continuation of the word in a sentence) did not change significantly across dementia severity, suggesting that the mechanism producing these responses remains relatively resistant to deterioration in dementia.
It has been proposed that paradigmatic associations are made by conserving syntactic markers (which delineate a word's grammatical class) while minor alterations are made in the word's semantic markers (which delineate lexical features). Paradigmatically related stimulus-response word pairs are of the same grammatical class, can be interchanged within a sentence, and are contrasted with respect to a single semantic marker (for example, man-woman).

The dementia patients in this research, like normals, produced more paradigmatic responses to noun stimuli than verb stimuli suggesting that individuals with dementia are sensitive to the grammatical class of the stimulus word. Thus the failure of dementia patients to make paradigmatic responses does not appear to be due to a loss of syntactic markers. The authors suggested instead that the decrease in paradigmatic responses in dementia could be due to a deficit in lexical knowledge characterised by a progressive loss of the semantic markers normally attached to words.

Finally, Smith, Murdoch and Chenery (1989) found that patients with moderate or moderately severe DAT produced significantly more naming errors than healthy controls on three tests of object naming (including visual and tactile naming tests).

The proportion of the total naming errors made by DAT patients composed of errors requiring semantic knowledge of the target item, for example semantic similarity (within class) and definition (description of the target item or its function) errors was in general greater than other error types. The authors took the predominance of semantic similarity and definition errors displayed by the DAT patients as evidence supporting the preservation of their ability to recognise the target and identify the semantic class to which it belongs, despite their inability to provide the lexeme corresponding to the correct individual class member.

Smith et al. concluded that their findings supported a semantic network disruption as the basis of the naming disturbance observed in Alzheimer subjects.

Henderson, Mack, Freed, Kempler and Andersen (1990) administered a visual confrontation naming task (the Boston Naming Test) to Alzheimer's disease patients on two occasions six months apart. They found that the number of naming errors made by the DAT patients was considerably greater than that of published values for the nondemented elderly, and that individual subjects tended to make errors on the same items on both occasions.

Consistency in erroneous naming responses between the test sessions occurred significantly more often than expected under the assumption of no response consistency; eighty per cent of errors occurred at both test sessions while only twenty per cent of errors were inconsistent at the two test times.

The authors referred to previous findings by Huff et al. (1986) whereby on a name recognition task in which the possible responses included words semantically related to the correct response, AD patients tended to make errors on the same items that they were unable to name to confrontation. Henderson et al. hypothesised that, considered in conjunction with previous results, their findings may be used to argue that the naming deficit of AD is due, at least in part, to a loss of semantic information from the lexicon.

Also in agreement with the findings of Huff et al. (1986), Chertkow and Bub (1990) reported an item-specific loss of knowledge manifested by an item-to-item correspondence between DAT patients' loss of name comprehension (failure on a same-category spoken-word-to-picture matching test) and name production (failure to name the same item). The ten DAT patients studied by Chertkow and Bub performed at normal levels on tests of visual perception and object decision, and on a mixed-category spoken-word-to-picture matching test in which objects representing mixed semantic categories and sharing basic perceptual features were presented in vertical displays of five stimuli each.
However, the DAT patients were significantly impaired in relation to controls on a subsequent same-category, spoken-word-to-picture-matching paradigm in which pictorial stimuli from the mixed-category matching task were presented in arrays each containing five items from the same semantic category. The DAT patients were also significantly anomic in relation to the control group in a picture-naming test using the same 150 stimuli from the matching tests.

Comparison of each patient's errors on corresponding items in the naming and same-category matching tests revealed a significantly higher naming success rate for items correctly matched than for items incorrectly matched. This clear correspondence was taken by the authors as "an association of deficits at the level of individual concept items" (1990, p. 214) and therefore evidence for loss of information due to a central storage disorder.

In order to further explore the extent of semantic loss, Chertkow and Bub (1990) used Warrington's (1975) probe technique, asking forced-choice questions about superordinate category membership (one question) and knowledge of detailed perceptual, functional or contextual attributes (six questions) of objects presented as both picture and word stimuli. The authors found that the DAT patients made few errors on superordinate category questions, achieving similar levels of accuracy to the normal control subjects, but they were significantly more impaired than controls in answering detailed questions about perceptual and functional attributes. In addition, a pattern emerged whereby the dementia patients were more impaired on all tests for biological categories (for example, animals, fruits, vegetables) than non-biological categories (for example, clothing, furniture, tools); almost no errors were made regarding body parts. Degraded items, that is those on which 3 or more errors were made on the 12 detailed questions (6 for the picture, 6 for the word) were characterised by a failure to answer questions both for words and pictures.

The authors suggested that their patients were displaying evidence of a loss of semantic knowledge that affects the categorisation of verbal and nonverbal material as concepts.

Evidence for an Intact but Inaccessible Lexical System

There is evidence that the semantic system at a single-word level may remain partially intact up to a relatively late stage in the disease process and that, in the early stages of the disease, access to the semantic lexicon is the main problem. Evidence for this model comes from several sources.

AD patients have been shown to retain knowledge not only of the category of a given concept but also of its more defining properties, such as physical features and functions. For example, dementia patients can demonstrate through gestures the recognition of objects they cannot name. As previously described, Schwartz, Marin, and Saffran (1979) described the progressive deterioration of a dementia patient who was unable to name any of 70 familiar household items except *cup*, but demonstrated correct identification of the objects through precise mimes.

In tasks of confrontation naming, the vast majority of misnamings made by dementia patients are related in some way to the stimulus (for example, "seed" for watermelon; "bird" for owl) (Bayles & Tomoeda, 1983), suggesting that they know about the meaning of the word but cannot find the exact name. With advancing severity of disease, the naming error rate increases and responses tend to become less logical and not as likely to be related to the stimulus (Bayles and Tomoeda, 1983). This could indicate that specific items in the lexicon are lost in the later stages of disease progression.

Grober, Buschke, Kawas and Fuld (1985) suggested that conceptual attributes are not lost in demented patients but may be less accessible than in normals because of alterations in the relative saliency of attributes which affect the organisation of semantic information. In their study of 20 patients with dementia of mixed aetiology, including AD, they presented subjects with a target noun (such as airplane) and asked them to pick out from a checkist of eighteen other words those that were related to the target (Experiment 1). The dementia patients were highly accurate (95% correct in comparison with 98% for normals) on this task, suggesting that they retain knowledge of the semantic attributes of at least some concepts.

In a second experiment using the same noun stimuli and a forced-choice procedure in which dementia patients had to choose which of a pair of words was related to a test noun, Grober et al. found that targets were selected overwhelmingly by all of the patients (six of the 10 subjects selected all 72 targets). The researchers concluded that the high levels of accuracy maintained by the dementia patients when selecting attributes for concepts were incompatible with the hypothesis that dementia is associated with the loss of specific attributes from semantic representations.

However, in Experiment 1 the dementia patients did seem to have difficulty deciding which attributes were important to the meaning of the test noun. Attributes that were considered by intact speakers as essential to understanding the meaning of the concept were missed as often as attributes that were considered less important.

The authors took these findings as an indication that although demented patients may retain knowledge of a concept's attributes they are unaware of the relative importance (i.e., saliency) of these attributes to the overall meaning of the concept.

This possibility was confirmed in a third experiment in which dementia patients were asked to rank the importance of attributes to the understanding of each of the test nouns used in Experiment 1.

Target concepts were presented with three attributes rated by intact speakers as being essential, of intermediate importance and nonessential to the meaning of the concept (for example, for the concept airplane, the words *fly*, *radar*, and *luggage*, respectively); patients were asked to pick the attribute that was most important in defining the test noun, and then which of the remaining two attributes was next in importance. While dementia patients did perform better than would be expected on the basis of guessing alone, they did not rank attributes as well as healthy aged subjects; analysis of the rankings of essential attributes revealed that dementia patients considered essential attributes to be less important than other intermediate and nonessential features three times more often than nondemented subjects. The results of Experiment 3 were taken as evidence that dementia causes a reduction in the weights assigned to the most important attributes of at least some concepts.

Grober et al. concluded that, considered together, their findings imply that individuals with dementia are cognizant of connections between attributes and concepts and can identify attributes as being part of a word's meaning, but may not appreciate the relative importance of these attributes in delineating meaning.

They further suggested that "The net effect of this reduction in weights is to change the organisation of semantic information from a set of attributes that is ordered by their relative importance to the concept to a set of attributes that is more equally weighted" (1985, p.284).

In this context, the loss of semantic information which has been proposed from other studies may represent an extreme case whereby the weights assigned to specific attributes are so reduced that they are at a level below the threshold or cut-off needed for correct concept identification.

Findings from Flicker, Ferris, Crook and Bartus (1987) suggest that whether patients with Alzheimer-type dementia demonstrate knowledge of an object's function depends on how they are tested. These authors investigated semantic abilities in patients with either early (mild-to-moderate) or advanced (severe) DAT in two experiments involving the recognition and recall of object names and functions. In Experiment 1, an object identification and an object function recognition task both used the representation on a video monitor screen of a 25-room house consisting of a 5 x 5 matrix. Each 'room' in the house contained an image of a household object, derived from the set of pictures standardised by Snodgrass and Vanderwort (1980).

In the object identification task the name of one of the objects appeared above the house and each patient was instructed to select its picture from the group of 25 pictures, for a total of twelve trials.

In the object function recognition task, patients were instructed to point to the 8 items which would be most useful for a particular chore (getting up and dressed, cooking dinner, setting the table, and dusting the furniture); a different set of 25 household items was presented on each of four trials. As part of Experiment 1 patients were also asked to name twenty items from the Boston Naming Test, presented singly on a video monitor (object naming), and to generate a list of male first names in a category fluency paradigm.

In a second experiment, the same set of twenty items from the Boston Naming Test was presented on a video monitor to a new set of patients, who were instructed to name each object and then to describe what the object was used for, or if this question was inappropriate, to describe what the object did or where it was found (object function recall). Finally, each object picture was presented simultaneously with a choice of four words on the video monitor and subjects were instructed to select the object name (object recognition test); distractor items in each list included members of the same semantic category, superordinate category names, perceptual distractors, phonological distractors, or unrelated items.

The patients with advanced dementia were markedly impaired on all the tests in relation to elderly normals and patients with mild-to-moderate DAT. The early DAT patients, although markedly impaired relative to aged normals on the tests of object naming and category fluency in Experiment 1, were least impaired in selecting the picture of an object after its name had been provided (object identification) and in selecting objects that could be used for a particular task (object function recognition).

They performed at normal levels on the object identification task and exhibited a small performance decrement on the object function recognition task.

In Experiment 2, significant impairments were observed in early dementia patients in all three paradigms (object naming, object function recall and object recognition tasks). Many of the errors of dementia patients on the latter task (object recognition) were elicited by the same-category distractor items.

In interpreting their results, Flicker et al. acknowledge that the familiarity of the stimulus material may have been a critical variable underlying the differential performance of the DAT patients. Thus, the picture stimuli used in Experiment 2 were derived from the Boston Naming Test, in which the object names have a wide-ranging frequency of usage, but the picture stimuli used in both paradigms in Experiment 1, on which the early DAT patients achieved near ceiling-level performances, consisted of images of relatively common household items.

The findings of differential performance by Flicker et al.'s patients may also be accounted for in terms of task demands. Thus, patients with early DAT were most impaired relative to normals when required to specify the names of items within a category (category fluency), the names of pictured objects (object naming), or the functional usage of objects (object function recall); all these paradigms require effortful and unguided recall. In contrast, when provided with a written object name, these patients were able to recognise and select its visual representation from a relatively large display of 25 items (object identification).

In addition, when provided only with the same display of pictured objects, they were only slightly impaired in selecting the objects which shared a specified functional attribute.

Other kinds of evidence have also been interpreted as proof that especially in the early stages of DAT although Alzheimer patients retain knowledge about the semantic features of concepts, they are impaired in their ability to access this information by self-directed search.

For example, with regard to the suggestion of differential performance across tests, Martin and Fedio (1983) reported that their relatively mildly impaired Alzheimer patients performed well within normal limits on two standardised measures of semantic knowledge: the Vocabulary (word definition) and Similarities (knowledge of category membership) subtests of the Wechsler Adult Intelligence Scale (WAIS).

Performance on both these measures was at a higher level relative to all other WAIS subtests, whereas the same patients were considerably impaired on tests requiring retrieval of a specific referent (i.e., naming and fluency).

Nebes and Brady (1988) carried out a study to further examine the proposal by Martin and Fedio (1983) that while demented patients retain general semantic information about a concept, such as its membership in its superordinate category, they no longer possess knowledge of a concept's distinctive features and functions.

In a Semantic Fields task, they compared the time taken by mildly and moderately demented Alzheimer's patients and normal young and elderly controls to decide whether a relationship exists between a target noun and each of ten concepts.

The patients were shown, one at a time, a series of twelve test objects represented by line drawings, with the object name printed beneath each drawing to ensure the object identity was clear. After seeing each test object, ten randomly intermixed words (five related and five unrelated) were displayed individually in a tachistoscope and patients were asked to indicate by a "yes" or "no" spoken response whether each stimulus word was related to the test object. For each object the five related words were: the name of the test object itself (an identity relationship), the object's superordinate category, an action or function characteristic of the object, a distinctive physical feature, and a general associate. The other five words were totally unrelated to the test object.

In a subsequent Attribute Generation test, patients were shown the names of ten different objects and asked to produce three attributes for each object: a distinctive physical feature of the named object, a characteristic action involving the object, and an associate. The attributes were requested singly and the order in which they were requested was counterbalanced across research participants.

The results of the Semantic Fields test showed that in comparison to old and young normals, patients with dementia were no slower in determining that a target concept was related to a characteristic action or physical feature than they were that the concept was related to its superordinate category or to a generally associated concept. The authors concluded that the patients with Alzheimer's disease were not differentially impaired with respect to any particular type of attribute when detecting the relationship between a concept and its various attributes.

Furthermore, the results of the Attribute Generation task showed that while the demented patients had a great deal of difficulty retrieving attributes of a given concept, they were not differentially impaired in retrieving any particular type of attribute.

Analysis of the proportion of inaccurate responses showed the smallest difference in error rate between normals and Alzheimer patients was with respect to 'actions'; although features and associates were more difficult to retrieve, this pattern was equally true for both normal individuals and Alzheimer patients.

Nebes and Brady's results appear to support and extend Grober et al.'s (1985) findings that attributes are not lost from the semantic representations of patients with dementia. The findings do not however agree with those of Martin and Fedio (1983) which suggest that demented patients lose their knowledge of the specific attributes of concrete concepts.

Nebes and Brady suggest that a possible reason for this disagreement in results may lie in the demands of the experimental tasks. In their study and that of Grober et al. (1985) the task requirements were such that research participants indicated whether a given attribute was related to a particular concept, and thus they had only to be aware of the existence of an association between the attribute and the concept.

In contrast, in the Martin and Fedio (1983) study patients were asked explicit questions about physical and functional attributes of pictured objects (for example, "Is it made of metal?"; "Is it used for cutting?"); such questions require a directed search of a concept's semantic field for a particular attribute.

Nebes and Brady (1988) therefore conclude that the degree to which a task requires retrieval of specific information might be important in determining whether or not demented patients demonstrate knowledge of concept attributes.

Bayles, Tomoeda and Trosset (1990) carried out a study in which the primary objective was "to test the theory that semantic memory deterioration in Alzheimer's disease progresses from a loss of object-specific attribute knowledge to more general loss of category knowledge" (1990, p. 507). They asked mildly and moderately demented Alzheimer patients to name thirteen object drawings selected from the Boston Naming Test which spanned the range of test difficulty (Naming Task). They subsequently asked the same subjects to specify the larger group of objects to which the stimulus objects belonged (Category Recall) and finally to identify, from among four written choices, the category for each stimulus object (Category Recognition). For each item the incorrect choices included : another item within the category, another semantic category, and an object visually similar to the stimulus. Task difficulty effects were controlled by determining the ratio of difficulty of the naming and category knowledge tasks.
It was hypothesised that, if object-specific knowledge is lost before more general category knowledge, then naming performance should become progressively inferior to performance on the category knowledge tasks, with increased severity of disease. In fact, the authors observed the opposite outcome: when task difficulty effects were controlled, object naming became progressively easier with increased disease severity relative to the recognition and recall of object category information.

The pattern of deterioration of category knowledge relative to naming performance was more pronounced for Category Recall, a generative task, than for Category Recognition, a forced-choice task. In the Category Recall test, normal control subjects and mild DAT patients were most likely to give an unrelated response; in both groups providing an attribute was more common than giving an item in the same category.

Moderate DAT patients typically did not know the answer, or gave an equal number of these response types. The misnamings produced by the patients were analysed because the theory under investigation was built in part upon the finding that naming errors are often superordinate category names or members of the same category as the stimulus, which has been interpreted as evidence of category knowledge.

However, Bayles et al. found that misnamings in the form of the superordinate were virtually non-existent in all (control and dementing) groups of research participants. Naming another item in the same category was much less common among mild and moderate Alzheimer's disease than normal control subjects. The Alzheimer patients were more likely to name an object attribute than another item in the same category. The authors concluded that to the degree that confrontation naming is a test of attribute knowledge, their data do not support the theory that attribute knowledge is lost before category knowledge during the course of DAT. Furthermore, the fact that naming an attribute was considerably more common among dementia patients than among normal controls "inevitably challenges the theory that attribute knowledge is lost while category knowledge is maintained." (1990, p. 507).

The errors made by the dementia patients on the Category Recognition task (which consisted most often of selecting the foil that was semantically related to the stimulus) suggest that although the dementia patients failed in identifying the category for the stimulus object, they nevertheless appeared to retain some awareness of the semantic relation between the stimulus and another member of the same class.

Bayles et al. (1990) propose, like Nebes and Brady (1988), that control of task difficulty effects likely accounts for differences between their study results and those of previous investigators. Thus, Alzheimer patients may have less difficulty in sorting by category than answering attribute questions because sorting may be easier than question answering. Patients may be better at answering category probes (for example "Is it an X?") because these are easier than attribute probes which involve comparison of two concepts (for example "Is X bigger than Y?").

In this study, the more prominent deficit of AD patients on the Category Recall than the Category Recognition task could be attributed to the fact that the former required an explicit statement of category knowledge whereas subjects only needed to recognise the correct category in the Recognition task. The lack of a significant relation between type of misnaming and performance on either category knowledge task may be a clue that category and naming tasks may use category knowledge differently. If the process of naming typically involves identification of the stimulus and the process of categorising typically involves identification of the stimulus plus recognition and / or recall of its category, then naming may be viewed as a component of the more complex process of categorising.

In this respect, Alzheimer's disease would be expected to impair complex processes more rapidly than simple ones (Bayles, Tomoeda and Trosset, 1990).

Funnell and Hodges (1990) reported data from a two-year longitudinal study of a progressive anomia in a patient with Alzheimer-type dementia which suggested that the naming disorder was essentially one of impaired access from semantic description to the spoken word forms, a deficit previously unreported in DAT. Confrontation naming tests presented to their patient 'Mary' during the first year exposed a specific anomia which contrasted with ceiling comprehension on the British Picture Vocabulary Scale (Dunn, Dunn, Whetton and Pintilie, 1982).

Comprehension deteriorated during the second year of testing but remained superior to naming; thus, in the second year of testing Mary named only 15 / 55 pictures correctly but was able to distinguish 45 / 55 of the correct names when presented together with close semantic distractors.

In order to monitor naming performance, five picture sets (A to E) comprising animal and object drawings were presented on four occasions over two years. The mean name frequency of the picture sets declined across sets from A to E. Mary was found to be equally impaired in naming to verbal definition and supplying names to complete a sentence, but could repeat the same object names perfectly and was able to read them aloud with high success (93% correct).

This observation suggested that the spoken word representations for these names remained intact but that access to the phonological word forms from pictures and verbal descriptions was selectively impaired. Mary made no visual errors and a small proportion of semantic and phonologically related errors; the only error type to increase significantly over repeated tests was a failure to respond within the fifteen second time limit. The frequency of the name affected naming performance, but did not appear to interact with the severity of the naming disorder, suggesting that the parameters of the normal naming system were unaffected but were brought below ceiling by the disease process.

Presentation of an initial phoneme cue increased naming success for pictures not named within the 15 second time limit, but cueing became less effective as spontaneous naming ability declined over repeated tests. A systematic pattern of decline was observed. Some naming responses were consistently spared across the four test sessions while others became unavailable spontaneously and remained so across subsequent test sessions. Before specific naming responses disappeared from spontaneous use, there appeared to be an intervening stage at which some responses could be elicited by an initial phoneme cue, suggesting a low level of spontaneous activity of insufficient strength to produce a name unaided.

This suggested that cueing occupied a central position between spontaneous naming and absolute failure to respond. In the main, phonemic cueing seemed to succeed only for those items that had recently been named spontaneously. Once an item failed to be named it was unlikely to be named subsequently either spontaneously or with a cue.

The finding that specific naming responses items were affected consistently indicated that disorders of access are not invariably associated with inconsistent responding.

The authors concluded that important new insights into the characteristics of progressive anomia in DAT were obtained by taking a longitudinal approach.

Diesfeldt (1989) examined for consistency in errors between comprehension and production of the same words, and reported that semantic errors were not item-specific. The findings were interpreted in terms of difficulties of access and degraded semantic representations rather than as specific and permanent loss of semantic information about words and concepts.

In this study, moderately demented elderly patients with Alzheimer's disease were presented with a 28-item spoken word to picture matching comprehension task in which two target objects drawn from each of seven common categories (kitchen utensils, clothes, fruit, animals, tools, body parts and vehicles) were pictured together with either three distractor items from the same category (Same Category set) or three randomly chosen distractors from the other six categories (Mixed Category set).

The fourteen pictured target objects were tested one week later in a picture naming task, allowing for the examination of comprehension and naming performance for the same set of items. Normal subjects did not make any errors on the comprehension task.

The DAT patients performed at similar levels to controls on the Mixed Category items; on the Same Category items however, dementia patients made significantly more errors than on Mixed Category items and in relation to the mean control group score.

Performance on the Naming Task was significantly lower for DAT patients than for normal controls; however an analysis of naming scores revealed no significant advantage for items pointed to correctly in both Same Category and Mixed Category arrays (75% correctly named) over items correctly pointed to only under the Mixed Category condition (66.8% correctly named).

An interesting implication of the latter score is that pictures that elicit errors in comprehension can be correctly named on other occasions, thus indicating that word comprehension (a recognition task) may not always be easier than word retrieval.

Applying the Semantic Impairment Index formula of Butterworth, Howard and McLoughlin (Butterworth et al., 1984 - quoted in Diesfeldt, 1989) the Same Category comprehension task yielded a high (74%) level of sensitivity with respect to detecting semantic impairment. Diesfeldt therefore concluded that the assessment of language in dementia should not be limited to the testing of confrontation naming but should include a measure of word comprehension which requires the ability to distinguish among representatives of the same semantic category.

Finally, with respect to the efficacy of semantic cueing, Chertkow and Bub (1990) reported that presentation of a semantic cue consisting of the imageable word which was highly associated with the target item was ineffective for 86.9 per cent of items unnamed on an object naming test. Further analysis showed that semantic cueing was effective in only 5.4 percent of cases where the test item was found to be semantically degraded in response to verbal attribute probes. From their results Chertkow and Bub concluded that semantic cueing was not effective in aiding naming in their patients with semantic deterioration.

Therefore the evidence from various semantic processing paradigms shows that patients with Alzheimer's disease do demonstrate semantic impairments although the nature and extent of their semantic deficit appears to be heavily influenced by stimulus and task variables.

Thus the way in which the DAT patient's access to semantic information is tested may determine that individual's level of success, which in turn affects assessment outcomes with respect to gauging preserved semantic skills and the possibility of therapeutic strategies to maintain functional communication skills for as long as possible.

THE RESEARCH RATIONALE

This research set out to evaluate the performance of a group of older people aged 65 years and above and with probable Alzheimer-type dementia, against a baseline established by a Control group of normal elders, on a series of lexical-semantic processing tests.

The DAT participants were selected to fulfil eligibility criteria relating to disease aetiology and level of cognitive decline. Fifteen individuals were selected who had in common a diagnosis of probable dementia of the Alzheimer type, and each presented at one of the following four stages of cognitive decline on evaluation with the Global Deterioration Scale (GDS) clinical rating tool:

- GDS Stage 2 (Very Mild) and GDS Stage 3 (Mild) cognitive decline:

the phases of forgetfulness

- GDS Stage 4 (Moderate) and GDS Stage 5 (Moderately Severe) cognitive decline:

the phases of late confusion and early dementia

A population of normally ageing individuals were selected to provide a baseline norm of cognitive and linguistic processing in "well" elderly people representing the age span from 65 to 85+ years of age. The Control subjects were selected to form three age bands each spanning nine years in order to observe the effects of advancing chronological age upon performance.

They were also selected to ensure close matching with the DAT group on the demographic variables of age, sex, educational and occupational background in order to minimise the possible influence of these factors on cognitive and linguistic performance and therefore isolate the effects of dementia.

All research participants were required to complete the following two test batteries:

- The Standard Measures Battery for Cognitive and Language Function

a selection of seven standardised cognitive measures in routine clinical use with older people, testing visual perceptual skills, orientation and episodic memory, vocabulary comprehension, lexical association, generative naming and pre-morbid IQ

- The Experimental Battery for Semantic Processing

a series of six semantic tasks devised by the research author to examine the integrity of processes involved in the recognition and recall of single words comprising nouns drawn from fifteen well-known semantic categories of living (animals, birds, body parts) and non-living (clothing, furniture, jewellery) objects

A longitudinal component was incorporated into the research methodology, whereby the people with DAT were approached for retest at an interval of mean duration nine months subsequent to initial testing in order to observe changes in cognitive and semantic performance attributable to disease progression.

The following comparative measures were applied in evaluating the performance of the people with DAT:

- comparison between the performance of the people with DAT and the normal subjects within each of the three age-spans between 65 to 85+ years

- comparison between the performance of the people with DAT at each severity level

- comparison between the DAT peoples' performance at initial test and at retest

Specific hypotheses were raised regarding expectations of performance by the people with DAT on the standardised cognitive tests and the lexical processing measures at initial testing and retest :

- relative to the controls
- relative to their initial performance

The analyses examined for the influence of the following factors on test performance:

- effects of advancing chronological age on semantic processing by normal elders
- effects of severity and duration of DAT on semantic processing
- relative efficacy of semantic and phonemic cueing in aiding lexical recall
- the interference effects of distractors with varying relatedness to their target items
- the influence of semantic category on recognition and recall of category members
- role of visual perceptual factors in lexical-semantic performance

In order to compare the relative success of the spoken, picture and written modalities in facilitating lexical access, the following conditions were utilised in test presentation:

- spoken word to object picture match
- spoken word to written object name match
- sorting object pictures and written object names to spoken semantic category cue
- confrontation naming of object pictures
- generative naming to spoken category cue

The implications of the research findings were considered with respect to clinical assessment and interventions for older people with Alzheimer-type dementia.

THE RESEARCH HYPOTHESES

General Predictions with Respect to the Research Populations

The normal elderly and Alzheimer's disease research participants were selected to form closely matched populations with respect to the demographic characteristics of age, sex, education, occupational background and pre-morbid intellectual abilities. It was therefore predicted that variability both between and within the two groups in cognitive and semantic performance would reflect the influence of:

- the presence of dementia of the Alzheimer type (between groups effect)
- advancing age (within Control group effect)
- advancing severity of dementia (within DAT group effect)
- the heterogeneity in patterns of deterioration which has been documented as a characteristic feature of Alzheimer-type dementia (within DAT group effect)

Proceeding on the basis of these premises, a number of specific research hypotheses were raised with respect to the performance of the Control and DAT groups on the tests comprising the research protocol.

Predictions with Respect to the Performance of the Control Subjects

The Control subjects were expected to achieve high levels of accuracy on all the research tests comprising the Standard Measures Battery for Cognitive and Language Function and the Experimental Battery for Semantic Processing - with any performance decrements being observed within the highest age band of 85+ years.

Predictions with Respect to the Performance of the DAT Participants

Given that individuals with dementia of the Alzheimer type are known to experience difficulties on tests of cognitive processing which involve memory, fluency, naming and the comprehension of lower frequency lexical items, it was expected that the people with DAT would demonstrate significant decrements in relation to the Control subjects on the following standardised cognitive measures:

- level of orientation to time, place and events (CAPE Orientation Test)
- independence in functional activities (CAPE Physical Disability Scale)
- the comprehension of low frequency vocabulary (British Picture Vocabulary Scale)
- the free recall of nouns belonging to semantic categories (Set Test)

It was also predicted that the people with DAT may demonstrate deficits in performance in relation to the Control subjects on the Pyramids and Palm Trees Test, a semantic test which requires the individual to infer semantic associations between pictured nouns.

Further significant decrements in performance on the same cognitive measures were expected to emerge between the four subgroups of dementia severity (Very Mild, Mild, Moderate and Moderately Severe) as a reflection of advancing cognitive decline.

It was also predicted that at retest, the progression of dementia with time would be reflected in a decrement in the performance of the people with DAT on the standardised screening measures relating to orientation (CAPE Orientation Test) and level of functional dependence (CAPE Physical Disability Scale).

Predictions with Respect to the Experimental Battery for Semantic Processing

Having established that the people with DAT would experience significant deficits in performance on cognitive measures on which normally ageing subjects would perform without significant difficulty, hypotheses were raised with respect to the performance of the people with DAT on the tests of lexical semantic processing.

- Hypotheses with Respect to the Recognition by Unique Feature Test

This semantic test focused on the ability of individuals with dementia to utilise information which is known to native speakers of the English language, about very specific identifying attributes or "unique features" of everyday objects.

The hypothesis was raised that the people with DAT would demonstrate the ability to use such unique feature information to distinguish target nouns from amongst other distractor nouns with varying strengths of semantic association with the target.

It was therefore predicted that each of the DAT severity subgroups would achieve their best relative performance in relation to the Control baseline on the Recognition by Unique Feature tests, therefore demonstrating the accessibility of knowledge within semantic memory of individual concepts and specific identifying features associated with them.

- Hypotheses with Respect to the Recognition by Category Test

Recent conceptualisations of the breakdown of semantic knowledge in Alzheimer-type dementia suggest that patients maintain success on tests of superordinate category knowledge, in preference to their performance on tests of subordinate knowledge or specific feature attributes, which may be vulnerable to earlier loss.

In this research it was predicted that the people with DAT may demonstrate less success on the Recognition by Category tests which required them to infer noun associations based on membership of a common semantic category.

This test was relatively unguided in contrast to the Recognition by Unique Feature test in which very specific attribute information was provided to guide and facilitate successful noun recognition.

- Hypotheses with Respect to Modality of Presentation

The additional factor of modality of stimulus presentation was introduced by presenting each of the two semantic recognition tests in both picture and written form. It was predicted that the people with DAT should demonstrate success levels which did not differ significantly between the picture and written presentations of the Recognition by Unique Feature tests, confirming successful access to lexical information through both modalities.

- Hypotheses with Respect to Lexical Production

Impairments in both confrontation naming and generative naming skills are early identifying features of DAT. It was therefore expected that the people with DAT would be significantly impaired in relation to the Control group in their performance on the Picture Naming and Generative Naming tests, and that performance between the GDS severity subgroups would decline significantly as a reflection of advancing clinical decline.

It was also predicted that the people with DAT may show further decline in naming and generative naming skills at retest, in association with advancing duration of disease.

Following on from the expectation that the people with DAT would be able to utilise specific feature cues to facilitate noun recognition, it was hypothesised that the ability to name the same set of sixty target nouns in the Picture Naming Test would be facilitated by presentation of the unique feature attributes in the form of spoken semantic cues.

Furthermore, if recognition and naming performance could be demonstrated to be upheld at retest, despite measurable decline in cognitive and functional performance, therefore the ability to utilise semantic cueing information could be presumed to be resistant to some extent to the effects of disease progression.

With respect to the Generative Naming Test, it was expected that the people with DAT would demonstrate significant decrements in relation to the Control baseline with respect to both the number and variety of nouns recalled.

However, the accompanying hypothesis was also raised that a 'core vocabulary' of nouns may be identified in the responses of the DAT participants at initial test and at retest, suggesting the functional maintenance of aspects of lexical knowledge despite disease progression.

THE PILOT STUDY

Rationale for Conducting the Pilot Study

Prior to commencing the research procedure, a small pilot study was carried out with the primary aim of enabling verification of the following with regard to the research methodology :

- the feasibility of administering the research battery, which incorporated a series of individual test procedures, to a population of normal elderly people

Specifically, would normal elderly subjects be able to cope with the demands placed by the test battery upon their cognitive skills of attention, concentration, visual discrimination and semantic and episodic memory ?

- the feasibility of administering the research battery to a population of older people with dementia

Having established that the research procedure would be suitable for administration to an elderly population with normal cognitive functioning, would it be also suitable for a population of elderly individuals with cognitive decrements due to dementia ?

- The suitability of the test materials for a population of older people, given possible constraints of sensory perceptual processing limitations. The recent literature reports findings of differences in the visual perceptual performance of elderly people which can be attributed to variations in the visually presented stimulus, for example photographs versus line drawings, and colour as opposed to black and white print.

All the materials used in this study were presented in the black and white modality in the form of line drawings and printed words. It was important to confirm that these stimuli could be easily perceived by a normal elderly population, in order to enable the detection of genuine difficulties in perceiving the stimuli which could be attributed to the effects of dementia.

Therefore in constructing the picture and printed word test stimuli, care was taken with respect to the variables of size and simplicity of outline to ensure optimum clarity of presentation. The pilot study provided the opportunity to verify that the test stimuli fulfilled the criteria with respect to visual presentation.

Number of Research Participants in the Pilot Study

A small group of seven older people, comprising three individuals with dementia of the Alzheimer type and four normally ageing Control subjects, was recruited to participate in the pilot study.

In recruiting small populations of individuals to participate in the pilot procedure, it was acknowledged that the research groups were not of sufficient size to justify the application of statistical comparisons.

However, the primary emphasis of the pilot study was upon validating the suitability of the research materials as a basis from which to develop the final research protocol, thereby identifying any features associated with the methodological design which may be problematic for older people and to implement test modifications accordingly.

Selection Criteria for the Pilot Study Research Participants

All the research participants were required to fulfil selection criteria of being aged over 65 years, native English speakers, able to read and write English, with sufficient vision to read large size print and sufficient hearing to detect speech in a quiet setting (using eyeglasses and hearing aid if required), with no previous known history of focal cerebrovascular lesion, chronic depression, Parkinson's Disease or alcohol or drug abuse, and co-operative and consenting to participate in the research procedure.

The Control subjects were older people who were "well" and living independently in the community in either their own homes or warden-controlled accommodation.

The people with DAT were older people who had been given a diagnosis of probable dementia of the Alzheimer type (DAT), following a history for at least six months of noticeable decline in memory and one or more associated cognitive skills of language, thinking or perception, and for whom other possible causes of dementia such as chronic depression, multiple cerebral infarcts, Huntington's chorea and potentially reversible confusional states had been excluded.

Three of the four Control subjects were recruited from the day hospital facility at the local hospital, which they were attending as outpatients for the treatment of mobility problems. The remaining Control subject was recruited through a local church group.

All three people with DAT were recruited through a day care centre in the local community for older people with mental health needs. They were selected in consultation with the staff responsible for their care. Consent for their participation was obtained from their principal carer.

Details of the age and sex distribution for the pilot Control and DAT research participants are displayed in Table 1.

TABLE 1
Demographic Characteristics of the Pilot Study Participants

	CONTROL GROUP	DAT GROUP
PARTICIPANTS	4	3
SEX		
Male	1	0
Female	3	3
AGE		
Range	78 - 93 years	77 - 90 years
Mean	**88.60**	**84.33**
Stdev	6.45	6.7

Educational and Occupational Characteristics of the Research Participants

The Control and DAT pilot study participants were selected to be closely matched on the variables of education and occupational background.

All the participants were aged between 14 to 16 years at the time of leaving school.

The majority of pilot study participants had been employed in the clerical, retail and factory trades.

Table 2 overleaf displays a breakdown of this demographic data for individual research participants.

TABLE 2
Demographic Data for Individual Pilot Study Participants

SUBJECT	SEX	AGE	OCCUPATION
CONTROL GROUP			
Subject PC1	Female	78	Dance instructor
Subject PC2	Female	89	Clerical and Factory work
Subject PC3	Male	91	Occasional work
Subject PC4	Female	92	Clerical & Shop work
DAT GROUP			
Patient PD1	Female	77	Shop Assistant
Patient PD2	Female	86	Homemaker & Shop work
Patient PD3	Female	91	Homemaker

PC = Pilot Control Participant PD = Pilot Dementia Participant

Duration of DAT in the Research Participants

Information regarding the time since onset of dementia had been provided by each individual's principal carer; this information was based on the time from which they first became aware of memory difficulties, disorientation and other changes in the older person.

There was considerable variation between the individuals with DAT with respect to the reported duration of dementia symptoms. Thus, the reported date of onset was eighteen months for one participant and sixty months for the other. Information regarding the date of onset of dementia was not available for the remaining participant.

Evaluation of the Severity of Cognitive Decline

Each of the three pilot DAT patients was rated for severity of cognitive decline with reference to the Global Deterioration Scale for Assessment of Primary Degenerative Dementia (GDS), a clinical rating instrument devised by Reisberg, Ferris, De Leon and Crook (1982). Despite a large degree of variability noted between individuals with DAT with respect to time since onset of disease, nevertheless all three were evaluated as being at one of two stages of cognitive decline according to the GDS, specifically GDS Stage 4 (Moderate level of cognitive decline - the late confusional phase) and GDS Stage 5 (Moderately Severe level of cognitive decline - the early dementia phase).

This data is displayed in Table 3.

TABLE 3
Duration and Severity of Dementia for the Pilot DAT Participants

Participant	Age	Sex	Duration of DAT	GDS Rating of Cognitive Decline
PD1	77	Female	data not available	GDS 5
PD2	86	Female	60 months	GDS 4
PD3	91	Female	18 months	GDS 4

GDS 4 = moderate level of cognitive decline

GDS 5 = moderately severe level of cognitive decline

The Pilot Test Batteries

The pilot experimental procedure consisted of two test batteries, entitled the Standard Measures Battery for Cognitive and Language Function and the Experimental Battery for Semantic Processing.

The pilot version of the Experimental Battery for Semantic Processing consisted of four tests devised by the research author to test the semantic processes involved in the recognition and recall of single lexical items, specifically nouns.

The pilot Standard Measures Battery for Cognitive and Language Function comprised four standardised assessments of cognitive and linguistic functioning which are commonly used in the clinical assessment of older people.

Rationale Underlying the Design of the Test Batteries

The individual tests comprising the pilot test batteries, the reasons for their inclusion in the procedure, and individual test design are described in the following section.

The Standard Measures Battery for Cognitive and Language Function was administered to every research participant prior to the administration of the Experimental Battery for Semantic Processing.

- The Standard Measures Battery for Cognitive and Language Function

The tests in this battery were selected to enable assessment of the following cognitive abilities:

♦ everyday orientation to person, place and time	CAPE: Survey Version
♦ estimated pre-morbid level of IQ functioning	The Short NART
♦ generative naming skills	The Set Test
♦ lexical association skills in the picture modality	Pyramids and Palm Trees

- CLIFTON ASSESSMENT PROCEDURES FOR THE ELDERLY (CAPE)

(Survey Version - Pattie, 1981)

The shortened version of this assessment battery, incorporating two sub-scales from the full version - the 12-item Information & Orientation Test and the Physical Disability Scale rating scale - was used to gain an indication of general orientation to person, place and time, and level of dependence in functional tasks of daily living.

- THE NATIONAL ADULT READING TEST (NART - Nelson, 1982)

(Short NART - Beardsall & Brayne, 1990)

The shortened version of the full-length 50-item NART requires test participants to read aloud a list of 25 irregular words. Performance on the 25-item NART has been used (Beardsall and Brayne, 1990) to predict scores on the full-length NART and thus to obtain an estimate of premorbid IQ for elderly people.

The shortened NART has been shown to be comparable in accuracy with the full-length version in terms of predicting IQ's on the WAIS (Crawford et. al. 1991); it may therefore be regarded as a reliable tool in clinical practice for estimating premorbid IQ.

- THE SET TEST

(Isaacs & Akhtar, 1972)

This test of generative naming has been advocated as a rapid and easily administered quantitative screening procedure for the early detection of impaired mental status in the elderly. The test requires participants to name as many items as they can recall in each of four semantic categories or 'sets', named aloud and presented in the following order: *colours*, *animals*, *fruits*, *towns*. There is no time limit for each set. The subject is awarded one point for each correct item named, with a maximum of 10 points in each set and a maximum total score of 40. A total Set Test score of under 15 items has been found to correspond closely with a clinical diagnosis of dementia (Isaacs & Kennie, 1973).

For the purposes of this research the method of administration of the Set Test was modified whereby all research participants were instructed that they would be given a time of one minute for each set. This variation in presentation was introduced to give a finite time limit for each category and therefore appease probable anxiety in the DAT participants, for whom it was anticipated that the uncued conditions of the generative naming test would cause the greatest effort, evident for example as delays in being able to initiate recall and list items for each set.

- PYRAMIDS & PALM TREES TEST

(Howard & Patterson, 1992)

The three picture version of this word association test was administered to obtain an indication of participants' ability to recognise semantic links between pictorially presented nouns. The test requires participants to select which of two picture stimuli is the semantic associate for the target object in the triad. In order to minimise fatiguability, only the initial 30 test items were administered to the participants. Table 4 displays the number of items included in each standardised test measure.

TABLE 4
The Number of Items in Each Standardised Test

TEST	NUMBER OF TEST ITEMS
CAPE	12
NART	25
SET TEST	4 semantic categories x 1 minute each
PYRAMIDS & PALM TREES	30

- The Experimental Battery for Semantic Processing

The four tests comprising the pilot version of this battery were designed to evaluate the recognition and recall of single lexical items, specifically nouns. There were two tests of noun comprehension and two tests of noun production. The noun stimuli utilised comprised both common concrete nouns and proper nouns.

Specific lexical processing abilities tested were:

- the recognition of objects by their attributes of semantic category (Recognition by Category Test) and distinguishing feature (Recognition by Feature Test)
- the recall of object names under test conditions of picture confrontation naming (Naming Test)
- the ability to generate nouns from specified semantic categories (Generative Naming Test)

The Design of the Noun Processing Tests

The thirty distinctive feature attribute cues presented in the Recognition by Feature Test were constructed by describing a distinguishing feature of each object stimulus. Each distinctive feature cue was designed to capture very specific information about its target noun, thus ensuring that cognitively intact native speakers of the English language would easily recognise the attribute as being uniquely associated with the target, with reference to previously acquired semantic knowledge of noun concepts.

In most instances the distinctive feature attribute consisted of a function or activity associated with the target noun. In some instances, a descriptive label of the target noun was chosen, for example for the target *dog* : 'man's best friend'.

The set of thirty target noun stimuli utilised in the Recognition by Feature Test, which were presented in picture form, also comprised the thirty noun targets for the Picture Naming Test.

Finally, in order to evaluate the efficacy of semantic cueing in facilitating both the recognition and recall of objects, the thirty distinctive attribute cues from the Recognition by Feature Test were presented as spoken semantic cues in the Picture Naming Test for items which were not be named spontaneously.

The Recognition by Category and Generative Naming tests were based on a common set of five semantic categories. The five categories were selected in order to observe the ability of elderly people (both normal subjects and those with dementia) to generate items from categories likely to hold personal relevance and 'reminiscence value' (Boys' and Girls' names, Occupations, Relatives, and Sports).

The noun stimuli utilised in the Recognition by Category Test were presented as written words.

The five semantic categories are displayed in Table 5.

TABLE 5
The Categories of the Recognition by Category and Generative Naming Tests

Girls' Names
Boys' Names
Relations
Occupations
Sports

The number of test items comprising each pilot semantic processing test was as follows:

<u>Noun Comprehension Tests</u>

- Recognition by Feature Test (picture stimuli) 30 items
- Recognition by Category Test (written stimuli) 5 items

<u>Noun Production Tests</u>

- Naming Test (picture stimuli) 30 items
- Generative Naming Test (spoken stimuli) 5 categories

The Pilot Study Findings

- Predicted IQ Scores for the Control and DAT Groups

Table 6 displays the mean estimated IQ scores derived from the scores of the Control and DAT research participants on the Short NART.

The data confirms similar mean IQ scores for both groups.

TABLE 6
Full Scale IQ Quotients for the Pilot Research Participants

GROUP	Mean Estimated IQ	IQ Range
CONTROL	93.75	(82 - 100)
DAT	94.66	(92 - 98)

- Test Completion Rates for the Control and DAT Groups

The number of participants within each group who completed the test battery was compared in order to monitor the level of completion and thereby establish the ability of the research populations, normal older people and those with DAT, to tolerate the administration of the two successively presented test batteries. The findings are presented in the following section.

♦ The Standard Measures Battery for Cognitive and Language Function

One Control subject failed to yield a score for the Pyramids and Palm Trees test, and two DAT participants were unable to complete the same test.

The Control group successfully completed every other cognitive screening test. Participant PD1, who was unable to complete the Pyramids and Palm Trees test, also failed to respond to the Set Test.

♦ The Experimental Battery for Semantic Processing

A higher rate of successful completion was observed on the pilot lexical processing tests. The only test which yielded incomplete data was the Generative Naming Test, which one Control subject and one DAT participant did not complete.

Reasons for failure to complete the tests included one or more of the following:

- participant experienced difficulty in responding to the test items
- participant fatigued and did not wish to proceed with further testing
- decision by the researcher to abandon testing to prevent participant anxiety

It was noted that every Control subject completed the full research protocol in a single test session, whereas every DAT participant required more than one test session.

The number of individuals completing each test in the two research batteries is displayed in Table 7 and Table 8.

TABLE 7
The Number of Research Participants Completing the Standard Tests

	CONTROL (N=4)	DAT (N = 3)
CAPE	All	All
SHORT NART	All	All
SET TEST	All	2
PYRAMIDS & PALM TREES	3	1

TABLE 8
The Number of Research Participants Completing the Semantic Tests

	CONTROL (N=4)	DAT (N = 3)
Picture Recognition by Feature	All	All
Picture Naming	All	All
Written Recognition by Category	All	All
Generative Naming	3	2

- Heterogeneity in Performance of the Research Participants

Heterogeneity with respect to the performance of individual pilot study research participants was observed within both the Control and DAT groups.

Heterogeneity between the people with DAT was evident in the variability between their individual performance profiles. The performance profile of Participant PD1, characterised by low scores and non-completion of tasks, was particularly at variance with the scores of the two other people with DAT. However, Participant PD1 had been evaluated as presenting with the greatest level of cognitive decline at entry to testing.

Within the Control group, atypical scores with respect to those of the majority of the group were noted in the performance of Subject PC2 on the Standard Measures Battery for Cognitive and Language Function.

This subject generated the fewest items for the categories of *Animals* and *Colours* on the Set Test, and achieved an extremely variant score on the Short NART. The scores of this subject therefore pulled down the baseline established by the Control group. Less variability was noted within both subject groups in their performance on the tests comprising the Experimental Battery for Semantic Processing.

The Control and DAT group means and individual participant scores for the Pilot Study test batteries are presented in Tables 9, 10, 11, 12, 13 and 14.

TABLE 9
The Pilot Standard Measures Battery for Cognitive and Language Function Scores for Control Subjects

TEST	SUBJECT PC1	SUBJECT PC2	SUBJECT PC3	SUBJECT PC4	MEAN
CAPE	12 / 12	11 / 12	11 / 12	12 / 12	**11.5**
Stdev.					(.58)
SHORT NART	25 / 25	11 / 25	24 / 25	21 / 25	**20.25**
Stdev.					(6.39)
PYRAMIDS & PALM TREES	29 / 30	27 / 30	no score	22 / 30	**19.50**
Stdev.					(13.33)
SET TEST					
Animals	32	6	11	11	**15.00**
Stdev.					(11.58)
Fruits	27	8	8	9	**13.00**
Stdev.					(9.34)
Towns	20	10	9	13	**13.00**
Stdev.					(4.97)
Colours	16	7	11	13	**11.75**
Stdev.					(3.77)

TABLE 10
The Pilot Standard Measures Battery for Cognitive and Language Function Scores for DAT Participants

	Participant PD1 (GDS 5)	Participant PD2 (GDS 4)	Participant PD3 (GDS 4)	MEAN
CAPE	2 / 12	6 / 12	10 / 12	**6.00**
Stdev.				4.00
SHORT NART	19 / 25	17 / 25	16 / 25	**17.33**
Stdev.				1.53
PYRAMIDS & PALM TREES	no score	no score	23 / 30	**7.67**
Stdev.				13.28
SET TEST				
Colours	no score	11	11	**7.33**
Stdev.				6.35
Animals	"	8	8	**5.33**
Stdev.				4.62
Fruits	"	7	9	**5.33**
Stdev.				4.73
Towns	"	8	8	**5.33**
Stdev.				4.62

TABLE 11
The Pilot Experimental Battery for Semantic Processing
Scores for Control Subjects

TEST	SUBJECT PC1	SUBJECT PC2	SUBJECT PC3	SUBJECT PC4	MEAN
Picture Recognition by Feature	30 / 30	28 / 30	29 / 30	29 / 30	**29.00** (Stdev. 0.82)
Written Recognition by Category	13 / 15	14 / 15	14 / 15	15 / 15	**14.00** (Stdev. 0.82)
Picture Naming	30 / 30	26 / 30	28 / 30	29 / 30	**28.25** (Stdev. 1.71)

TABLE 12
The Pilot Experimental Battery for Semantic Processing
Scores for DAT Participants

TEST	Participant PD1 (GDS 5)	Participant PD2 (GDS 4)	Participant PD3 (GDS 4)	MEAN
Picture Recognition by Feature	28 / 30	28 / 30	29 / 30	**28.33** (Stdev. 0.58)
Written Recognition by Category	12 / 15	10 / 15	9 / 15	**10.33** (Stdev. 1.53)
Picture Naming	17 / 30	29 / 30	25 / 30	**23.67** (Stdev. 6.11)

TABLE 13
The Pilot Generative Naming Test : Scores for Control Subjects

	SUBJECT PC1	SUBJECT PC2	SUBJECT PC3	SUBJECT PC4	MEAN
Girls' Names	53	19	17	no data	**22.25**
Stdev.					22.20
Boys' Names	36	14	12	no data	**15.50**
Stdev.					15.00
Occupations	35	2	17	no data	**13.50**
Stdev.					16.22
Relatives	13	14	16	no data	**10.75**
Stdev.					7.27
Sports	19	12	10	no data	**10.25**
Stdev.					7.85

TABLE 14
The Pilot Generative Naming Test : Scores for DAT Participants

	Participant PD1 (GDS 5)	Participant PD2 (GDS 4)	Participant PD3 (GDS 4)	MEAN
Girls' Names	no data	11	10	**7.00**
Stdev.				6.08
Boys' Names	no data	9	5	**4.67**
Stdev.				4.51
Occupations	no data	7	7	**4.67**
Stdev.				4.04
Relatives	no data	4	no data	**1.33**
Stdev.				2.31
Sports	no data	7	5	**4.00**
Stdev.				3.61

Statistical Considerations with Respect to the Pilot Study Results

In view of the small number of participants comprising each pilot group, and the variability in performance noted between individual participants within each group, it was acknowledged that the likelihood of finding a statistical difference was unlikely and that the application of inferential statistical analysis would not be validated.

Application of the non-parametric *Mann-Whitney U-Test* yielded significant differences at $p < 0.05$ (two-tailed test) between the scores of the Control and DAT groups on the following two tests of the Standard Measures Battery for Cognitive and Language Function.

- the CAPE Orientation Test (U = .0   2-Tailed P corrected for ties = 0.03)
- the category of *Towns* in the Set Test (U = .0   2-Tailed P corrected for ties = 0.03)

With respect to the Experimental Battery for Semantic Processing, the application of the non-parametric *Mann-Whitney U-Test* did not yield significance for the data analyses at $p < 0.05$.

In order to gain a picture of the performance of the pilot DAT group in relation to the performance baseline established by the Control group, the performance of each DAT participant on every test was expressed as a percentage of the Control mean.

The data from these analyses is presented in Table 15 and Table 16.

TABLE 15
The Pilot Standard Measures Battery for Cognitive and Language Function Performance of the DAT Participants as a Percentage of the Control Mean

	Control Mean	Participant PD1 (GDS5)	Participant PD2 (GDS4)	Participant PD3 (GDS4)
CAPE	11.50	17.4%	52.2%	86.9%
SHORT NART	20.25	93.8%	83.9%	79.0%
PYRAMIDS & PALM TREES	19.50	no score	no score	117.9%
SET TEST				
Animals	15.00	no score	53.3%	53.3%
Fruits	13.00	no score	53.8%	69.2%
Towns	13.00	no score	61.5%	61.5%
Colours	11.75	no score	93.6%	93.6%

The results in Table 15 show the great variability between individual DAT participants in their performance on the CAPE Test, which called upon orientation and episodic memory skills.

For example, Participant PD3, the only DAT participant to complete the test of semantic association (Pyramids and Palm Trees) achieved a score which was greater than that obtained by two of the Control subjects, thus yielding the high overall percentage score of 117.9%

With respect to the number of items recalled in response to each of the semantic categories of the Set Test, the two DAT participants who completed the test were each able to recall more than 50% of the mean number recalled by the Controls. The DAT participants also demonstrated an opposite trend to the Control group, recalling the least number of nouns for the category of *Animals,* for which the Controls achieved the highest mean, and the greatest number for the category of *Colours*, although this was the category for which the Controls recalled the fewest items.

The results in Table 16 show that with respect to the Experimental Battery for Semantic Processing, every person with DAT achieved scores at greater than 60% of the Control mean on the Naming Test and both recognition tests.

The DAT group consistently achieved their highest scores on the Recognition by Feature Test, performing at ceiling level or near-ceiling levels (96.5%) relative to the Control mean.

TABLE 16
The Pilot Experimental Battery for Semantic Processing
Performance of the DAT Participants as a Percentage of the Control Mean

	Control Mean	Participant PD1(GDS5)	Participant PD2 (GDS4)	Participant PD3 (GDS4)
Picture Recognition by Feature	29.00	96.5%	96.5%	100%
Written Recognition by Category	14.00	85.7%	71.4%	64.3%
Picture Naming	28.25	60.2%	102.6%	88.5%
Generative Naming				
Girls' Names	22.25	no data	49.4%	44.9%
Boys' Names	15.50	no data	58.06%	32.3%
Occupations	13.50	no data	51.85%	51.85%
Relatives	10.75	no data	37.2%	no score
Sports	10.25	no data	68.3%	48.8%

Interpretation of Findings for the Pilot Study

The pilot study findings confirmed the following points with respect to the performance of the research participants:

- The Pilot Control Subjects

The pilot Control subjects demonstrated a high rate of successful test completion. All the Control subjects were aged above 75 years, with two subjects being above ninety years of age.

Despite some variability noted in the performance of individual Control subjects on the tests of the Standard Measures Battery for Cognitive and Language Function, most subjects achieved scores representing greater than 80% success on the Short NART, CAPE and Pyramids and Palm Trees tests.

All the Control subjects achieved very high (minimum 87% success level) or ceiling scores on the tests of the Experimental Battery for Semantic Processing. None of the subjects reported difficulties in perceiving the test stimuli.

The response of the Control subjects to the materials and tests developed for the pilot procedure therefore verified these materials as appropriate with respect to the factors of visual presentation, length of time required to administer, and cognitive processing demands, for normally ageing older people in the seventh, eighth and ninth decades.

- The Pilot DAT Group

The people with DAT achieved a high completion rate for both test batteries. As predicted, the people with DAT also performed at high levels in relation to the Controls on the tests of the Experimental Battery for Semantic Processing, which confirmed that the picture and written test materials devised for the research procedure were suitable, with respect to presentation and length of administration, for older people with cognitive impairment consequent upon Alzheimer-type dementia.

Modification and Development of the Pilot Test Protocol

The pilot experimental tests were administered to the pilot subject population primarily as a preliminary trial to ensure suitability for administration to populations of normal older people and older individuals with dementia of the Alzheimer type.

Subsequent to the running of the pilot study, and on the basis of the pilot study findings, a number of modifications were introduced to the research protocol, as described in the following section.

- The Standard Measures Battery for Cognitive and Language Function

This battery was expanded to include a standardised measure of visual perceptual abilities, and a standardised measure of vocabulary comprehension.

THE VISUAL OBJECT AND SPACE PERCEPTION BATTERY (VOSP)

(Warrington & James, 1991)

This test procedure provides a measure of visual processing abilities. Two sub-tests were selected from this battery to ensure that research participants had adequate visual perceptual skills to enable discrimination of the picture and word stimuli.

The Dot Counting Test (10 items) provides a spatial scanning task to evaluate the ability localise single points, and requires subjects to count a series of black dots.

The Shape Detection Test (20 items) is a pre-test screening protocol to ensure adequate discrimination of visual shape. It requires subjects to indicate whether or not an 'X' shape is present upon a background.

THE BRITISH PICTURE VOCABULARY SCALE (BPVS) - Short Form

(Dunn, Dunn, Whetton and Pintilie, 1982)

This test gives a measure of receptive vocabulary and evaluates the auditory comprehension of single concepts. The shortened 32-item version of the BPVS was administered to provide an evaluation of vocabulary comprehension.

The test requires subjects to select one line drawing from a display of four in response to an auditorily presented single word; the stimuli comprise a series of nouns, adjectives, verbs and adverbs which increase in complexity as the test progresses.

- The Experimental Battery for Semantic Processing

The following modifications were introduced to the lexical processing tests:

- The categories in the Generative Naming Test were modified in both their theme and number.

It was decided to establish a common semantic basis underlying the research protocol, such that each test in the procedure utilised concrete, picturable nouns from a common set of semantic categories. Therefore the theme of the categories was changed from the five categories representing mixed common and proper nouns, to the fifteen categories of objects represented in the Picture Naming and Recognition by Feature tests, thereby increasing the number of semantic categories in the Generative Naming Test to fifteen.

The semantic categories were chosen from amongst those identified by Battig and Montague in their 1969 study of category norms. The categories consisted of six 'living' and nine 'non-living' object groups, selected to represent familiar and functional categories. They are displayed in Table 17.

TABLE 17
The Fifteen Semantic Categories Represented in the Research Protocol

Living Objects	Non-Living Objects
Animals	Clothing
Birds	Household Objects
Body parts	Footwear
Fruit	Furniture
Insects	Jewellery
Vegetables	Kitchen Tools
	Musical instruments
	Tools
	Transport

- The Recognition by Feature Test was further developed.

Based on the high levels of success demonstrated by the pilot study participants on the Recognition by Feature Test, it was decided to expand the set of specific feature attribute cues, and also to design a written version of the Recognition by Feature Test, thus enabling evaluation of the facilitatory effect of the attribute cues with respect to both pictured noun stimuli and written object names.

The sixty distinctive feature attribute cues were re-named to be known as the 'Unique Feature Cues' and the test was accordingly re-named as the Recognition by Unique Feature Test.

The set of target nouns utilised in both the Recognition by Unique Feature and Picture Naming tests was accordingly increased from thirty to sixty, to include the 30 noun stimuli from the Written Recognition by Unique Feature Test.

The sixty target nouns included in the Recognition by Unique Feature and Naming tests consisted of four members from each of the fifteen semantic categories represented throughout the research protocol.

A written version was also designed for the Recognition by Category Test, in order to evaluate the recognition of objects by their attribute of semantic category in both the picture and written modalities. This increased the total number of tests in the Experimental Battery for Semantic Processing from four to six.

The written version of each lexical recognition test was based on a different set of target nouns from their pictorial counterparts.

The design of each lexical processing test will be discussed further in the methodology chapter of this research.

The final versions of the Standard Measures Battery for Cognitive and Language Function and the Experimental Battery for Semantic Processing subsequent to the modifications of the pilot protocol are displayed in Table 18 and Table 19.

TABLE 18
The Standard Measures Battery for Cognitive and Language Function
Final Version

TEST	NUMBER OF TEST ITEMS
CAPE	12
VOSP Visual Screens	
Dot Counting Sub-test	10
Shape Detection Sub-test	20
SET TEST	4 Categories x 1 minute each
Short NART	25
PYRAMIDS & PALM TREES	30
BPVS	32

TABLE 19
The Experimental Battery for Semantic Processing : Final Version

TEST	TOTAL ITEMS
Recognition of Nouns by Unique Feature (picture version)	30 test items
Recognition of Nouns by Unique Feature (written version)	30 test items
Recognition of Nouns by Semantic Category (picture version)	15 test items
Recognition of Nouns by Semantic Category (written version)	15 test items
Confrontation Naming of Object Pictures	60 test items
Generative Naming Test	15 categories

METHODOLOGY

The Research Participants

The research involved groups of older people aged above 65 years, selected to represent the following populations:

- The Control Group

  normal elderly people who were 'well' and living independently in their own homes in the community, representing the age spectrum from 65 to 87 years

- The Dementia of the Alzheimer Type (DAT) Group

  older people who had been given a diagnosis of probable dementia of the Alzheimer type (DAT) and were rated by the research author with reference to a clinical rating instrument (the Global Deterioration Scale) as presenting at one of four stages of cognitive decline, from Very Mild through to Moderately Severe, at their initial entry to the research study.

Criteria for Selecting the Research Participants

All the research participants were required to fulfil the following inclusion criteria:

- Age above 65 years at entry to the research procedure
- Native speakers of English
- Able to read and write English
- Sufficient vision to read large size print, with spectacles if necessary
- Sufficient hearing to detect speech in a quiet setting, with hearing aid if worn
- No previous known history of focal cerebrovascular lesion, Parkinson's Disease, abuse of alcohol or drugs, or chronic depression
- Willing to co-operate in the test procedure
- Consent for participation given by the elderly person or their principal carers

For inclusion in the dementia of the Alzheimer Type (DAT) group, older people were selected to meet the following further criteria:

- A history, for at least six months, of noticeable decline in memory and one or more associated cognitive skills (e.g., language, thinking, perception)
- Exclusion of a potentially reversible confusional state caused by illness, infection or reaction to medication, as the cause of dementia
- Exclusion of chronic depression, multiple cerebral infarcts or other dementia-causing disease (e.g. Huntington's chorea) as the cause of dementia
- Main carer(s) aware of the diagnosis of dementia as the possible underlying pathology

In order to ensure that the eligibility criteria relating to aetiology were fulfilled, a brief 12-item Health Screening Questionnaire relating to general medical history was devised by the research author and administered to all potential participants prior to initiating the research protocol.

The questionnaire also included questions about participants' demographic details (number of years of education and main occupation) and auditory-visual abilities, for example whether eyeglasses and a hearing aid were normally worn.

Details of the Health Screening Questionnaire may be found in Appendix 2.

Procedures for Recruiting the Research Participants

All the research participants were resident within a circumscribed area of London. The Control subjects were recruited mainly through local day centres and clubs for older people. Some Control subjects were recruited from the population of elderly people attending the day hospital facility at the local hospital for treatment of problems not associated with neurological lesions (for example leg ulcers, fractures). The people with DAT were recruited mainly through local day care centres with specialised facilities for frail elderly people with mental illnesses particularly dementing diseases. Some people with DAT were recruited through the local hospital where elderly people with a known diagnosis of dementing disease were either attending the day hospital as outpatients for multidisciplinary assessment, or admitted into hospital for a period of respite care. One person with DAT was recruited from a local nursing home.

Permission and Consent

Permission to recruit older people living in the locality for participation in the research was obtained from the Regional Medical Ethics Committee.
Permission to recruit and test elderly clients at each day centre was obtained through the manager responsible for the centre.

Control subjects were approached about the possibility of participating in the research and the procedure was explained to them, after which they were requested to indicate their consent to participate in writing on the consent form devised for the research.

Potential candidates for the DAT group were selected following consultation with the professional staff involved in their care, regarding each individual's suitability and ability to co-operate with the research procedure.
Individuals who were in the earlier stages of DAT and therefore presented with a relatively mild cognitive impairment were informed about the research procedure and, if they were agreeable to participate, were requested to indicate their own consent in writing on the consent form.
For people with DAT in the relatively more advanced stages of cognitive decline, their main carer (for example spouse, son, daughter, companion) was also approached whenever possible. This was done in order to ensure that the carers were informed about, and consenting to, their elderly relative with dementia participating in the research procedure.

It was also explained to the people with DAT and their carers that, as indicated on the consent form, the research procedure incorporated a longitudinal component and therefore participants would be approached to repeat the procedure after an interval which would most likely be of between six to nine months.

Age Bands of the Control Subjects

In order to observe any effects of increasing chronological age upon the performance of normal elderly people, the Control subjects were selected to represent three age bands, each band representing a span of nine years.

The number of Control subjects within each age band was as follows:

- 65 - 74 years: (n = 9) Male = 4 Female = 5
- 75 - 84 years: (n = 7) Male = 4 Female = 3
- 85+ years: (n = 5) Male = 0 Female = 5

The number of people with DAT within each of the same age bands was as follows:

- 65 - 74 years: (n = 3) Male = 1 Female = 2
- 75 - 84 years: (n = 9) Male = 2 Female = 7
- 85 + years: (n = 3) Male = 1 Female = 2

Details of the age and sex of the Control and DAT group research participants are displayed in Table 20.

TABLE 20
Age and Sex of the Research Participants

Subject Group	CONTROL	DAT
NUMBER	21	15
SEX		
Male	8	3
Female	13	12
AGE		
Range	65 - 87 years	68 - 88 years
Mean	**76.67**	**78.40**
Stdev	7.73	6.31

As evident from Table 20, both the Control and DAT group populations comprised more female than male participants.

The mean age of the DAT participants was noted to be slightly higher than that of the Control subjects.

Numbers of Research Participants

The original research design had proposed to recruit up to 20 Control subjects within each age band (total of N = 60) and up to 30 people for the DAT group (N = 30). However, it was not possible to recruit the numbers anticipated for either group. This was due to two major factors. Firstly, time constraints which arose in connection with the administration of the full research protocol, particularly with respect to the people with DAT, restricted the total number of individuals who could be tested. Furthermore, a number of individuals who had been considered as potential research participants were subsequently not included due to one or more of the following exclusion circumstances:

- The individual declined when invited to participate in the research
- The individual changed their mind about participating after testing had been initiated, therefore the procedure was abandoned
- The individual was taken ill before testing was commenced or completed
- The individual was found to present a greater level of cognitive loss than anticipated when originally considered as a research participant
- The individual was found to experience poor vision causing interference in the ability to see the test materials accurately
- The individual was found to experience a level of hearing loss great enough to interfere with perception of the spoken instructions and test cues
- The individual moved away from the local area and into residential care some distance away before testing could be completed, for example at retest.

The final numbers of participants in each group at initial entry to the research therefore comprised:

21 Control subjects	Male = 8	Female = 13
15 people with DAT	Male = 3	Female = 12

<u>Educational and Occupational Characteristics of the Research Participants</u>

The participants selected to form the Control and DAT groups were closely matched with respect to the demographic variable of number of years at school. It was also endeavoured to select Control and DAT individuals who were matched with respect to their former main occupation.

- <u>Educational Characteristics</u>

The mean age at leaving school for the Control subjects was 14.25 years (Range = 12 - 18 years).

The mean age at leaving school for the people with DAT was 15.27 years (Range = 13 - 21 years).

The mean number of years of education was therefore slightly higher for the people with DAT.

This data for the Control and DAT groups is displayed in Table 21.

TABLE 21
Mean Age at Leaving School for the Control and DAT Groups

	CONTROL	DAT
Range	12 - 18 years	13 - 21 years
Mean	**14.25 years**	**15.27 years**
Stdev.	1.21	2.60

A more detailed breakdown of educational history for individual Control and DAT research participants is displayed in Table 22 and Table 23.

TABLE 22
Frequency Data for Age at Leaving School
Control Subjects

left school at 12 years	n = 1
left school at approximately 13 years	n = 1 (precise data not available)
left school at 14 years	**n = 15**
left school at 16 years	n = 2
left school at 18 years	n = 1
data not available	n = 1

TABLE 23
Frequency Data for Age at Leaving School
DAT Participants

left school at 13 years :	n = 1
left school at 14 years :	**n = 10**
left school at 16 years :	n = 1
left school at 18 years :	n = 1
completed higher education (21 years) :	n = 2

The data confirms that the majority of individuals in both the Control and DAT groups were aged 14 years at the time of leaving school.

- Occupational Characteristics

A summary of the main types of occupation represented within the Control and DAT groups and their frequency of occurrence are displayed in Table 24.

In Table 25 and Table 26, the demographic data with respect to age, sex, age at leaving school and main occupation is displayed for each individual in the Control and DAT groups.

TABLE 24
Summary Data for Occupations Represented in Each Group

	CONTROL GROUP	DAT GROUP
Manual / Building / Factory Work	2	4
Shop Work	2	2
Homemaking	1	1
Nursery Nurse / Home Caring	1	1
Food Inspection / Food Preparation	0	2
Clerical / Secretarial / Post Office / Printing	9	2
Civil Service / Accountancy / Education	3	0
Engineering / Surveying	1	1
Writing / Broadcasting / Photographic Work	1	2
Data Not Available	1	0

TABLE 25

Individual Participant Demographic Data at Entry to the Research : CONTROL GROUP

PARTICIPANT	SEX	AGE	APPROXIMATE AGE LEAVING SCHOOL	OCCUPATION
C1	M	65	14	Factory Worker
C2	F	66	14	Homemaker
C3	F	68	18	Office Worker
C4	M	69	14	Postal Worker
C5	F	69	14	Secretary
C6	M	70	14	Shop Worker
C7	F	70	12	Nursery Nurse
C8	M	72	14	Surveyor
C9	F	73	14	Clerical Worker
C10	M	75	14	Photographic Work
C11	M	75	14	Ticket Supervisor
C12	M	76	DATA NOT AVAILABLE	DATA NOT AVAILABLE
C13	F	80	14	Clerical Worker
C14	M	82	13	Factory Worker
C15	F	84	14	Clerical Worker
C16	F	84	14	Education Officer
C17	F	86	16	Clerical Worker
C18	F	86	14	Accountant
C19	F	86	16	Civil Servant
C20	F	87	14	Shop Worker
C21	F	87	14	Telephonist

TABLE 26
Individual Participant Demographic Data at Entry to the Research : DAT GROUP
In Order of Increasing GDS Rating

PARTICIPANT	SEX	AGE	GDS RATING	APPROXIMATE AGE ON LEAVING SCHOOL	OCCUPATION
D13	M	73	2	14	Engineer
D5	F	76	2	14	Factory Worker
D6	F	77	2	14	Factory Worker
D8	F	81	2	14	Food Inspector
D1	F	68	3	21	Broadcaster
D7	F	69	3	21	Writer
D11	F	77	3	14	Shop Worker
D4	F	78	3	18	Home Carer
D2	F	77	4	14	Homemaker
D3	F	83	4	13	Food Preparation
D12	F	88	4	14	Shorthand Typist
D14	M	86	4	14	Builder
D10	F	76	5	14	Factory Packer
D15	M	77	5	16	Printer
D9	F	90	5	14	Shop Worker

The Severity of Cognitive Decline in Individuals with DAT

Each individual with dementia was evaluated for severity of cognitive decline with reference to the Global Deterioration Scale for Assessment of Primary Degenerative Dementia (GDS) (Reisberg, Ferris, De Leon and Crook,1982), a clinical rating scale specifically devised for the assessment of Alzheimer's Disease and description of the stages which characterise its progression. Reisberg et al. 1982) state that the following three major clinical phases can be identified in charting the progression of DAT:

- an early *forgetfulness* phase in which the deficit is primarily subjective but verifiable with objective cognitive testing

- an intermediate *confusional* phase in which the deficit is apparent to an objective observer

- a late *dementia* phase which begins when the patient can no longer survive without assistance

These three phases of Alzheimer's Disease are further refined into seven clinically rateable stages of cognitive decline from 'No Cognitive Decline' (GDS Stage 1) to 'Very Severe Cognitive Decline' (GDS Stage 7).

Each person with DAT was rated with reference to the GDS both at initial entry to the research project and at follow-up testing eight to nine months later.

In selecting participants for the DAT group, it was the intention of the research author that each participant should present at one of the four initial stages of cognitive decline according to the GDS, from Very Mild (GDS Stage 2) to Moderately Severe (GDS Stage 5) at entry to the research.

These stages and their clinical characteristics, as specified by Reisberg et al., (1982) are described below:

- <u>Very Mild Cognitive Decline (GDS Stage 2)</u>

The phase of forgetfulness. The person complains of memory deficit, most frequently involving forgetting previously well-known names and difficulty in remembering where familiar objects have been placed. There is no objective evidence of memory deficit in either the clinical interview or in social and employment situations.

- <u>Mild Cognitive Decline (GDS Stage 3)</u>

At this stage the earliest clear-cut clinical deficits appear. Concentration deficit may be evident on clinical testing. The person may demonstrate decreased facility in remembering the names of people just met and retaining material read from a book. Difficulties become evident in finding words and names. The person may lose or misplace possessions and become lost when travelling to unfamiliar locations. The clinical symptoms are accompanied by a mild to moderate level of anxiety and also denial of the difficulties. The person is no longer able to negotiate the demands posed by employment and social situations.

- Moderate Cognitive Decline (GDS Stage 4)

This is the late confusional phase, when a clear-cut deficit is apparent in the clinical interview. Affected individuals display decreased knowledge of recent events in their own lives and current events around them, and a deficit in memory for personal history may also be detected. People are no longer able to perform complex tasks accurately and efficiently. The ability to travel alone is curtailed. Difficulties in managing personal finances may be apparent. However, certain abilities remain preserved such that the person remains well orientated to time and person and is able to distinguish familiar people from strangers. At this stage, denial becomes a dominant defence mechanism in response to the evident decline in cognitive capacities, and a flattening of affect and withdrawal from previously challenging situations may be observed.

- Moderately Severe Cognitive Decline (GDS Stage 5)

This is the phase of early dementia, at which affected individuals can no longer survive without some assistance. They may have difficulty recalling a major relevant aspect of their current life, for example their address or telephone number, the school they attended or the names of members of the family. Patients at this stage are frequently disorientated to time or place, although they do retain knowledge of many major facts regarding themselves and others, for example their own name and the names of their spouse and children. There may be some difficulties with certain daily activities such as getting dressed.

Duration of DAT in the Research Participants

The approximate duration of dementia, that is the time since onset of observable disease symptoms, was calculated in months for each person with DAT at entry to the research.

The mean duration of DAT was 22 months (Range 6 - 42 months; Stdev 12.23)

Details of the duration of dementia and GDS rating for each person with DAT at entry to the research are presented in Table 27.

TABLE 27
Duration of Symptoms and GDS Ratings at Entry to the Research
DAT Participants

GDS RATING	Number of People at GDS Stage	Participant	Duration in Months
GDS STAGE 2 (Very Mild Cognitive Decline)	n = 4	D6	8
		D5	12
		D8	24
		D13	34
GDS Stage 3 (Mild Cognitive Decline)	n = 4	D1	12
		D4	12
		D7	12
		D11	12
GDS Stage 4 (Moderate Cognitive Decline)	n = 4	D14	6
		D2	24
		D3	36
		D12	36
GDS Stage 5 (Moderately Severe Cognitive Decline)	n = 3	D15	24
		D9	36
		D10	42

Range of duration = 6 - 42 months

Mean duration = 22 months (Stdev 12.23)

Locations of Testing

Research participants were tested at the following locations:

- in their own home
- at the day centre
- at the local hospital

At both the day centre and hospital locations, participants were tested individually in a quiet private room which was equipped with a dining height table to allow the test materials to be displayed.

Three of the people with DAT were tested in their own homes; in each case there was access to a dining or coffee table for the test procedure. If a DAT participant's spouse or carer wished to be present during the testing, this request was provided for, and the person was requested not to provide clues during the testing.

Duration of Testing

The time taken to complete the full test procedure varied between the research groups. The majority of the Control subjects required only one test session to complete the full research procedure. The maximum number of sessions required by any Control subject was two.

Each of the people with DAT required more than one session to complete the full research procedure; the number of test sessions required by the people with DAT ranged from two to six.

The minimum time taken to complete the research protocol was approximately 60 minutes (Range 60 - 120 minutes) for the Control subjects and approximately 80 minutes (Range 80 - 200 minutes) for the people with DAT.

The testing was timed to take into account the concentration span and fatigueability of research participants, and care was taken not to disrupt daily or established routines. Thus at the day centre, testing was carried out at times which took into account meal breaks and the arrival of transport to go home. Likewise, for research participants tested at home, the test session was stopped to allow for events such as the arrival of the meals-on-wheels luncheon service.

The Longitudinal Component of the Research Procedure

In order to evaluate the effects of disease progression upon the cognitive performance of the people with DAT, the research procedure incorporated a longitudinal component whereby participants were re-tested after an interval of eight to nine months.

The retest procedure was delayed beyond this time frame for some of the DAT participants due to unforeseen circumstances such as a period of illness or a temporary move into respite care.

The number of DAT participants able to participate at retest was reduced by the occurrence of one or more exclusion circumstances. Thus, four individuals with dementia were unable to participate in the retest procedure due to reasons of a prolonged period of illness causing an overall decline in health and cognitive status, a sudden and rapid deterioration necessitating admission into hospital, or a move away from the area into an alternative residential setting.

For other DAT participants, it was not possible to complete the full procedure at retest. In most cases this was due to the individual deteriorating in health subsequent to testing having commenced.

The researcher abandoned testing if the person with dementia was observed to be experiencing a level of difficulty which could cause distress, or if the person indicated that they did not wish to, or felt unable to proceed further with testing.

The Design of the Research Protocol

The research procedure comprised two test batteries:

- an initial Standard Measures Battery for Cognitive and Language Processing
- an Experimental Battery for Semantic Processing

The final version of each test battery was developed as a result of modifications carried out following the administration of the Pilot Study test protocol.

The rationale underlying the design and administration of the research test batteries will be described in the following sections.

- The Standard Measures Battery for Cognitive and Language Function

The six standard measures were_administered to every research participant as a preliminary testing procedure, after the participants or their carers had given written consent to participate in the research, and following the completion of the Health Screening Questionnaire.

The reasons for administering the Standard Measures Battery for Cognitive and Language Function were twofold:

- to establish a baseline or norm of cognitive and linguistic functioning for normal elderly subjects within the chosen age bands
- to use these baselines to isolate the decrements in performance which could be attributed to the effects of Alzheimer-type dementia in the DAT group

In order to ensure maximum visual clarity of the test stimuli for the research participants, enlarged presentations of the picture and written word stimuli from some tests in the battery were prepared for use in the research procedure.

The tests comprising the Standard Measures Battery for Cognitive and Language Function were administered to each participant in the fixed order of presentation which appears in the following section.

• CLIFTON ASSESSMENT PROCEDURES FOR THE ELDERLY (CAPE)

(Survey Version : Pattie, 1981)

Two sub-scales form the shortened version of this assessment were administered to gain an indication of:

- general orientation level (the 12-item Information and_Orientation Test)
- level of dependency in functional tasks (the Physical Disability Scale)

• THE VISUAL OBJECT AND SPACE PERCEPTION BATTERY (VOSP)

(Warrington & James, 1991)

Two sub-tests from the VOSP were selected to ensure that research participants had adequate visual perceptual skills to discriminate the picture and word stimuli used in the research procedure:

- the 20-item Shape Detection Test to assess discrimination of shapes
- the 10-item Dot Counting Test to assess the ability to localise single points

• THE NATIONAL ADULT READING TEST

(Shortened NART - Beardsall & Brayne, 1990)

The shortened 25-item version of the NART was included to obtain an estimate of pre-morbid IQ levels for the research participants.

• THE SET TEST

(Isaacs & Akhtar, 1972)

This generative naming test which utilises the four successively presented semantic categories of *Colours, Animals, Fruits,* and *Towns*, was included to assess the free recall of nouns by participants. A time of one minute was stipulated for each category, for the reasons previously described in the Pilot Study rationale.

• THE BRITISH PICTURE VOCABULARY SCALE (BPVS)

(Dunn, Dunn, Whetton and Pintilie, 1982)

The shortened 32-item version of this pictorially presented vocabulary comprehension test (Short BPVS) was included to gain a measure of the research participants' auditory comprehension of single lexical items.

• PYRAMIDS AND PALM TREES

(Howard & Patterson, 1992)

The initial 30 items from the picture to picture matching version of this word association test were administered to obtain an indication of the participants' abilities to recognise semantic associations between pictorially presented nouns.

Details of the number of items comprising each test in the Standard Measures Battery for Cognitive and Language Function are displayed in Table 28.

TABLE 28
Number of Test Items Comprising Each Standardised Test

TEST	TOTAL ITEMS
CAPE	10
<u>VISUAL SCREENING TESTS</u>	
Shape Detection sub-test	20
Dot Counting sub-test	10
NART	25
SET TEST	4 Categories x 1 minute each
PYRAMIDS & PALM TREES	30
Short BPVS	32

- <u>The Experimental Battery for Semantic Processing</u>

This battery consisted of a series of six tests designed by the research author to evaluate the integrity of the semantic processing mechanisms involved in the recognition and recall of single lexical items, specifically everyday concrete nouns. The test noun stimuli comprised black and white line drawings and printed words. All the noun stimuli were drawn from fifteen of the common semantic categories specified by Battig and Montague (1969) in their study of category norms.

The lexical processing tests called upon the following aspects of semantic knowledge:

- Recognition of nouns by a specific and unique feature attribute

(Picture and Written Recognition by Unique Feature tests)

- Recognition of nouns which share membership of the same semantic category

  (Picture and Written Recognition by Category tests)

- Confrontation naming of pictured nouns

(Picture Naming Test)

- Generating nouns members of a semantic category

  (Generative Naming Test)

A picture and a written version was devised for each of the Recognition by Unique Feature and Recognition by Category tests.

Semantic Processing Test Design and Materials

The picture stimuli utilised in the semantic tests were derived predominantly from the standardised line drawings of Snodgrass and Vanderwort (1980). A small number of hand drawn object pictures were also utilised, mainly to depict visual distractor stimuli in the Recognition by Unique Feature Test.

The line drawings were presented in black ink on a plain white background. All drawings were enlarged to be of a minimum height of 4 centimetres to ensure maximum enhancement of features and ease of visual clarity for the participants.

The written word stimuli were printed in bold black ink on a white background, in block capital letters of height 1centimetres.

The Experimental Battery for Semantic Processing comprised a total of 285 picture presentations of 170 individual nouns, and 225 written word presentations of 171 individual nouns. These figures reflect the fact that a number of picture and written noun stimuli were utilised on more than one occasion in the semantic tests.

The individual target noun stimuli comprising each test was as follows:

Each version of the Recognition by Unique Feature Test (picture and written versions) contained 30 target stimuli. Each of these 60 target nouns was presented in a display with distractor nouns.

The 60 target nouns comprising the picture and written versions of the Recognition by Unique Feature Test consisted of four members drawn from each of the fifteen semantic categories represented throughout the Experimental Battery for Semantic Processing.

Each version of the Recognition by Category Test (picture and written versions) contained a total of 45 target stimuli, presented on 15 display sheets of three target category members each.

The Picture Naming Test consisted of 60 picture stimuli, comprising the full set of target nouns from each of the picture and written versions of the Recognition by Unique Feature Test. The 60 picture stimuli were presented individually on plain white cards of dimensions 15 x 10 centimetres.

For both the Picture Recognition by Category (total test items = 15) and Picture Recognition by Unique Feature (total test items = 30) tests, the five picture stimuli comprising each test display were arranged in horizontal arrays of three parallel rows, on a plain white paper background of dimensions 30 x 41 centimetres (standard A3 size).

For both the Written Recognition by Category (total displays = 15) and Written Recognition by Unique Feature (total displays = 30) tests, the five written word stimuli comprising each test display were presented as horizontal arrays in three parallel rows on a plain white paper background of dimension 20.5 x 29 centimetres (standard A4 size).

The relative positioning of the target and distractor stimuli within each rectangular display was varied between successive test items. This ensured that the target and distractor stimuli were presented in each of the five possible positions in the display, as labelled in the diagram overleaf.

upper left corner		upper right corner
	centre	
lower right corner		lower left corner

The method of presentation of stimuli is illustrated in the following example drawn from the written version of the Recognition by Category Test:

CABBAGE (target)		POTATO (target)
	SOIL (related distractor)	
CARROT (target)		SCARF (unrelated distractor)

In the Recognition by Unique Feature Test, each test display of five stimuli in both the picture and written modalities consisted of a choice of nouns drawn from three different semantic categories. Each set of five stimuli included one target noun and four distractors, which varied in relatedness to the target as described below:

- *Visual distractor*: either an object sharing visual features with the target (picture version) or a word sharing phonetic features with the target (written version).

Example:	target = thimble	distractor = thistle	(written)
	target = mouth	distractor = fish	(picture)

- *Close semantic distractor*: a noun drawn from the same semantic category as the target which was also closely associated with the target.

Example:	target = dog	distractor = cat	(written)
	target = boot	distractor = shoe	(picture)

- *Distant semantic distractor*: a noun drawn from the same semantic category as the target but not closely or typically associated with the target.

Example:	target = crown	distractor = bracelet	(written)
	target = bed	distractor = bookcase	(picture)

- *Unrelated distractor*: a noun bearing neither visual nor semantic relationship to the target.

Example:	target = watch	distractor = table	(written)
	target = saw	distractor = bag	(picture)

In both picture and written versions of the Recognition by Category Test, each display of five stimuli consisted of the following:

- Three *target nouns* representing a single semantic category
- A *semantic distractor* noun associated with the three target category members
- An *unrelated distractor* noun bearing no relation to the three category members

Example: three category targets = eye, ear, nose (parts of the body)

semantic distractor = eyeglasses

unrelated distractor = feather

Rationale Underlying the Selection of Stimuli for the Semantic Processsing Tests

The nouns chosen as target and distractor stimuli were evaluated for their relative frequency of occurrence within their semantic categories by referring to the following two relevant pieces of research:

- the normative data of Battig & Montague (1969), in which noun exemplars generated for each of fifty-six categories were tabulated for frequency of occurrence and within-category rankings.

- the picture stimuli of Snodgrass and Vanderwort (1980), in which the investigators produced line drawings standardized against the variables of familiarity, imageability, and name agreement.

The 60 noun targets for the Picture Naming and Recognition by Unique Feature tests were selected with reference to the forty highest-ranking responses, that is those occurring with a frequency of ten or more times for each semantic category, as cited by Battig and Montague (1969).

Most of the noun targets, however, were placed within the twenty highest-ranking responses for that semantic category.

- Selection of Distractor Stimuli

The visual distractors were largely hand-drawn in order to ensure that they shared a minimum set of basic perceptual features with the target nouns which they were acting as distractor to.

The nouns chosen to be *close semantic distractors* in the Recognition by Unique Feature tests (picture and written versions) were selected not only to be strongly semantically associated with their targets, but also wherever possible to be the paired associate naturally elicited from native English speakers in response to the target noun, as in the following examples:

Test	Noun Target	Close Semantic Distractor
picture	cat	dog
picture	foot	hand
written	knife	fork
written	lion	tiger

The stimuli selected to be *distant semantic distractors* were chosen from amongst the least frequently generated category exemplars cited in the Battig and Montague (1969) norms. The distant semantic distractors were also nouns which would not normally be closely semantically associated with the targets by native English speakers, as in the following examples:

Test	Noun Target	Distant Semantic Distractor
picture	sheep	lion
picture	mouth	ankle
written	turkey	ostrich
written	knee	tongue

The *unrelated distractors* comprised a set of nouns bearing no relationship to the target nouns, and selected at random from within the fifteen semantic categories represented in the research procedure, as in the following examples:

Test	Noun Target	Unrelated Distractor
picture	lemon	spanner
picture	key	mouth
written	hand	duck
written	apple	chair

The Unique Feature Attribute Cues

The 'unique feature attribute cues presented to elicit each target in the picture and written versions of the Recognition by Unique Feature tests were constructed by describing a unique quality of the target noun. The cues were designed to capture very specific information about their noun targets, thus ensuring that they would be easily recognised by cognitively intact native speakers of the English language as being uniquely associated with their target nouns with reference to previously acquired semantic knowledge of the noun concepts.

In most instances the unique feature attribute consisted of a distinguishing function or activity associated with the target noun. In some instances, a descriptive label of the target noun was chosen, for example for the target *dog*: 'man's best friend'.

The unique feature attribute cues did not involve a comparison of the target noun in relation to other same-category nouns, for example 'it's bigger than...' or 'it's used in the same way as...'.

With one exception, the cues were not based on descriptions of the physical features of the target noun, which could be immediately evident in the picture stimuli, for example size or shape. The exception was the feature cue for the target *ladybird*: 'it has a spotted back'.

However, this cue was presented in the written version of the Recognition by Unique Feature Test with accompanying written noun stimuli and not picture stimuli.

A selection of the unique feature attribute cues is displayed overleaf.

Test	Noun Target	Unique Feature Attribute Cue
picture	spider	for spinning webs
picture	onion	makes your eyes water
picture	peacock	proud of its plumage
picture	lemon	for squeezing over pancakes
written	dog	man's best friend
written	lion	king of the jungle
written	ladybird	has a spotted back*
written	turkey	traditionally eaten at Christmas

* this cue, the only one to utilise a physical description, was used in the written test

Validation of the Unique Feature Attribute Cues

The sixty unique feature cues were validated in a small probe survey involving thirteen Speech and Language Therapy students. In this survey, each of the sixty descriptive cues was read aloud to individual subjects, with instructions to write down the first noun which came to mind upon hearing the description.

The findings of the probe survey were as follows :

- For **37** of the 60 cues, there was 100% agreement between the subjects, that is they responded to the cue with the same noun

- One of the 13 subjects produced a different noun from the remainder of the group in response to **12** of the 60 cues

- An alternative noun was offered in response to the remaining **11** cues by between two to four subjects

- For **1** cue (guitar), the cue elicited equal numbers of the both the target noun and one other alternative (harp)

From the results of this survey, it was concluded that the distinctive feature cues had been validated with sufficient strength to be accepted as reliable in eliciting the target nouns, given that in the research tests the spoken feature cues would be additionally accompanied by a picture or written depiction of the target when presented to research participants.

Randomised Order of Presentation of the Semantic Processing Tests

Two orders of test presentation were used for the Experimental Battery for Semantic Processing. These were designated as Order A and Order B. This measure was introduced as a methodological control to counteract possible interactions attributable to order of test presentation.

Under each presentation condition, the sequence was ordered such that the Recognition by Unique Feature and Recognition by Category tests varied in their position (either preceding or following) with respect to the Picture Naming and Generative Naming tests.

The fifteen semantic categories comprising the Generative Naming Test were grouped into three clusters of five categories each. These category clusters were then assigned presentation positions within each of Order A and Order B.

The categories comprising each cluster were as follows:

CLUSTER 1	CLUSTER 2	CLUSTER 3
animals	birds	body parts
clothing	fruit	furniture
kitchen tools	jewellery	insects
transport	footwear	tools
musical instruments	household objects	vegetables

Details of each order of test presentation may be found in Appendix 8.

Instructions and Method of Presentation for Individual Tests

The tests comprising the Standard Measures Battery for Cognitive and Language Function were administered to research participants in accordance with the instructions specified for each test. A set of instructions was devised for each test comprising the Experimental Battery for Semantic Processing. The instructions specific to each semantic test are described below; the verbatim instructions given may be found in the Appendix 9.

- Recognition of Nouns by Unique Feature (Picture and Written versions)

Participants were instructed to listen to the spoken cue presented by the researcher, and to choose from the display of five stimuli the appropriate picture or word to match each cue.

- Recognition of Nouns by Category (Picture and Written versions)

Participants were instructed to scan each display of five pictures or words and select the three which belonged together by virtue of being members of the same category.

- Confrontation Picture Naming Test

Participants were instructed to name aloud each of sixty individually presented line drawings of objects.

- Generative Naming Test

Each of the three category clusters was presented separately, and participants were instructed to name as many items as possible for each category in response to the spoken category name, within a time limit of one minute for each category.

Test Scoring Criteria

Prior to commencing each semantic test, the test instructions were presented to research participants and repeated if necessary to ensure that they had been understood.

One repetition of each attribute cue was given during the Recognition by Unique Feature test, and one repetition of the semantic category cue was given in the Recognition by Category and Generative Naming tests, if requested by the participant.

Two practice items were included at the beginning of each semantic processing test in order to familiarise participants with the task requirements.

In the Picture Naming Test, participants were allowed up to 15 seconds to attempt to name each picture. If they produced an incorrect name or indicated that they were unable to recall the name within this time limit, they were advised that they would be given a cue and the researcher then presented a *semantic cue* aloud, which consisted of the unique feature attribute utilised in the Recognition by Unique Feature Test.

In the event of the participant being unable to name the picture after presentation of the semantic cue, a further *phonemic cue* consisting of the initial syllable of the target noun was presented aloud to the participant.

The semantic and phonemic cues were therefore presented in the same manner as that used in the Boston Naming Test (Kaplan, Goodglass and Weintraub, 1983).

In the event of research participants being unsuccessful in naming the target picture subsequent to presentation of both cues, the picture was given an 'Unable to Name' score and the next picture stimulus in the sequence was presented.

All naming responses were recorded for further qualitative analysis.

Acceptance Criteria for Responses to the Picture Naming Test

In scoring the initial picture naming responses produced by participants, certain nouns were accepted and therefore scored as 'spontaneous correct'. The accepted noun responses included nouns which were either synonyms for the target nouns or the names of objects very similar in features to the target nouns, for example "lips" for *mouth*, "liner" for *ship*.

The acceptance criteria utilised in scoring the Picture Naming Test, and those responses which were not accepted, are presented in Table 29.

TABLE 29
Noun Responses Accepted for the Picture Naming Test

Target	Accepted Synonym or Noun	Nouns Not Accepted
mouth	lips	
rolling pin	roller	
suitcase	carrying case	briefcase, attache case
ship	liner	boat, sailboat, yacht
wardrobe		cupboard
bee		wasp
axe		chopper
corn		wheat, barley, cornflake
spade		shovel
shawl		wrap, scarf
chicken	hen	cockerel, rooster, cockadoodledoo

Acceptance Criteria for Responses to the Generative Naming Test

A further set of acceptance criteria was developed on the basis of the noun responses generated for each of the semantic categories in the Generative Naming Test. These acceptance criteria are presented in Table 30.

TABLE 30
Noun Responses Accepted for the Generative Naming Test

Category	Accepted Nouns	Nouns Not Accepted
Animals	all four-footed animals dolphin, whale, fish reptiles (lizard, crocodile) frog bird	insects
Clothes	accessories (gloves, socks, tie, scarf) footwear (shoes, boots)	
Footwear	socks other hosiery (tights, stockings) sports footwear (trainers, skates, football boots)	
Fruits & Vegetables	tomato avocado (accepted for either)	nuts (acorn, peanut)
Furniture	all household furniture television & video curtains, pictures carpets bathroom furniture	windows, doors kitchen machines radio bedlinen
Household Objects	objects used in the house or carried in a handbag furniture (chair, table, bed) windows & doors	animals transport food house

TABLE 30 (continued)
Noun Responses Accepted for the Generative Naming Test

Category	Accepted Nouns	Nouns Not Accepted
Insects	earthworm	reptiles mouse
Jewellery	crown tiara pearls	gemstones named alone (e.g., diamond, emerald)
Kitchen Tools	oven fridge kettle microwave	soap powder washing-up liquid bleach
Musical Instruments	bell whistle	gramophone
Tools	knife ladder scissors ruler garden tools	other kitchen utensils kitchen machines (blender, grater)
Transport	animal modes of transport (horse & cart, donkey, camel) sleigh balloon skates, skateboard, surfboard	

RESULTS

All the statistical analyses for this research were carried out applying the *SPSS For Windows* (Kinnear and Gray, 1994) statistical software package which is designed specifically for the analysis of data in the social and biological sciences.
A significance level of $p < 0.05$ (two-tailed test) was applied to all analyses in rejecting the null hypothesis.
The following comparisons formed the basis for the statistical analyses carried out on the data to test the experimental hypotheses :

- between the performance of the Control and DAT groups on every test
- between the performance of the Control subjects within each of the three age bands
- between the performance of the people with DAT at each of the four severity levels
- between the performance of the people with DAT at initial test and retest

Analysis of Group Performance on the Standard Measures Battery

In order to determine significant differences in performance between the research groups on the Standard Measures Battery for Cognitive and Language Function, comparisons of group means on each test were carried out applying the *t- test* for independent samples. The results of these analyses for the Visual Screening tests, the NART, the Pyramids and Palm Trees test, Short BPVS and Set Test are displayed in Table 31. The analyses for the CAPE sub-tests are reported separately elsewhere.

TABLE 31
The Standard Measures Battery for Cognitive and Language Function
The *Independent t-test* : Comparisons between Control and DAT Group Means

TEST		CONTROL	DAT	t-value	DF	Probability
Visual Screen 1	Mean	9.95	9.07	1.99	14.33	0.065*
Dot Counting	Stdev.	0.22	1.71			
Visual Screen 2	Mean	20.00	18.53	1.76	14.00	0.100*
Shape Detection	Stdev	0.00	3.23			
Short NART	Mean	22.90	16.73	4.13	19.83	**0.001***
	Stdev.	2.84	5.27			
Short BPVS**	Mean	29.67	24.09	2.52	11.04	**0.028***
	Stdev	2.24	7.16			
Pyramids &	Mean	28.86	23.27	3.34	14.08	**0.005***
Palm Trees	Stdev.	0.48	7.62			
Set Test						
Colours	Mean	12.43	9.13	3.60	34	**0.001**
	Stdev.	2.56	2.90			
Animals	Mean	13.62	8.20	4.39	34	**<0.001**
	Stdev.	3.02	4.39			
Fruit	Mean	12.95	6.53	6.38	34	**<0.001**
	Stdev.	2.71	3.31			
Towns	Mean	13.62	5.53	5.54	34	**<0.001**
	Stdev.	3.93	4.82			
Overall Mean		**13.12**	**7.32**			

significance level = $p < 0.05$ (2 - tail Sig.)

* t-value based on Unequal Variances

** only 11 DAT participants completed the Short BPVS test

Significant differences were established at a probability level of $p < 0.01$ between the performance of the Control and DAT groups on three of the cognitive measures: the Short NART, the Pyramids and Palm Trees Test, and all four categories of the Set Test. Significance was established at a significance level of $p < 0.05$ for the Short BPVS, indicating a greater likelihood that the outcome may have arisen due to chance variations in the data.

Examination of the range of scores achieved by individual Control subjects confirmed that, as predicted, the subjects scored at ceiling or near-ceiling on every cognitive test. This data is summarised in Table 32.

Examination of the performance of the Control subjects on the Set Test also showed that the Control subjects generated a significantly greater number of items for every category in the Set Test, producing an overall mean of 13 members per category as compared with an overall mean of 7 items generated by the people with DAT.

TABLE 32
The Standard Measures Battery for Cognitive and Language Function
Summary Performance Data for the Control Group*

	Ceiling Score	Subjects Achieving Ceiling Score	Minimum Score Achieved Within the Group	Most Frequent Score(s)
CAPE Orientation Test	12	13 / 21	10	Ceiling
Visual Screen 1 Dot Counting	10	20 / 21	9	Ceiling
Visual Screen 2 Shape Detection	20	All	N/A	Ceiling
Short NART	25	8 / 21	15	23,24,25
Pyramids & Palm Trees	30	19 / 21	28	Ceiling
Short BPVS	32	1/ 21	24	30, 31

* N = 21 Control subjects completed each test

Comparison Between the Control and DAT Group Predicted IQ Scores

The 25-item Short NART was administrated to gain an indication of pre-morbid IQ for the people with DAT. A predicted IQ score was obtained from converting the raw scores on the Short NART to Full NART predicted error scores according to test guidelines.

The mean IQ scores obtained for the Control and DAT groups are presented in Table 33.

TABLE 33
Mean Full Scale IQ Conversions from Predicted Full NART Error Scores

Group	Mean IQ	Range
CONTROL	102.5	90 - 101
DAT	89.2	75 - 101

It is evident from the results in Table 33 that the Control subjects achieved a higher mean IQ score despite methodological constraints applied to ensure that the Control and DAT groups were closely matched on the relevant demographic variables of years of education and occupational history.

Details of the predicted NART error scores and their conversion to Full Scale IQs for individual Control and DAT research participants may be found in Appendix 3,4, and 5.

Individual Variations in Performance on the Visual Screening Tests

Analysis of the Control group scores confirmed that, with the exception of one Control subject who made one error on the Dot Counting test, all the subjects scored at ceiling on both visual screening tests.

Examination of individual scores within the DAT group showed that nine of the fifteen patients (60 %) also achieved ceiling scores on both tests.

Of the six remaining patients, four scored highly on both tests, that is they made two or fewer errors (range of errors = 0 - 2) on either test.

Therefore, the overall DAT group score was lowered by the performance of two participants (Participant D7 and Participant D9) who achieved the following scores:

Participant D7:	4 / 10 (Dot Counting)	8 / 20 (Shape Detection)
Participant D9:	7 / 10 (Dot Counting)	16 / 20 (Shape Detection)

The scores of Participant D7 were strikingly low compared not only with the rest of the DAT participants but also with those of Participant D9.

The performance of Participant D7, and to a lesser extent that of Participant D9, indicated the existence of specific visual perceptual difficulties which did not characterise the performance of the DAT group as a whole.

However, these individual variations in visual perceptual performance did not produce statistically significant differences between the Control and DAT group means.

Performance of the Control and DAT Groups on the CAPE Sub-tests

All research participants were evaluated on the 12-Item CAPE Orientation Test as part of the Standard Measures Battery for Cognitive and Language Function.

The performance of the Control subjects confirmed the prediction that normal elderly subjects with no evident or suspected cognitive decrement would achieve ceiling or near-ceiling scores on such a test.

An *Independent t-test* comparing group means on the orientation test showed that the DAT participants achieved significantly lower scores at a significance level of $p < 0.001$.

The results of this analysis are presented in Table 34.

TABLE 34
The *Independent t-test* : The CAPE Orientation Test

	Mean	Stdev.	t-value	DF	Probability
CONTROL	11.57	0.59	6.42	14.80	**<0.001***
DAT	6.53	2.99			

significance level = $p < 0.05$ (2- tail Sig.)

* t-value based on Unequal Variances

The maximum score attainable on the CAPE Orientation Test is twelve. As previously shown in Table 32, thirteen Control subjects (62%) achieved the maximum score. Seven of the remaining eight Control subjects made only one error each, and one subject made two errors, which represented the highest error score within the group.

This contrasted greatly with the performance of the people with DAT. A total of 46% of the responses from the DAT group to this test were incorrect. Individual scores within the group were widely distributed and ranged from a perfect score of 12 to the lowest score of one item correct, with most scores falling between these extremes.

- Analysis of Error Frequency on the CAPE Orientation Test

The frequency of occurrence of errors made by individual Control and DAT participants on the CAPE Orientation Test was analysed in order to detect any pattern or consistency in the errors.

The analysis confirmed that the only test items to which Control subjects responded incorrectly were the final two questions:

Item 11: "Who is the Prime Minister?"

Item 12: "Who is the President of the United States of America?"

In contrast, errors within the DAT group occurred on every test item except the initial question:

Item 1: "What is your name?"

to which every participant responded correctly.

The next test item on which the people with DAT made the least number of errors was:

Item 2: "What are the colours of the British flag?"

The item to which the majority of the DAT group (13 / 15 subjects) were unable to respond correctly was the final question:

Item 12: "Who is the President of the United States of America?"

Ten or more of the people with DAT also responded incorrectly to each of the four questions preceding Item 12, which tested research participants' knowledge of the current month and year, their age, and the name of the Prime Minister.

These findings for the Control and DAT research participants are presented in Table 35 and Table 36.

TABLE 35
Frequency of Errors on the CAPE Orientation Test : Control Subjects

Score		Number of Subjects Achieving that Score	Items in Error
12	(No Errors)	13	N/A
11	(One Error)	7	The American President
10	(Two Errors)	1	The American President The Prime Minister

Number of Control subjects = 21

TABLE 36
Frequency of Errors on the CAPE Orientation Test : DAT Participants

Test Item	Number of Participants Making an Error
Your Name	0
Colours of the British Flag	2
Your Date of Birth	4
City we Are Living In	4
Address of this Place	4
Where are we Now	6
The Day Today	8
The Month	10
Your Age	10
The Year	11
The Prime Minister	11
The American President	13

Number of DAT participants = 15

- The CAPE Test : Functional Dependency Ratings

The Physical Disability Rating Scale of the CAPE yielded a measure of the level of functional dependency in everyday activities for each DAT participant at their initial entry to the research.

These functional dependency ratings are displayed in Table 37, together with the duration of dementia symptoms (expressed in months), ratings of the severity of cognitive decline according to the Global Deterioration Scale, and score achieved on the CAPE Orientation Test.

The results are presented in order of increasing duration of DAT.

TABLE 37
Measures of Dependency, Duration of DAT, GDS Rating and Orientation
DAT Participants

Participant	Duration of DAT (Months)	GDS Rating	CAPE Physical Disability Rating Scale	CAPE Orientation Score
GDS 2				
D6	8	2	B	8
D5	12	2	B	9
D8	24	2	B	11
D13	34	2	B	12
Mean	**19.5**			**10.0**
GDS 3				
D7	12	3	B	4
D1	12	3	B	4
D11	12	3	C	6
D4	12	3	B	8
Mean	**12.0**			**5.5**
GDS 4				
D14	6	4	C	8
D2	24	4	C	8
D3	36	4	C	5
D12	36	4	C	5
Mean	**25.5**			**6.5**
GDS 5				
D15	24	5	C	1
D9	36	5	D	3
D10	42	5	C	6
Mean	**34.0**			**3.3**

Definitions of CAPE Dependency Grades:
Grade A = No Impairment (independent elderly)
Grade B = Mild Impairment (low dependency)
Grade C = Moderate Impairment (medium dependency)
Grade D = Marked Impairment (high dependency)
Grade E = Severe Impairment (maximum dependency)

GDS Ratings
Stage 2 = Very Mild
Stage 3 = Mild
Stage 4 = Moderate
Stage5 = Moderately Severe

Duration of DAT in the Research Participants

The mean duration of disease for the DAT group was 22 months (Stdev. = 12.23). The overall trend was towards an increase in the mean duration of dementia (in months) concomitant with advancing severity of cognitive decline (GDS rating). However, this trend was not uniform as the mean duration of disease was noted to be higher for the four participants at GDS Stage 2 (Very Mild cognitive decline) than for those at GDS Stage 3 (Mild cognitive decline).

The lowest mean duration of dementia (12 months) was represented within the GDS Stage 3 subgroup. Furthermore, all four participants in this subgroup presented with the same duration of DAT at entry to the research.

However, a considerable variation in duration of dementia was found to exist within each of the three remaining GDS subgroups:

GDS 2:	Range = 8 months - 34 months	(spread = 26 months)
GDS 4:	Range = 6 months - 36 months	(spread = 30 months)
GDS 5:	Range = 24 months to 42 months	(spread = 18 months)

DAT Severity Ratings (GDS) and CAPE Orientation Test Scores

The mean CAPE Orientation Test scores achieved by the people with DAT at each GDS severity level were subjected to a comparative analysis to test the prediction of a progressive decrease in orientation scores with advancing severity of cognitive decline.

As evident from Table 37, an overall downward progression in CAPE orientation score associated with advancing severity of cognitive decline was confirmed, such that the participants with very mild cognitive decline (GDS Stage 2) achieved the highest mean CAPE orientation score, and the participants most advanced in severity (GDS Stage 5 - moderately severe cognitive decline) achieved the lowest mean score.

However, the DAT participants with a moderate level of cognitive decline (GDS Stage 4) achieved a slightly higher mean CAPE Orientation Test score than those with a mild level of cognitive decline (GDS Stage 3), although from a functional perspective, the higher-scoring GDS 4 participants had all been evaluated as being at a higher level of physical dependency than most participants in the GDS 3 subgroup.

A *Pearson Correlation Coefficient* analysis, carried out to examine for any significance in the relationship between the duration of dementia and scores achieved on the CAPE Orientation Test, yielded a non-significant coefficient of - 0.127 ($p = 0.658$). The same correlational analysis, carried out to examine for any significance between the duration of dementia and GDS rating of level of cognitive decline, yielded a correlation coefficient of 0.499 ($p = 0.058$), establishing a relatively high positive correlation between these two measures.

DAT Group Performance at Retest on the Standard Measures

The DAT participants were approached for retest on the entire research procedure after an interval of mean duration 9.10 months (Range 6 - 16 months) in order to establish a longitudinal analysis of cognitive, language and functional performance. Ten people with DAT from the original group of fifteen were approached for the retest procedure, although not all ten participants were able to proceed with every test in both research batteries. Therefore statistical evaluation of initial test and retest performance was based on the scores of an identified core group of participants for whom scores were available across tests in both batteries.

- Retest Evaluation of Severity, Orientation Level and Functional Dependency

In order to identify any decrements in cognitive and functional presentation which could be attributed to increasing duration of disease, the retest outcomes for the following three measures were compared with those obtained at initial testing:

- GDS rating of severity of cognitive decline
- CAPE Orientation Test
- CAPE Physical Disability Rating Scale

Retest GDS ratings and CAPE scores were obtained for all ten participants. The data is displayed in Table 38.

The ratings and scores achieved at initial testing are denoted by parentheses.

An asterisk (*) and bold lettering identifies greater severity of cognitive decline, or a decrement in performance, relative to initial testing.

TABLE 38
GDS Ratings, CAPE Scores and Duration of DAT at Retest

PARTICIPANT	GDS SCALE		CAPE ORIENTATION TEST		CAPE PHYSICAL DISABILITY RATINGS		DURATION of DAT IN MONTHS
	INITIAL	RETEST	INITIAL	RETEST	INITIAL	RETEST	RETEST
D13	(2)	2	(12)	**10***	(B)	B	47
D8	(2)	**3***	(11)	**10***	(B)	B	34
D5	(2)	2	(9)	9	(B)	B	23
D6	(2)	2	(8)	8	(B)	B	16
D1	(3)	**4***	(4)	4	(B)	B	28
D7	(3)	**4***	(4)	**3***	(B)	B	21
D11	(3)	3	(6)	**4***	(C)	C	18
D3	(4)	4	(5)	**3***	(C)	C	45
D10	(5)	5	(6)	**4***	(C)	**D***	48
D9	(5)	5	(3)	4	(D)	**E***	45

N = 10 DAT participants were evaluated at retest

* = decrement in performance relative to initial test

Definitions of CAPE Dependency Grades
Grade A = No Impairment (independent elderly)
Grade B = Mild Impairment (low dependency)
Grade C = Moderate Impairment (medium dependency)
Grade D = Marked Impairment (high dependency)
Grade E = Severe Impairment (maximum dependency)

GDS Ratings
Stage 2 = Very Mild
Stage 3 = Mild
Stage 4 = Moderate
Stage 5 = Moderately Severe

From Table 38 it is apparent that not every DAT participant presented at a greater level of either cognitive decline (as measured by GDS rating and orientation score) or functional dependency when evaluated at retest.

The cognitive measure on which a decline in performance was most frequently detected was the CAPE Orientation Test, on which 60% of the group obtained a lower score. 30% of the group were evaluated as presenting clinical symptoms which indicated progression to a more severe level of cognitive decline on the GDS, but only 20% of the group presented at a greater level of functional dependency according to the CAPE Physical Disability Scale.

- Retest Evaluation of Performance on the Remaining Standard Measures

The mean scores achieved by DAT group participants on the Standard Measures Battery for Cognitive and Language Function at initial test and retest are presented in Table 39. A varying number of participants (Range = 8 - 10) completed each test.

The *Paired samples t-test* was then used to carry out a repeated measures analysis of the core DAT group scores at initial test and retest. The outcomes of the analyses for the core group are presented in Table 40. Some individuals did not yield scores for every test, due to reasons such as fatigue or refusal, and this is reflected in the smaller number of pairs included in some paired analyses.

TABLE 39
The Standard Measures Battery for Cognitive and Language Function
Mean DAT Group Scores at Initial Test and Retest

TEST	VISUAL 1 DOTS	VISUAL 2 SHAPES	SHORT NART	BPVS	PYRAMIDS & PALM TREES
INITIAL TEST	8.67 (2.06)	18.11 (4.01)	16.50 (6.55)	22.62 (7.96)	22.30 (8.96)
RETEST	8.33 (2.60)	17.78 (4.12)	17.37 (6.76)	21.37 (7.07)	23.50 (5.62)
NUMBER PARTICIPATING	9	9	8	8	10

SET TEST	COLOURS	ANIMALS	FRUITS	TOWNS
INITIAL TEST	8.78 (3.38)	8.22 (4.57)	7.33 (3.04)	6.78 (5.45)
RETEST	7.22 (1.48)	5.67 (2.24)	5.67 (1.73)	5.56 (2.35)
NUMBER PARTICIPATING	9	9	9	9

( ) = standard deviation

NUMBER PARTICIPATING = number completing the test at both test sessions

TABLE 40
The Standard Measures Battery for Cognitive and Language Function
The *Paired Samples t-test* : Core DAT Group Scores at Initial Test and Retest

Test		Initial Test Mean	Retest Mean	t-value	DF	Probability
Visual Screen 1 Dot Counting N = 7		8.28	8.85	-1.19	6	.280
Visual Screen 2 Shape Detection N = 8		17.87	17.75	.26	7	.802
Short NART N = 6		16.50	18.83	-1.72	5	.146
Short BPVS N = 6		21.83	21.83	.00	5	1.00
Pyramids & Palm Trees N = 8		23.00	24.25	-.65	7	.539
<u>The Set Test</u>						
Colours	N = 7	8.57	7.14	1.13	6	.304
Animals	N = 8	7.50	4.87	1.99	7	.087
Fruits	N = 8	5.62	5.00	1.93	7	.095
Towns	N = 8	6.37	5.00	0.86	7	.416

Significance level = $p < 0.05$ (2- tailed Significance; Equal variances)

N = Number of pairs included in the t-test analysis

It is evident from the results in Table 40 that the increase in duration of dementia consequent upon the time interval between initial testing and retest did not produce significant decrements in the performance of the core DAT group on any cognitive test at the chosen significance level ($p < 0.05$).

Performance of the Groups on the Experimental Battery for Semantic Processing

The comparative analyses of the semantic performance of Control and DAT group participants focused on lexical recognition (Recognition by Unique Feature and Recognition by Category tests) and lexical production (Picture Naming and Generative Naming tests) at the single word level.

In accordance with the research predictions, the Control subjects achieved high levels of success, achieving ceiling or near-ceiling scores on every semantic measure. This suggested that the application of non-parametric testing was appropriate. Furthermore, inspection of the distribution of DAT group scores for the lexical recognition tests, especially the Recognition by Unique Feature Test on which the majority of participants achieved near-ceiling scores, also suggested the application of a non-parametric test procedure, the *Mann-Whitney U-Test*, in analysing the data. The parametric *Independent t-test* was applied in analysing the Naming Test data.

The outcomes of these analyses, presented in Table 41, confirmed that the DAT group mean was significantly lower than the Control mean on every semantic measure at a significance level of $p < 0.001$.

TABLE 41
The Experimental Battery for Semantic Processing : Control and DAT Groups

TEST		CONTROL N=21	DAT N=15			Probability
Mann-Whitney U-Test 2-Tailed P Corrected for ties				Z		
Picture Recognition by by Unique Feature	Mean Stdev.	30.00 0.00	27.87 2.53	-4.272		**<0.001**
Written Recognition by Unique Feature	Mean Stdev.	29.81 0.87	28.27 1.83	-4.004		**<0.001**
Picture Recognition by Category	Mean Stdev.	14.33 1.24	10.33 3.58	-3.989		**<0.001**
Written Recognition by Category	Mean Stdev.	13.57 1.96	8.53 3.96	-3.852		**<0.001**
Independent t-test Based on Unequal Variances				DF	t-value	
Picture Naming	Mean Stdev.	57.43 1.80	44.43* 8.40	13.80	5.70	**<0.001**

* N=14 (Picture Naming data from Participant D1 omitted due to extreme score)

Semantic Test	Maximum Score Possible
Picture Recognition by Unique Feature	30
Written Recognition by Unique Feature	30
Picture Recognition by Category	15
Written Recognition by Category	15
Picture Confrontation Naming	60

The Recognition Tests of the Experimental Battery for Semantic Processing

- Effects of Advancing Age on the Recognition Performance of Control Subjects

Powerful ceiling effects were observed in the scores achieved by every Control age-subgroup on all four recognition tests, in particular the Recognition by Unique Feature Test, as evident from the data display in Table 42 and Table 43.

A simple rank ordering by mean score for the age-subgroups on each recognition test did not support the experimental prediction of a directional decline across the three age bands, and the expectation that the oldest subjects (Age Band III) would achieve the lowest mean scores on each test. In fact, the reverse effect was observed for both versions of the Recognition by Category Test, such that the oldest subgroup achieved the highest scores while the youngest subgroup (Age Band I) achieved the lowest scores.

Further analyses applying a One-Way ANOVA with *Tukey's HSD test* of pairwise comparisons did not establish significant differences for any Control age-band comparison at the 0.05 significance level. Thus the semantic abilities involved were not compromised by advancing age. The data for these analyses is also displayed in Table 42 and Table 43.

TABLE 42
The Recognition by Unique Feature Test
The One-Way ANOVA : Tukey-HSD Test
Analysis for Effects of Advancing Age : Control Subjects

	PICTURE RECOGNITION BY UNIQUE FEATURE TEST		
	Number of Subjects	Mean	Stdev.
AGE BAND I	9	Ceiling	.000
vs			
AGE BAND II	7	Ceiling	.000
AGE BAND I	9	Ceiling	.000
vs			
AGE BAND III	5	Ceiling	.000
AGE BAND II	7	Ceiling	.000
vs			
AGE BAND III	5	Ceiling	.000

	WRITTEN RECOGNITION BY UNIQUE FEATURE TEST		
	Number of Subjects	Mean	Stdev.
AGE BAND I	9	29.55	1.33
vs			
AGE BAND II	7	Ceiling	.000
AGE BAND I	9	29.55	1.33
vs			
AGE BAND III	5	Ceiling	.000
AGE BAND II	7	Ceiling	.000
vs			
AGE BAND III	5	Ceiling	.000

Source	DF	F Ratio	F Probability
Between Groups	2	.643	.537
Within Groups	18		
Total	20		

TABLE 43
The Recognition by Category Test
The One-Way ANOVA : Tukey-HSD Test
Analysis for Effects of Advancing Age : Control Subjects

	PICTURE RECOGNITION BY CATEGORY TEST Number of Subjects	Mean	Stdev.
AGE BAND I	9	14.00	1.73
vs			
AGE BAND II	7	14.57	.787
AGE BAND I	9	14.00	1.73
vs			
AGE BAND III	5	14.60	.548
AGE BAND II	7	14.57	.787
vs			
AGE BAND III	5	14.60	.548

Source	DF	F Ratio	F Probability
Between Groups	2	.546	.589
Within Groups	18		
Total	20		

	WRITTEN RECOGNITION BY CATEGORY TEST Number of Subjects	Mean	Stdev.
AGE BAND I	9	13.11	2.37
vs			
AGE BAND II	7	13.43	1.99
AGE BAND I	9	13.11	2.37
vs			
AGE BAND III	5	14.60	.548
AGE BAND II	7	13.43	1.99
vs			
AGE BAND III	5	14.60	.548

Source	DF	F Ratio	F Probability
Between Groups	2	.946	.407
Within Groups	18		
Total	20		

- The Recognition Test Performance of the DAT Group

The mean and range of scores achieved by the DAT participants on the Recognition by Unique Feature and Recognition by Category tests are presented in Table 44.

TABLE 44
The Semantic Recognition Tests
Mean and Range of Scores Achieved by the DAT Group

TEST	GROUP MEAN	Stdev.	MINIMUM SCORE	MAXIMUM SCORE
Picture Recognition by by Unique Feature	27.87	(2.53)	23	Ceiling (30)
Written Recognition by Unique Feature	28.27	(1.83)	24	Ceiling (30)
Written Recognition by Category	8.53	(3.96)	3	Ceiling (15)
Picture Recognition by Category	10.33	(3.58)	5	Ceiling (15)

N = 15 DAT participants completed every test

The recognition test scores achieved by the fifteen DAT participants were subjected to comparative analyses to investigate for any significant effects of:

- stimulus mode (pictures or written words) within each test condition (Feature and Category)
- test condition (Feature and Category) within each stimulus mode

To allow comparison of the DAT participants' performance across the Recognition by Unique Feature and Recognition by Category tests, a new statistic was calculated, derived by expressing each participant's score as a percentage of the Control mean for that test. This conversion imposed a common and standard unit of measurement across the recognition tests, even though the tests varied in number of stimuli - 30 items and 15 items, respectively. The mean percentage scores thus obtained for each test, indicating the relative success of the DAT group in relation to the Control norms, are displayed in Table 45.

- Testing for Effect of Stimulus Mode

Inspection of the distribution of scores for the Recognition by Unique Feature Test, on which eleven of the fifteen DAT participants achieved scores representing greater than 90% of the Control mean, suggested that the application of a nonparametric analysis, the *Wilcoxon Matched-Pairs* test, was appropriate.
The test yielded a non-significant effect of stimulus mode (picture or written).
A non-significant effect of stimulus mode was also found with respect to the Recognition by Category Test, using the parametric *t-test for paired samples.*

- Testing for Effect of Recognition Condition

Application of the non-parametric *Mann-Whitney U-Test* for independent samples to detect possible significant effects of recognition condition (by feature or category) within each stimulus mode yielded significance at $p < 0.05$ significance level in both the picture and written modes. This confirmed that the recognition performance of the DAT participants was significantly enhanced, in the picture and written modality, when they were required to recognise object features as opposed to object categories. These results are displayed in Table 46.

TABLE 45
The Semantic Recognition Tests
Performance of the DAT Participants as a Percentage of the Control Baseline

TEST	CONTROL Mean	DAT Mean	Mean Relative % DAT: Control
CATEGORY TESTS			
Written Recognition by Category	13.57	8.53	**62.88%**
Picture Recognition by Category	14.33	10.33	**72.11%**
FEATURE TESTS			
Picture Recognition by by Unique Feature	30.00	27.87	**92.89%**
Written Recognition by by Unique Feature	29.81	28.27	**94.82%**

TABLE 46
Effect of Stimulus Mode upon Feature and Category Recognition

The Wilcoxon Matched-Pairs Test

TEST	PICTURE RECOGNITION BY UNIQUE FEATURE with WRITTEN RECOGNITION BY UNIQUE FEATURE
Z = -1.098	2-Tailed P = .272

The Paired Samples t-test

TEST	PICTURE RECOGNITION BY CATEGORY with WRITTEN RECOGNITION BY CATEGORY	
t-value = 1.94	df = 14	2-Tail Sig. = .073

Effect of Feature and Category Conditions in each Mode

The Mann-Whitney U-Test

TEST	PICTURE RECOGNITION BY UNIQUE FEATURE with PICTURE RECOGNITION BY CATEGORY
Z = -2.062	2-Tailed P = .039
TEST	WRITTEN RECOGNITION BY UNIQUE FEATURE with WRITTEN RECOGNITION BY CATEGORY
Z = -3.104	2-Tailed P = .002

- <u>Effects of Severity of DAT on Recognition Test Performance</u>

The percentage scores achieved on the recognition tests by the DAT participants within each GDS subgroup were analysed to investigate any significant performance decrements with advancing cognitive decline. The findings are presented in Table 47.

The DAT participants at every level of cognitive impairment from Very Mild to Moderately Severe achieved mean scores representing over 90% of the Control baseline on the written version of the Recognition by Unique Feature Test.
These high levels of performance, that is at greater than 90% of the Control baseline, were maintained on the picture Recognition by Unique Feature Test by every GDS subgroup except the most severely cognitively impaired participants (GDS Stage 5) who achieved a score representing 81% of the Control norm.

Performance on the Recognition by Category tests was more variable. The participants at the mildest level of cognitive decline (GDS Stage 2) again achieved the highest mean scores within the DAT group on both picture and written presentations of the categorisation test, while the most severely cognitively impaired participants (GDS Stage 5) achieved the lowest overall score within the group, at less than 30% of the Control baseline, on the written categorisation test.
Of interest in the dispersion of scores was the finding that mildly impaired participants (GDS Stage 3) consistently performed at a lower percentage of the Control baseline than moderately impaired participants (GDS Stage 4) on all four recognition tests. The GDS Stage 3 participants also achieved similar mean scores in the picture and written modes under each test condition (Recognition by Unique Feature and Category).

Therefore the pattern of scores achieved by each severity subgroup did not support a uniform progressive decrease in performance with increasing cognitive decline for either recognition test, although participants at the mildest level of cognitive decline (GDS Stage 2) consistently achieved the highest mean scores within the DAT group on every recognition test.

TABLE 47
The Category and Feature Recognition Tests
Analysis of Advancing DAT Severity and Performance Relative to Control Mean

TEST	Written Recognition by Category	Picture Recognition by Category	Written Recognition by Unique Feature	Picture Recognition by Unique Feature
CONTROL MEAN	13.57	14.33	29.81	30.00
GDS 2 Very Mild n = 4	12.00 (2.58)	13.25 (2.22)	Ceiling	29.75 (.50)
% Control Mean	**88.5%**	**92.75%**	**101%**	**99.25%**
GDS 3 Mild n = 4	8.00 (2.58)	8.00 (3.56)	27.25 (1.71)	27.50 (3.11)
% Control Mean	**59%**	**56%**	**91.5%**	**91.75%**
GDS 4 Moderate n = 4	9.00 (4.55)	10.25 (4.50)	28.25 (.96)	29.00 (.82)
% Control Mean	**66.25%**	**71.75%**	**94.75%**	**96.75%**
GDS 5 Moderately Severe n = 3	4.00 (1.73)	9.66 (2.08)	27.33 (2.89)	24.33 (.58)
% Control Mean	**29.33%**	**67.66%**	**91.66%**	**81%**

( ) = standard deviation

In order to ascertain whether the four recognition tests would detect significant deficits in performance with advancing severity of cognitive decline, the non-parametric *Mann-Whitney U-Test* was applied to the six pairwise analyses possible between the GDS subgroups for each test.

The results of the *Mann-Whitney* pairwise analyses are displayed in Table 48.

The major observation from these analyses was that of consistently significant performance decrements at a significance level of $p < 0.05$ on the written version of the Recognition by Unique Feature Test, which clearly differentiated participants at the Very Mild level of cognitive decline (GDS Stage 2) from participants at every other severity level (mild, moderate and moderately severe).

Significant decrements associated with increasing severity were also noted for four other comparisons, three of which differentiated the Very Mild participants from other severity subgroups, as shown below:

Test	Significant Comparison ($p < 0.05$)
Picture Recognition by Category	Very Mild versus Mild
Written Recognition by Category	Very Mild versus Moderately Severe
Picture Recognition by Unique Feature	Very Mild versus Moderately Severe
Picture Recognition by Unique Feature	Moderate versus Moderately Severe

TABLE 48
The Recognition Tests : *Mann-Whitney U-Test* Analysis by Severity of DAT

TEST	Picture Recognition by Category	Written Recognition by Category	Picture Recognition by Unique Feature	Written Recognition by Unique Feature
Very Mild	13.25	12.00	29.75	Ceiling
versus				
Mild	8.00	8.00	27.50	27.25
2-Tailed P	**.042**	.079	.122	**.014**
Very Mild	13.25	12.00	29.75	Ceiling
versus				
Moderate	10.25	9.00	29.00	28.25
2-Tailed P	.219	.309	.155	**.013**
Very Mild	13.25	12.00	29.75	Ceiling
versus				
Moderately Severe	9.66	4.00	24.33	27.33
2-Tailed P	.075	**.032**	**.026**	**.018**
Mild	8.00	8.00	27.50	27.25
versus				
Moderate	10.25	9.00	29.00	28.25
2-Tailed P	.378	.663	.549	.369
Mild	8.00	8.00	27.50	27.25
versus				
Moderately Severe	9.66	4.00	24.33	27.33
2-Tailed P	.373	.075	.285	.714
Moderate	10.25	9.00	29.00	28.25
versus				
Moderately Severe	9.66	4.00	24.33	27.33
2-Tailed P	.857	.142	**.031**	1.00

2-Tailed Probability corrected for ties

- <u>Differentiation from the Control Baseline by Level of Severity</u>

The *Mann-Whitney U-Test* was applied in a further analysis to determine at which level of cognitive decline the DAT group scores could be differentiated from the Control baseline. This data is displayed in Table 49.

TABLE 49
The Recognition Tests
***Mann-Whitney* Analysis of GDS Subgroups in Relation to the Control Mean**

TEST	Written Recognition by Category	Picture Recognition by Category	Written Recognition by Unique Feature	Picture Recognition by Unique Feature
CONTROL MEAN	13.57	14.33	29.81	30.00
GDS 2 Very Mild n = 4	12.00	13.25	30.00	29.75
2-Tailed P	.193	.129	.663	**.022**
GDS 3 Mild n = 4	8.00	8.00	27.25	27.50
2-Tailed P	**.003**	**.001**	**<0.001**	**<0.001**
GDS 4 Moderate n = 4	9.00	10.25	28.25	29.00
2-Tailed P	**.016**	**.008**	**<0.001**	**<0.001**
GDS 5 Moderately Severe n = 3	4.00	9.66	27.33	24.33
2-Tailed P	**.004**	**.004**	**<0.001**	**<0.001**

2-Tailed Probability corrected for ties

The performance of the Very Mild group (GDS Stage 2) differed significantly from the Control baseline only on the Picture Recognition by Unique Feature Test ($p < 0.05$).

The analyses yielded significant decrements in performance at $p < 0.01$ between the Control baseline and every other dementia severity level on both picture and written versions of the Recognition by Unique Feature Test.

The mean scores achieved by DAT participants within each of the remaining three severity levels (GDS Stages 3 - 5) differed significantly from the Control baseline at $p < 0.01$ on both picture and written versions of the Recognition by Category Test, with the exception of the scores of the Moderately impaired group (GDS 4) on the written version of the Recognition by Category Test, for which significance was established at $p < 0.05$.

- Qualitative Analysis of Erroneous Responses to the Noun Recognition Tests

The errors made by the Control and DAT research participants on each of the four recognition tests were subjected to a qualitative analysis to determine whether similar patterns could be identified between the groups in the erroneous selection of distractors.

The findings are summarised in the following section.

- Control Group Errors on the Recognition by Unique Feature Tests

Every Control subject performed at ceiling on the picture version of this test. On the written version of the test only one subject did not obtain a perfect score, making four errors.

- Control Group Errors on the Recognition by Category Tests

The Control subjects achieved a success level of 95.5% on the picture version of the Recognition by Category Test, and 90.5% on the written version, indicating less successful performance overall on the categorisation tests than on the tests of specific feature recognition.

The Control subjects made only two types of selection error on the category tests; these were classified as follows :

Type I: selecting the semantic distractor and two of the three targets

Type II: selecting the unrelated distractor and two of the three targets

The Control subjects produced a greater frequency of errors on the written version of the categorisation test.

Thus, fourteen subjects scored at ceiling on the picture test and the remaining seven subjects produced a group total of 14 errors, 13 of which were Type I.

Only eleven subjects achieved a ceiling score on the written test and the remaining ten subjects made a combined total of 30 errors. Again, the majority of these errors (27 / 30) were of Type I and the remaining 3 errors were Type II.

- DAT Group Errors on the Recognition by Unique Feature Tests

In reverse pattern to the Control group, the DAT group achieved a higher mean score on the written version of the Recognition by Unique Feature (28.27) test than the picture version (27.87). Thus, four participants performed without error on the written test, and five participants performed without error on the picture test. The total number of error responses was 26 on the written test, representing 6% of possible responses, and 32 on the picture test, representing 7% of possible responses.

The error type which occurred with the highest frequency was selection of the close semantic distractor, which constituted over 55% of total errors on both picture and written tests, at both initial testing and retest.

- DAT Group Error Types at Retest on the Recognition by Unique Feature Tests

Retest scores were obtained from eight participants for each version of this test.

The number of error responses on the Recognition by Unique Feature Test was noted to increase at retest on both picture and written versions of the test. Error responses constituted a similar proportion (12%) of total responses on both versions of the test. One participant completed the picture test without error, and two participants achieved a perfect score on the written test. Participant D7 was able to complete only eight of the thirty test items on the picture version of the Recognition by Unique Feature Test; this score was at great variance with the scores of the other participants and was therefore excluded from the subsequent analyses of error types.

A breakdown of error types on the Recognition by Unique Feature tests and their frequency of occurrence at initial testing and retest is shown in Table 50.

Table 50
The Recognition by Unique Feature Test
Relative Proportions of Error Types for the DAT Participants

	PICTURE VERSION		WRITTEN VERSION	
Error type	Initial Test (N=15)	Retest (N=7*)	Initial Test (N=15)	Retest (N=8)
Total Number of Group Errors	32	25	26	28
Total Possible Group Responses**	450	210	450	240
Percentage of Errors	7.1%	11.9%	5.8%	11.7%
Close Semantic Distractor	21	14	16	16
Percentage of Errors	65.6%	56%	61.5%	57.1%
Distant Semantic Distractor	4	4	6	7
Percentage of Errors	12.5%	16%	23.1%	25%
Visual Distractor	4	4	2	3
Percentage of Errors	12.5%	16%	7.7%	10.7%
Unrelated Distractor	2	3	0	0
Percentage of Errors	6.2%	12%	-	-
Don't Know	1	0	2	2
Percentage of Errors	3.1%	-	7.7%	7.1%

* Retest Picture version scores for Participant D7 omitted due to extremely variant score

** Total possible group responses = Number of test items x Number of participants

The percentage figures have been rounded to one decimal point

- DAT Group Errors on the Recognition by Category Tests

In contrast to their performance on the Recognition by Unique Feature tests, which was at levels representing more than 92% of the Control mean, the DAT group achieved scores representing below 75% of the Control mean on both presentations of the Recognition by Category tests. Two participants were excluded from the retest analyses for the Recognition by Category tests; one person declined and one experienced extreme difficulty in responding to the [picture] test requirements.

Analysis of the pattern of errors for the DAT group at initial testing showed that the most frequently occurring error type on both picture and written versions of the categorisation test was Type I (selecting the semantic distractor and two of the three targets), which was also the predominant error type produced by the Control subjects on both picture and written administrations of the test. This error distribution pattern was also retained in the responses of the seven core DAT group participants who completed the picture and written Recognition by Category tests at retest.

The DAT participants produced three additional types of selection error which were not observed in the responses of the Control group; these were classified as:

Type III: selecting both distractors in addition to one or more target items

Type IV: selecting the semantic distractor and all three targets

Type V: no response to the stimuli

Type III errors occurred with a higher frequency at retest, in contrast to Type V errors which decreased in frequency at retest. Type IV errors occurred only at initial testing and predominantly on the written version of the test. A breakdown of these error types and their frequencies of occurrence at initial test and retest is presented in Table 51.

Table 51
The Recognition by Category Test
Relative Proportions of DAT Core Group Error Types

	PICTURE CATEGORY TEST		WRITTEN CATEGORY TEST	
Error type	Initial Test (N=15)	Retest (N=7*)	Initial Test (N=15)	Retest (N=7*)
Participants Scoring at Ceiling	1	1	1	0
Total Possible Group Responses**	225	105	225	105
Total Number of Group Errors	70	38	97	41
Percentage of Errors	31.1%	36.2%	43.1%	39%
Type I				
Semantic Distractor & two targets	47	27	59	24
Percentage of Errors	67%	71%	60.8%	58.5%
Type III				
Both Distractors & one or more targets	8	4	10	9
Percentage of Errors	11.4%	10.5%	10.3%	21.9%
Type II				
Unrelated Distractor & one or more targets	7	5	6	6
Percentage of Errors	10%	13%	6%	15%
Type V				
No Response / Other	6	2	8	2
Percentage of Errors	8.6%	5.3%	8.2%	4.9%
Type IV				
Semantic Distractor & all three targets	2	-	14	-
Percentage of Errors	2.9%		14.3%	

* N = 7 DAT participants completed this test at retest
** Total possible group responses = Number of test items x Number of Participants
The percentage figures have been rounded to one decimal point

- Comparative Analysis of Recognition Test Performance at Initial Test and Retest

Table 52 shows the mean scores achieved on the four recognition tests by the core group of eight individuals with DAT who participated at both initial testing and retest. It is evident that the mean scores achieved on the picture and written presentations of each test at retest replicate the relative levels of success achieved on each presentation at initial testing.

TABLE 52
The Semantic Recognition Tests
Mean Scores for the Core DAT Group at Initial Test and Retest

TEST CONDITION		INITIAL TEST		RETEST
PICTURE RECOGNITION BY UNIQUE FEATURE	Mean Stdev	27.75 2.71	Mean Stdev	23.13* 9.63
WRITTEN RECOGNITION BY UNIQUE FEATURE	Mean Stdev	27.88 2.36	Mean Stdev	26.50 3.51
PICTURE RECOGNITION BY CATEGORY	Mean Stdev	10.00 3.70	Mean	8.38** 4.10
WRITTEN RECOGNITION BY CATEGORY	Mean Stdev	8.50 4.50	Mean Stdev	8.00* 5.16

* Participant D7 obtained a zero score on this test

** Participant D6 obtained a zero score on this test

The core DAT group scores were then subjected to statistical analysis applying the *Paired samples t-test* in order to detect any significant deficits between initial test and retest performance on the recognition tests.

The results of the *t-test* analyses are presented in Table 53.

TABLE 53
The Semantic Recognition Tests
The *Paired Samples t-test* : Core DAT Group Scores at Initial Test and Retest

TEST	Initial Mean & Stdev.	Retest Mean & Stdev.	DF	t-value	2-Tail Sig.
PICTURE RECOGNITION BY UNIQUE FEATURE	27.75 2.71	23.13 9.63	7	1.70	.133
WRITTEN RECOGNITION BY UNIQUE FEATURE	27.88 2.36	26.50 3.51	7	1.14	.293
PICTURE RECOGNITION BY CATEGORY *	10.00 3.70	8.38 4.10	7	.86	.416
WRITTEN RECOGNITION BY CATEGORY *	8.50 4.50	8.00 5.16	7	.37	.725

Significance level = $p < 0.05$

As evident from the statistical outcomes, the performance of the core DAT group on the Recognition by Unique Feature and Recognition by Category tests did not deteriorate significantly during the test-retest time interval.

Confrontation Naming Performance of the Control and DAT Groups

- Comparative Analysis of Naming Success for the Control and DAT Groups

The mean number of items which were named correctly and spontaneously by the Control and DAT groups on the 60-item Picture Naming test were subjected to a comparative analysis using the *t -test* for independent samples.

The analysis yielded significance at $p < 0.001$, showing that the people with DAT named significantly fewer items on their initial and uncued naming attempts than the Control subjects. The results of the *t-test* analysis are displayed in Table 54.

Omission of Extreme DAT Participant Naming Data

The statistical analyses for the Naming Test were based on the responses of N = 14 DAT participants. The naming data from Participant D1 was omitted from every analysis as a result of this individual's extreme difficulty in naming pictures, leading to scores which were incomplete and at great variance with the scores of the remaining DAT group participants. Thus, at initial testing Participant D1 attempted only the first thirty items from the full set of sixty. Four items were named correctly and spontaneously, and a further 12 items were named correctly following presentation of the phonemic cue. The test was then abandoned to prevent participant distress.

Similarly at retest, Participant D1 attempted to name the initial 30 test items. None were named either spontaneously or following presentation of the semantic cue, but 15 items were named correctly in response to the phonemic cue.

TABLE 54
Picture Naming Performance
The *Independent t-test* Analysis

Group	Number of Participants	Mean	Stdev.	DF	t-value	Probability
CONTROL	21	57.43	1.80	13.80	5.70	**<0.001**
DAT	14*	44.43	8.40			

$p < 0.05$ (2-Tail Significance; t-value based on Unequal variances)

* Naming Test data from Participant D1 not included in the analysis due to extremely variant score

Age Effects on the Naming Performance of Control Subjects

A simple ranking of the mean number of items named by Control subjects within each of the three age subgroups revealed a very small progressive decrease in Naming Test scores through the age bands, suggesting a decline with advancing age.

In order to establish whether this observed decline was statistically significant, and also to test the experimental prediction of a directional decrement in naming performance with advancing age, the data was subjected to the nonparametric *Jonckheere Trend Test* for ordered alternatives.

The outcome of the *Jonckheere Trend Test* was not significant ($Z = 0.817$; One-tailed test) therefore confirming that no two age-bands differed significantly at the $p < 0.05$ significance level.

Thus in the population tested, the naming ability of normal elderly subjects was not significantly compromised by advancing age, and subjects within the highest age band (mean age 86.4 years) demonstrated similar levels of success to subjects aged between 65 to 84 years, in recalling the names of pictured objects.

The results of the analysis are displayed in Table 55.

TABLE 55
Age Effects on the Naming Performance of Control Subjects
The *Jonckheere Trend Test for Ordered Alternatives*

Comparison	Number of Subjects	Mean	Stdev.
Age band I	9	57.89	1.83
vs			
Age Band II	7	57.14	2.34
Age Band II	7	57.14	2.34
vs			
Age Band III	5	57.00	0.71
Age Band I	9	57.89	1.83
vs			
Age Band III	5	57.00	0.71

Predicted Order	Number of Subjects (N = 21)	J	Z	One-tailed test
Age band III	n = 5	84	0.817	Not significant
Age band II	n = 7			
Age band I	n = 9			

Age Band I = 65 - 74 years (Mean = 69.1 years)

Age Band II = 75 - 84 years (Mean = 79.4 years)

Age Band III = 85+ years (Mean = 86.4 years)

<u>Naming Success in Relation to the Severity of DAT</u>

The non-parametric *Mann-Whitney U-Test* was applied to a series of comparative analyses which sought to establish at which level of dementia severity a significant difference in naming performance would arise in relation to the Control mean.

The comparisons were significant at every level at $p < 0.01$. The statistical outcomes confirmed that the people with DAT were significantly impaired in their spontaneous picture naming abilities compared to the normal Control population from even the mildest stage of cognitive decline (Very Mild) as defined by the GDS rating scale. The data from these analyses is presented in Table 56.

As an additional comparative analysis of naming performance, the naming score for each DAT participant was expressed as a percentage of the Control mean, and from this a mean percentage naming score obtained for each GDS severity subgroup in relation to the Control baseline.

This data is presented in Table 57.

TABLE 56
DAT Group Naming Scores in Relation to the Control Mean
***Mann-Whitney U-Test* Analysis by GDS Severity Level**

Comparison	Number of Participants	Z	Probability
Control vs Very Mild	21 4	-3.07	.002
Control vs Mild	21 3*	-2.78	.005
Control vs Moderate	21 4	-3.15	.002
Control vs Moderately Severe	21 3	-2.78	.005

$p < 0.05$ (2-Tailed Probability - corrected for ties)

* Data from Participant D1 not included in the analysis due to extreme score

GDS Stage 2 = Very Mild
GDS Stage 3 = Mild
GDS Stage 4 = Moderate
GDS Stage 5 = Moderately Severe

TABLE 57
DAT Group Naming Success in Relation to the Control Baseline
Analysis by Severity Level

Severity Band	Mean Score	Group Mean	Stdev.	Percentage of Control Mean
GDS 2 (Very Mild)				
D6	42	49.5	5.45	86.19%
D8	49			
D5	53			
D13	54			
GDS 3 (Mild)				
D1	4	44.0*	9.54	76.61%
D7	33			
D4	49			
D11	50			
GDS 4 (Moderate)				
D2	26	43.5	11.73	75.74%
D12	48			
D3	49			
D14	51			
GDS 5 (Moderately Severe)				
D10	36	39.3	4.93	68.49%
D9	37			
D15	45			

Control Mean Score = 57.43

* Data from Participant D1 not included in the analysis due to extreme score

The naming success of the DAT participants at each severity level confirmed the research expectation of a progressive decline in confrontation naming success with increasing severity of cognitive decline.

The DAT participants rated as being the least cognitively impaired (GDS Stage 2) achieved the highest naming success rate in relation to the Control baseline. Conversely, the DAT participants rated as presenting the most advanced level of cognitive decline (GDS Stage 5) achieved the lowest naming success rate in relation to the Controls.

The number of items named correctly and spontaneously by the DAT participants at each severity level was subjected to a pairwise analysis applying the non-parametric *Mann-Whitney U-Test* analysis to determine whether the observed differences in naming success between the severity subgroups were significant.

The analyses did not establish significance for any of the severity level comparisons. This demonstrated that in the population tested, the picture naming abilities of DAT participants representing increasing levels of severity of cognitive decline did not differ significantly.

The data from these analyses is displayed in Table 58.

TABLE 58
DAT Group Naming Success in Relation to Severity of Cognitive Decline
The *Mann-Whitney U Test*

Comparison	N	Mean Score	Probability
Very Mild (GDS 2)	4	49.5	.372
vs			
Mild (GDS 3)	3*	44.0	
Very Mild (GDS 2)	4	49.5	.309
vs			
Moderate (GDS 4)	4	43.5	
Very Mild (GDS 2)	4	49.5	.077
vs			
Moderately Severe (GDS 5)	3	39.3	
Mild (GDS 3)	3*	44.0	.858
vs			
Moderate (GDS 4)	4	43.5	
Moderate	4	43.5	.289
vs			
Moderately Severe	3	39.3	
Mild (GDS 3)	3*	44.0	.513
vs			
Moderately Severe (GDS 5)	3	39.3	

$p < 0.05$ (2-Tailed Probability - Corrected for ties)

* Data from Participant D1 not included in the analysis due to extreme score

Qualitative Analysis of the Control and DAT Group Naming Responses

The responses of the Control and DAT participants to the 60-item Picture Naming Test were classified according to the following four parameters:

- the number of items named correctly on initial presentation without the aid of cues
- the number of items named correctly after presentation of a semantic cue (the unique feature attribute of the target item)
- the number of items named correctly after presentation of a phonemic cue (the initial syllable of the target name)
- the number of items which could not be named despite presentation of both a semantic and a phonemic cue

The frequency of occurrence of each of these response types for the Control and DAT groups is displayed in Table 59.

TABLE 59
Frequency Distribution of Response Types on the Naming Test
Control and DAT Groups

	Misnamed	Correct to Semantic Cue	Correct to Phoneme Cue	Unable to Name
Control Group (N = 21)	54	51	2	1
Total possible responses = 1260*				
DAT Group (N = 15)	188	85	47	56
Total possible responses = 810**				

Total Naming Test items = 60

* figure calculated on the basis of Number = 21 x 60 test items

** figure based on: 13 participants attempted to name all 60 items
data from Participant D1 omitted from analysis
one participant (D2) named only 30 test items

Table 60 displays the percentage ratios for the frequency of occurrence of each response type, and the success rates of the semantic and phonemic cues in facilitating correct naming, for the Control and DAT groups.

TABLE 60
Relative Percentage Ratios for Response Types on the Naming Test
Control and DAT Groups

	Raw Score	Percentage*
CONTROL SUBJECTS		
Total possible responses = 1260		
Number of Correct Naming Responses	1206	95.7%
Number of Items Misnamed	54 / 1260	4.3%
Number of Semantic Cues given	54	
Named correctly after Semantic Cue	51	94.4%
Number of Phonemic Cues given	3	
Named correctly after Phonemic Cue	2	66.7 %
Number unable to name after both Cues	1 / 54	1.8%
DAT PARTICIPANTS		
Total possible responses = 810**		
Number of Correct Naming Responses	622	76.8%
Number of Items Misnamed	188 / 810	23.2%
Number of Semantic Cues given	188	
Named correctly after Semantic Cue	85	45.2%
Number of Phonemic Cues given	103	
Named correctly after Phonemic Cue	47	45.6 %
Number unable to name after both Cues	56 / 188	29.8 %

* percentage figures rounded to one decimal point

** based on N = 14 (13 participants x 60 items, 1 participant x 30 items, and no score for Participant D1)

The percentage analyses show that only 4 % of the Control group responses were incorrect, whereas misnamings constituted 23% responses from the people with DAT.

The presentation of a semantic cue enabled the Control subjects to subsequently name the majority (over 94%) of items initially misnamed.

Presentation of the semantic cue enabled the DAT participants to correctly name 45 % of the test items which were initially misnamed.
A further 46% of test items which were not facilitated by the semantic cue were subsequently named correctly by the DATparticipants in response to the phonemic cue.
30% of the items for which both semantic and phonemic cues had been given remained unnamed by the DAT participants, producing an 'Unable to Name' response.
This proportion of items which could not be named by the DAT participants represented an increase of fifteen times greater than the figure of just under 2% items which the Control group were unable to name.

Classification System for Misnaming Response Types

A qualitative classification system was devised by the author on the basis of the types of misnaming responses produced by the Control and DAT research participants.
The classification typology is presented in Table 61.
The frequency of occurrence of each type of misnaming response type, expressed in terms of percentage figures, is subsequently displayed in Table 62.

TABLE 61
Classification System for Qualitative Analysis of Misnamings

Semantically Related Misnaming

- Another noun from the same semantic category
- Description of function or action associated with the target noun
- Description of physical feature or component part of the target noun
- Name of semantic category to which the target noun belongs

Out-of Category Visually Related Misnaming

Object from a different semantic category which is visually similar to the target in its basic outline

("snake" for worm; "measure" for worm; "bottle" for medal; "bunch of potatoes" for grapes)

Noun from a Different Semantic Category

Object from a different semantic category which has no visual similarity to the target

("peas" for apples)

Gestured Response: Functional

Gesture or drawing in the air to depict the target object's shape or function

Slang or 'own term' word ("chopper" for axe; "cockadoodledoo" for chicken)

Negated Noun

("Not a ...")

Unrecognised Correct

Object named correctly aloud but without recognition or acknowledgement

TABLE 61 (continued)
Classification System for Qualitative Analysis of Misnamings

Unrelated word, phrase or story-telling response

("one of my mates" for lion)

Indication of Don't Know or Inability to name

("I don't know"); ("I know what it is but I can't get it")

Phonemically Related Misnaming

Phonologically similar word created from a phoneme substitution

Fragment or syllable of the target noun

("beet" for bee)

Overlap (combination of error types)

- Visually related misnaming and another error type

("he's musical-is it plucking?" for hammer)

- The semantic category label and a description of the object, or a same-category noun

("wasp-with a spotted jacket on" for ladybird) ("a bird-cuckoo" for woodpecker)

- A gesture, supplemented by the category label, a same-category noun, or a description of the target noun

(strumming gesture and "music-people using their fingers", for guitar)

(gesture up the arm and "little green things that go up", for corn)

TABLE 62
Relative Frequency of Occurrence of Each Misnaming Type
Control and DAT Groups

	CONTROL		DAT	
Total Number of Errors	54		188*	
Misnaming Type		%		%
Semantically Related Misnamings	37	68.5%	105	56%
Same-category noun	35	95%	84	80%
Description of Function or Action	1	3%	8	8%
Description of Part or Feature	0	-	4	4%
Category Label	1	3%	9	9%
Out-of-Category Visually Related Misnaming	9	17%	31	16.5%
Don't Know or Inability to Name	3	6%	22	12%
Overlap (more than one error type)	_	_	9	5%
Slang or 'Own Term' word	4	7%	6	3%
Unrecognised Correct	1	2%	4	2%
Noun from a Different Semantic Category	_	_	4	2%
Negated Noun	_	_	3	2%
Functional Gesture	_	_	2	1%
Response Unrelated to Target	_	_	1	0.5%
Phonemically Related Misnaming	_	_	1	0.5%

* based on N = 14: 13 participants x 60 items, 1 participant x 30 items
no score for Participant D1
Percentages have been rounded to the nearest figure

It is apparent from the data in Table 62 that the most common misnaming type for both the Control and DAT groups was that of a *semantically related misnaming,* most commonly a different noun from the same semantic category.

The second most frequent response for both groups consisted of naming an object which shared visual features with the target, but was not semantically related to the target.

The DAT participants were also noted to produce several misnaming types which were not observed amongst the Control group responses, the most frequently occurring of these being 'Don't Know' responses followed by 'overlap' or multi-type responses.

Naming Test Performance of the Core DAT Group at Retest

Comparison between the raw scores achieved on the Naming Test by each of the eight core DAT group participants at initial test and retest did not confirm a uniform direction of change, that is a deterioration, in naming success.

Thus, although two participants decreased in their naming success at retest, two participants retained their initial test scores, and four participants or 50% of the group achieved an increased naming success rate.

These findings are presented in Table 63.

Table 63
Direction of Change in Naming Success at Initial Test and Retest
The Core DAT Group

Participant	Initial Score	Errors at First Test	Retest Score	Errors at Retest	Naming Success
D1	4	56	0	60	decreased
D13	54	6	48	12	decreased
D7	33	27	33	27	stable
D5	53	7	53	7	stable
D9	37	23	47	13	increased
D6	42	18	51	9	increased
D3	49	11	53	7	increased
D11	50	10	52	8	increased
Mean*	45.43		48.14		
Total Errors**		102		83	

Total Naming Test items = 60
* Based on N = 7 (extreme scores of Participant D1 not included in the analyses)
** Total score does not include Participant D7 errors

A *Paired samples t-test* analysis was applied to statistically compare the mean number of items named correctly and spontaneously (without cueing) by the core DAT group at initial test and retest. The statistical analysis was based on the scores of seven participants; as in the previous analyses, the scores of Participant D1 were omitted due to extreme variance from those of the other group participants.

The *t-test* findings are displayed in Table 64.

TABLE 64
Initial Test and Retest Naming Success for the Core DAT Group
The *Paired samples t-test* Analysis

Test	Initial Test N = 7*	Retest N = 7*	DF	t-value	Probability
MEAN	45.43	48.14	6	-1.29	.244
Stdev.	8.18	7.08			
Minimum Scores	33 / 60	33 / 60			
Maximum Scores	54 / 60	53 / 60			

$p < 0.05$ (Two-tail Significance)

* Based on N = 7 (extreme scores of Participant D1 not included in the analyses)

As evident from Table 64, the core DAT group did not demonstrate a significant deficit at retest in their spontaneous naming success.

Success of the Semantic and Phonemic Cues in Facilitating Naming

Table 65 displays the proportion of misnamings and the relative success of the semantic and phonemic cues in facilitating naming by the core DAT group at initial test and retest.

As previously observed from the mean naming scores, there was no decline between test sessions in the proportion of items named successfully and without cueing on initial attempt.

However, whereas at initial testing near-equivalent naming success rates were facilitated for the core DAT group by the semantic and phonemic cues (47% and 37% respectively), at retest the semantic cues were noted to be relatively less successful (27.7% success rate) than the phonemic cues (65% success rate) in facilitating naming.

TABLE 65
Relative Percentage Ratios for the Core DAT Group Naming Response Types
Initial Test and Retest

	Raw Score	Percentage*
INITIAL TEST		
Total possible responses = 420**		
Number of Correct Naming Responses	318	75.7%
Number of Items Misnamed	102 / 420	24.3%
Number of Semantic Cues given	102	
Named correctly after Semantic Cue	48	47.1%
Number of Phonemic Cues given	54	
Named correctly after Phonemic Cue	20	37%
Number unable to name after both Cues	34 / 102	33.3%
RETEST		
Total possible responses = 420**		
Number of Correct Naming Responses	337	80.2%
Number of Items Misnamed	83 / 420	19.8%
Number of Semantic Cues given	83	
Named correctly after Semantic Cue	23	27.7%
Number of Phonemic Cues given	60	
Named correctly after Phonemic Cue	39	65%
Number unable to name after both Cues	21 / 83	25.3%

* Percentage figures have been rounded to one decimal point
** based on (N = 7) participants x 60 Naming Test items (not Participant D1)

Qualitative Analysis of the Distribution of Misnaming Types at Retest

The classification system for misnaming responses was applied to the retest naming data of the core DAT group in order to examine for any change in the relative frequency of occurrence of each response type.

The findings are displayed in Table 66.

It is apparent from the data that *semantically related misnamings* constituted approximately 50% of the core DAT group error types at both initial testing and at retest. The semantically related misnamings were most frequently (71%) the name of another noun from the same semantic category, at both test sessions.

The other notable changes in the distribution of misnamings at retest for the DAT group were an increase in the relative proportion of items which could not be named (*Don't know* response - 26.5%) and a relative reduction in the occurrence of visually related misnamings (8%) in relation to initial testing (18%).

TABLE 66
Frequency of Occurrence of Misnaming Types at Initial Test and Retest
The Core DAT Group *

	INITIAL TEST		RETEST	
Total Number of Errors	102		83	
Misnaming Type		%		%
Semantically Related Misnamings	55	54%	42	51%
Same-category noun	39	71%	30	71%
Category Label	8	14.5%	3	7%
Description of Function or Action	6	11%	6	14%
Description of Part or Feature	2	4%	3	7%
Out-of-Category Visually Related Misnaming	18	18%	7	8%
Don't Know or Inability to Name	7	7%	22	26.5%
Slang or 'Own Term' word	5	5%	1	1%
Overlap (more than one type)	5	5%	6	7%
Unrecognised Correct	4	4%	1	1%
Negated	3	3%	1	1%
Noun from Another Semantic Category	2	2%	_	
Functional Gesture	1	1%		_
Single or Multi-word Response Unrelated to Target	1	1%	3	4%
Phonemically Related Misnaming	1	1%		_

* based on N = 7 participants; results for Participant D1 reported elsewhere
Percentages have been rounded to the nearest figure

Performance of the Research Groups on the Generative Naming Test

The mean number of nouns generated in response to each of the fifteen semantic categories on the Generative Naming Test by the Control and DAT groups were subjected to a *One-Way ANOVA* to examine for significant variations in recall performance.

- Between-Groups *ANOVA*

The statistical analyses were based on the scores of only twelve DAT participants; three individuals were unable to proceed with the test due to extreme difficulty in generating nouns in response to any of the test categories, causing the test to be abandoned.

As predicted, the analyses yielded a significant main effect for group, yielding a probability level of $p < 0.001$ (DF 1,31) for every category except *Kitchen Tools* and *House Objects*, for which the *ANOVA* was significant at $p < 0.01$ (DF 1,31). The statistical outcomes demonstrated that the DAT participants recalled significantly fewer items than the Controls for every semantic category.

This data is presented in Table 67. It is evident from the data that:

- both groups generated the highest number of items in response to the category of *Body Parts*
- the groups differed with respect to the category for which they generated the least number of items: *Footwear* (Control group) and *Insects* (DAT group)

TABLE 67
The Generative Naming Test : One-Way Betweeen-Groups *ANOVA*

CATEGORY	Mean Items Generated CONTROL (N=21)	DAT (N=12*)	F Ratio (DF 1,31)	F Probability
FOOTWEAR	7.52	4.42	31.67	<0.001
TOOLS	8.24	4.42	18.51	<0.001
JEWELLERY	8.38	4.92	18.46	<0.001
INSECTS	10.43	4.33	39.65	<0.001
TRANSPORT	11.09	5.58	43.66	<0.001
KITCHEN TOOLS	11.24	7.42	12.31	.0014
FURNITURE	11.52	5.42	49.00	<0.001
MUSIC	11.62	4.83	42.14	<0.001
BIRDS	12.28	5.08	39.20	<0.001
FRUIT	12.71	6.42	39.24	<0.001
HOUSE OBJECTS	12.95	8.58	11.47	.0019
VEGETABLES	13.00	6.33	32.40	<0.001
CLOTHES	15.09	8.42	35.58	<0.001
ANIMALS	15.14	7.00	47.77	<0.001
BODY PARTS	19.28	9.67	29.96	<0.001

Data presented in order of increasing items generated by the Control group

* (data for three participants [D1, D2, D13] was omitted from the analyses due to these individuals being unable to carry out the Generative Naming task)

A rank ordering was carried out to observe more closely the within-group influence of semantic category on generative naming performance.

The outcomes of the rank ordering are presented in Table 68 and Table 69. The data within each display is ordered by decreasing mean number of nouns generated.

In Table 69, the category rankings for the Control group are displayed alongside the DAT group scores to show the categories on which both groups achieved identical rankings, which were those of : *Body Parts, Clothing, Fruit* and *Furniture.*

TABLE 68
CONTROL SUBJECTS
Rank Ordering for the Categories of the Generative Naming Test

CATEGORY	MEAN	STDEV	RANK
BODY PARTS	19.28	(4.34)	1
ANIMALS	15.14	(3.48)	2
CLOTHES	15.09	(2.55)	3
VEGETABLES	13.00	(3.45)	4
HOUSE OBJECTS	12.95	(3.46)	5
FRUIT	12.71	(2.76)	6
BIRDS	12.28	(3.32)	7
MUSIC	11.62	(2.76)	8
FURNITURE	11.52	(2.50)	9
KITCHEN TOOLS	11.24	(2.79)	10
TRANSPORT	11.09	(2.09)	11
INSECTS	10.43	(2.27)	12
JEWELLERY	8.38	(1.91)	13
TOOLS	8.24	(2.47)	14
FOOTWEAR	7.52	(1.63)	15

TABLE 69
DAT PARTICIPANTS*
Rank Ordering for the Categories of the Generative Naming Test

CATEGORY	MEAN	STDEV	RANK	CONTROLS
BODY PARTS	9.67	(5.68)	**1**	**1**
HOUSE OBJECTS	8.58	(3.75)	2	5
CLOTHES	8.42	(3.89)	**3**	**3**
KITCHEN TOOLS	7.42	(3.37)	4	10
ANIMALS	7.00	(2.79)	5	2
FRUIT	6.42	(2.81)	**6**	**6**
VEGETABLES	6.33	(2.80)	7	4
TRANSPORT	5.58	(2.64)	8	11
FURNITURE	5.42	(2.23)	**9**	**9**
BIRDS	5.08	(2.91)	10	7
JEWELLERY	4.92	(2.71)	11	13
MUSIC	4.83	(3.09)	12	8
TOOLS	4.42	(2.43)	13	14
FOOTWEAR	4.42	(1.31)	14	15
INSECTS	4.33	(3.28)	15	12

* based on N = 12 (data for three participants [D1, D2, D13] omitted from the analyses due to these individuals being unable to carry out the test)

Generative Naming Performance of the Core DAT Group at Retest

Comparison between the Generative Naming Test scores for the six core group DAT participants for whom scores were available at both test sessions, showed a decrease at retest in the mean number of items generated for all except two of the fifteen semantic categories, those of *Fruit* and *Footwear*.

The mean number of nouns generated for each category was subjected to a *Paired samples t-test* analysis to determine whether the differences between initial test and retest were statistically significant.

The analyses did not yield significance for any category, showing that the generative naming performance of the core DAT group did not deteriorate significantly during the time interval (mean 9 months) between initial test and retest.

The statistical findings for the *t-test* are displayed in Table 70. The data is listed in order of decreasing mean items generated at retest.

TABLE 70
Generative Naming Performance
The *Paired samples t-test* Analysis : Core DAT Group at Initial Test and Retest

CATEGORY	Initial Test Mean*	Retest Mean*	t-value (DF = 5)	Probability 2-tail Sig.
CLOTHES	8.00 (3.09)	7.83 (4.45)	.12	.913
BODY PARTS	7.83 (5.67)	7.17 (5.98)	.54	.611
ANIMALS	6.17 (2.48)	6.00 (2.37)	.15	.883
FRUIT	5.00 (1.79)	5.67 (3.01)	-.63	.555
KITCHEN TOOLS	7.00 (2.83)	5.50 (4.37)	.89	.415
HOUSE OBJECTS	6.83 (2.93)	4.83 (3.71)	.97	.377
FURNITURE	5.67 (1.21)	4.50 (2.74)	1.34	.239
FOOTWEAR	4.00 (.89)	4.33 (2.25)	-.50	.638
TRANSPORT	5.33 (3.33)	4.17 (2.86)	1.47	.201
VEGETABLES	5.83 (2.93)	4.00 (3.09)	1.94	.110
JEWELLERY	4.83 (2.23)	3.67 (1.75)	2.44	.058
BIRDS	4.33 (1.75)	3.33 (2.16)	1.07	.332
MUSIC	4.83 (2.32)	3.17 (2.56)	2.19	.080
TOOLS	4.33 (3.14)	2.33 (1.97)	1.39	.223
INSECTS	3.17 (2.56)	2.33 (2.58)	1.54	.185

$p < 0.05$ 2-tail Significance

* Based on N = 6 core group participants who completed the test at both sessions

Analysis of the Variety of Nouns Generated for Each Semantic Category

The mean number of individual nouns generated by the twenty one Control subjects and the six core DAT participants who completed the Generative Naming Test at both initial test and retest sessions are displayed in Table 71. The data is ordered by decreasing number of nouns generated by the Control subjects. The DAT participants generated fewer noun responses at retest for every category except *Footwear* and *Fruit.*

A noun count was then carried out in order to evaluate the variety of different nouns which comprised the responses produced by each group of participants. The noun count was calculated on the basis of nouns generated in accordance with the acceptability criteria stated in the methodology; repetitions differentiated by the use of modifiers such as adjectives (e.g. 'short skirt', 'long skirt') were not counted as separate responses.

Listings of the individual nouns generated by each group of participants for each of the fifteen semantic categories may be found in Appendix 31. The noun listings showed that fewer individual noun types were represented within the responses of the core DAT group at retest for eleven of the fifteen categories, indicating that a smaller range of nouns may have been available for recall. For the categories of *Clothes* and *Footwear*, the responses of the DAT group represented, respectively, two more and one more distinct noun which had not been named at initial test.

TABLE 71
The Noun Count
The Mean Number of Nouns Produced for Each Semantic Category

CATEGORY	CONTROL N = 21	DAT Core Group N = 6 Initial Test	DAT Core Group N = 6 Retest
BODY PARTS	19.28	7.83	7.17
ANIMALS	15.14	6.17	6.00
CLOTHES	15.09	8.00	7.83
VEGETABLES	13.00	5.83	4.00
HOUSE OBJECTS	12.95	6.83	4.83
FRUIT	12.71	5.00	5.67
BIRDS	12.28	4.33	3.33
MUSIC	11.62	4.83	3.17
FURNITURE	11.52	5.67	4.50
KITCHEN TOOLS	11.24	7.00	5.50
TRANSPORT	11.09	5.33	4.17
INSECTS	10.43	3.17	2.33
JEWELLERY	8.38	4.83	3.67
TOOLS	8.24	4.33	2.33
FOOTWEAR	7.52	4.00	4.33

DAT Core Group based on N = 6 participants who completed the test at both sessions

Table 72 displays the nouns which were most frequently cited by the Control subjects, and by the core DAT group participants, at the initial test session.

TABLE 72
The Most Frequently Cited Nouns for Each Semantic Category

CATEGORY	CONTROLS	DAT TRIAL 1 (N = 6)
ANIMALS	cat (17) dog (17) tiger (16) horse (16)	dog (6) cat (5) pig (3) tiger (3)
BIRDS	sparrow (17) pigeon (14)	sparrow (3) robin, blackbird, thrush, canary, pigeon (2)
BODY PARTS	nose (18) ankle (17) leg (17)	leg (5) arm (4) ears (3) eyes (3)
CLOTHING	pants (18) coat (16) trousers (15) skirt (15)	skirt (5) coat (4)
HOUSE OBJECTS	chair (8) table (8) flannel, toothbtush, saucepan (7)	cup (2) saucer (2) plate (2) T.V. (2)
FOOTWEAR	boots (20) shoes (19) sandals (19) slippers (19)	shoe (6) boot (6) slippers (4)
FRUIT	apple(20) pear (18) grapes (15) orange (15) banana (15)	apple (5) pear (5) banana (4)
FURNITURE	table (20) chair (19) bed (15)	chair (6) table (6) sideboard (3) bed (3)

( ) = number of research participants generating the noun response

TABLE 72 (continued)
The Most Frequently Cited Nouns for Each Semantic Category

CATEGORY	CONTROLS	DAT TRIAL 1 (N = 6)
INSECTS	bee (19) wasp (18) spider (17) ant (14)	fly (3) bee (3) wasp (2) worm (2)
JEWELLERY	necklace (19) ring (17) earring (17) bracelet (17)	ring (5) necklace (4) bracelet (4)
KITCHEN TOOLS	frying pan (14) saucepan (14) spoon (13) fork (13) knife (13)	knives (5) forks (4) spoons (4)
MUSIC	piano (19) violin (19) trumpet (16)	piano (5) drums (4)
TOOLS	hammer (18) saw (18) chisel (14)	hammer (5) saw (3) chisel (3)
TRANSPORT	train (21) bus (21) car (20) plane (17)	bus (5) car (3) train (3) bike (3)
VEGETABLES	potato (20) cabbage (18) carrot (18)	carrots (6) potatoes (5) cabbage (5)

( ) = number of research participants generating the noun response

Table 73 displays the noun responses most frequently cited by the six core DAT group participants at each testing session. Noun responses common to both test sessions are marked in bold.

TABLE 73
The Most Popular* Noun Exemplars Generated for Each Semantic Category

CATEGORY	DAT TRIAL 1	DAT TRIAL 2
ANIMAL	**dog (6)** **cat (5)** pig (3) tiger (3)	**dog (6)** **cat (5)** sheep (3) horse (3) mice (3)
BIRDS	**blackbird (2)** **thrush (2) sparrow (3) robin (2)**	**blackbird (3)** **thrush (3) sparrow (2) robin (2)**
BODY PARTS	**leg (5)** **arm (4)**	**legs (5)** **arms (5)** neck (4)
CLOTHING	**coat (4)** skirt (5)	**coat (4)** shoes (4)
HOUSE OBJECTS	cup (2) saucer (2) plate (2) T.V. (2)	chair (3) table (2) bed (2) saucepan s (2)
FOOTWEAR	**shoe (6)** **boot (6)** **slippers (4) sandals (3)**	**shoes (6)** **boots (4), sandals (4)** **slippers (3)** Wellingtons (3)
FRUIT	**apple (5)** **pear (5) banana (4)**	**apple (6)** **pear (5) banana (5)** orange (5)
FURNITURE	**chair (6)** **table (6)** **bed (3)** sideboard (3)	**chair (5) bed (5)** **table (4)** armchair (3)

( ) = number of research participants generating the noun (N = 6 participants)

* = all responses generated more than once

TABLE 73 (continued)

The Most Popular* Noun Exemplars Generated for Each Semantic Category

CATEGORY	DAT TRIAL 1	DAT TRIAL 2
INSECTS	**fly (3)** bee (3) **wasp (2) worm (2)**	**worm (3)** **wasp (2) fly (2)** spider(2)
JEWELLERY	**ring (5)** **necklace (4)** **bracelet (4)**	**ring (3)** **necklace (4)** **bracelet (3)**
KITCHEN TOOLS	**knives (5)** **forks (4)** **spoons (4)**	**knife (4)** **fork (4)** **spoon (3)**
MUSIC	**piano (5)** drums (4)	**piano (4)**
TOOLS	**hammer (5)** **chisel (3)** saw (3)	**hammer (3)** **chisel (2)**
TRANSPORT	**bus (5)** **car (3) bike (3) train (3)**	**bus (5)** **car (4) bicycle (3) train (3)**
VEGETABLES	**carrots (6)** **potatoes (5) cabbage (5)**	onions (4) **carrots (3)** **potatoes (3)**

( ) = number of research participants generating the noun (N = 6 participants)

* = all responses generated more than once

The Noun Map for the Core DAT Group

A 'noun map' was constructed from the noun responses given by the core DAT group of six participants who completed the Generative Naming Test at both test sessions. The noun map was completed in order to identify the 'core' vocabulary items generated at both test sessions, and thereby reflect the category exemplars which remained accessible from the lexical store despite advancing duration of dementia.

Table 74 displays the noun map for each semantic category.

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

ANIMALS

DAT TEST 1

	dog (6)	cat (5)		
	pig (3)	tiger (3)		
	horse (2)	monkey (2)	lion (2)	bird (2)
Frequency = (1)	donkey	antelope	elephant	
	cow	giraffe	kangaroo	
	lamb	zebra	fish	
	kitten	camel	walrus	

DAT TEST 2

	dog (6)	cat (5)	
	sheep (3)	horse (3)	mice (3)
	rabbit (2)		
Frequency = (1)	lion	gorilla	cow
	tiger	chimpanzee	pony
	giraffe	orangutan	pig
	kangaroo	monkey	donkey
	seals	rat	

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

BIRDS

DAT TEST1

sparrow (3)

robin (2) blackbird (2) thrush (2) canary (2) pigeon (2)

Frequency = (1)

swan	raven	bluebird
crow	swallow	penguin
owl	blue tit	wren
dove	parrot	
woodpecker	nightingale	

DAT TEST 2

thrush (3) blackbird (3)

sparrow (2) robin (2)

Frequency = (1)

owl	budgie
nightingale	blue tit
canary	swallow
pigeon	swan
parrot	cuckoo

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

BODY PARTS

DAT TEST 1

leg (5)	arm (4)		
ears (3)	eyes (3)		
head (2)	hands (2)	feet (2)	fingers (2)
elbow (2)	knee (2)	nose (2)	neck (2)

Frequency = (1)

shoulders	face	thigh	waist
back	chin	bust	heart
toes	mouth	hip	lungs
ankle	teeth	stomach	chest

DAT TEST 2

arms (5)	legs (5)			
neck (4)				
fingers (2)	elbow (2)	head (2)	eyes (2)	nose (2)
feet (2)	ankles (2)	chest (2)	hip (2)	

Frequency = (1)

toes	face	hands
joints	wrist	backbone
knees	thigh	ears
stomach	back	hip

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

CLOTHES

DAT TEST 1

skirt (5)				
coat (4)				
blouse (3)	cardigan (3)	hat (3)	shoes (3)	trousers (3)
dress (2)	stockings (2)	vest (2)	jumper (2)	

Frequency = (1)

underwear	petticoat	knickers	shorts
bra	bag	tunic	overalls
pants	mac	kilt	apron
corset	costume	jersey	blazer

DAT TEST 2

coat (4)	shoes (4)			
dress (3)	socks (3)	stockings (3)		
pinafore (2)	pants (2)	hat (2)	corset (2)	vest (2)
knickers (2)	boots (2)			

Frequency = (1)

gloves	mac	bedsocks
scarf	dressing gown	cardigan
slip	nightdress	anorak
blazer	jacket	blouse
trousers	sandals	suit
pullover		

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

FOOTWEAR

DAT TEST 1

shoe (6)	boot (6)
slippers (4)	
sandals (3)	
Frequency = (1)	
socks	moccasin
ankle boot	Wellington boot
court shoe	

DAT TEST 2

shoes (6)	
boots (4)	sandals (4)
slippers (3)	Wellingtons (3)
galoshes (2)	
Frequency = (1)	
stockings	sunshoe
moccasin	lace-ups

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

FRUIT

DAT TEST1

apple (5) pear (5)

banana (4)

plum (2) orange (2) peach (2)

Frequency = (1)

tomato	melon
tangerine	cherry
greengage	strawberry
grapes	gooseberry
pineapple	blackcurrant

DAT TEST 2

apple (6)

orange (5) banana (5) pear (5)

grape (2)

Frequency = (1)

lemon	cherry	plum
mango	peaches	gooseberry
tangerine	blackcurrant	pomegranate
grapefruit	fig	

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

FURNITURE

DAT TEST 1

table (6) chair (6)

sideboard (3) bed (3)

armchair (2) settee (2) stool (2)

Frequency = (1)

coffee table	cot
footstool	pouffee
dresser	suite
cupboard	fire
door	lamp

DAT TEST 2

chair (5) bed (5)

table (4)

armchair (3)

settee / sofa (2) sideboard (2)

Frequency = (1)

wardrobe	cot
dresser	dressing table
couch	coffee table

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

HOUSEHOLD OBJECTS

DAT TEST 1

cup (2)	saucer (2)	plate (2)	television (2)	
Frequency = (1)				
knife	sugar basin	cloth	telephone	handbrush
fork	jug	dishcloth	cupboards	feather duster
spoon	teapot	floorcloth	sideboard	
frying pan	brush	duster	table	
saucepan	comb	shoes	chair	
glass	coathanger	clock	broom	

DAT TEST 2

chair (3)				
table (2)	bed (2)	saucepans (2)		
Frequency = (1)				
knives	plates	pans	curtains	handbrush
forks	cups	cans	brush	scrubbing brush
spoons	saucers	floor cloth	comb	toilet brush
kettle	dishes	dish cloth	duvet	bucket

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

INSECTS

DAT TEST1

bee (3)	fly (3)	
wasp (2)	worm (2)	
Frequency = (1)		
ant	gnat	spider
butterfly	mosquito	caterpillar
snail	bug	moth

DAT TEST 2

worm (3)		
spider (2)	fly (2)	wasp (2)
Frequency = (1)		
ant	mosquito	
bee	butterfly	
flea		

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

JEWELLERY

DAT TEST 1

ring (5)		
necklace (4)	bracelet (4)	
brooch (3)	earrings (3)	
watch (2)	crown (2)	chain (2)

Frequency = (1)
tiara
anklet
stud
cross

DAT TEST 2

necklace (4)			
bracelet (3)	ring (3)		
chain (2)	pearls (2)	earring (2)	watch (2)

Frequency = (1)
brooch
scarf ring
medal
locket

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

KITCHEN TOOLS

DAT TEST 1

knives (5)

forks (4) spoons (4)

pans (2) kettles (2) pot (2) plates (2)

Frequency = (1)

scales	frying pan	towel
sieve	chip pan	wash-up bowl
baking tin	brush	cups
rolling pin	scrubbing brush	saucers
kettle	scraper	crockery
bowl	dishes	saucepan
dish	jars	glasses

DAT TEST 2

knife (4) fork (4)

spoon (3)

tablespoon (2) saucepan (2)

Frequency = (1)

cup	ladle	teaspoon
saucer	carving knife	toaster
plate	slicer	frying pan
dishes	grater	pans
basin	masher	gas stove
pots	fish slice	kettle

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

MUSIC

DAT TEST 1

piano (5)

drums (4)

cello (2)	organ (2)	trombone (2)	violin (2)

Frequency = (1)

accordion	maracas
banjo	flute
saxophone	clarinet
bugle	mouth organ
tambourine	trumpet
cymbal	whistle

DAT TEST 2

piano (4)

Frequency = (1)

trumpet	accordion	drum
oboe	cornet	triangle
bugle	cello	organ
horn	harp	xylophone
flute	violin	mouth organ

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

TOOLS

DAT TEST 1

hammer (5)

saw (3) chisel (3)

screwdriver (2) nails (2) spade (2)

Frequency = (1)

hacksaw	drill	scissors
ruler	scraper	shears
rake	pliers	hoe

DAT TEST 2

hammer (3)

chisel (2)

Frequency = (1)

saw	drill	scissors
spanner	pliers	nail
file	chopper	torch

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

TRANSPORT

DAT TEST 1

bus (5)

car (3) bike (3) train (3)

coach (2) plane (2) boat (2) ship (2)

Frequency = (1)

tram	scooter
airplane	sled
caravan	toboggan
motorbike	balloon
trolley bus	pram

DAT TEST 2

bus (5)

car (4)

bicycle (3) train (3)

plane (2) boat (2)

Frequency = (1)

tram	motorbike
lorry	glider
coach	canoe

TABLE 74
THE NOUN MAP
The Core DAT Group : Initial Test and Retest

VEGETABLES

DAT TEST1

carrots (6)

potatoes (5) cabbage (5)

peas (4)

onions (3)

turnip (2) tomatoes (2)

Frequency = (1)

swede	beetroot
beans	cucumber
parsnips	sprouts
artichoke	greens

DAT TEST 2

onions (4)

potatoes (3) carrots (3)

cabbage (2) tomatoes (2) cucumber (2)

Frequency = (1)

cauliflower	marrow
leeks	beetroot
beans	lettuce
peas	turnips

DISCUSSION

This research evaluated the performance of a group of fifteen people aged over 65 years and with a diagnosis of probable dementia of the Alzheimer type (DAT) against the performance of a group of twenty one normally ageing people on two test batteries:

- a series of standardised cognitive and language measures in routine clinical use with older people
- a battery of semantic tests designed by the research author, focusing on the recognition and recall of concrete nouns

The research design incorporated the following longitudinal and qualitative analyses:

- comparisons between the performance of normal older people representing each of three age spans between 65 and 85+ years to detect any age-related differences
- comparisons between the performance of people at varying levels of dementia severity to detect the effects of increasing cognitive decline upon lexical processing
- comparison between the performance of people with DAT at initial testing and after an interval to analyse the effect of increasing duration of disease on performance

Specific hypotheses were raised regarding expectations in performance of the people with dementia on the cognitive and semantic measures :

- in relation to the Control subjects
- at retest, relative to their initial performance
- at increasing levels of dementia severity

This section will discuss the findings in the context of the research hypotheses.

General Findings with Respect to the Research Populations

- Homogeneity Between the Control and DAT Research Populations

The methodological criteria for the research ensured that the research participants selected to form the Control and DAT groups were true representatives of the populations of, respectively:

- ♦ healthy ageing individuals between the ages of 65 to 90 years, and who are not experiencing cognitive deficits
- ♦ individuals aged over 65 years who have in common a diagnosis of probable dementia of the Alzheimer type at one of four levels of severity as the probable cause of their cognitive and functional difficulties,

in addition to being closely matched with respect to the demographic variables of sex, age, education and occupational background and pre-morbid intellectual capacities, in order to minimise the possible influences of these factors upon cognitive and linguistic performance and therefore isolate DAT as the causative factor underlying deficits in cognitive and linguistic functioning.

- Sex Distribution of the Research Participants

The research participants in both groups were predominantly female (more than 60% in each group) and the DAT group comprised a higher proportion of female individuals (12 / 15 = 80%) compared with the Control group (13 / 21 = 62%).

It did not prove possible to recruit higher numbers of male participants whilst staying within the methodological subject selection criteria.

However this may be taken as a reflection of current population trends with respect to the relative proportions of males and females forming the population of older people in the community and therefore the trend for a higher number of females among those older people presenting with dementing disease.

There do not appear to be findings in the available research suggesting that the sex of individuals with dementia is a significant factor in influencing performance outcomes.

- Age Characteristics of the Research Participants

The mean age of the Control subjects was 76.67 years (range 65 - 87 years) and was thus slightly lower than the mean age of the people with DAT which was 78.40 years (range 68 - 88 years). However, the variation was small and therefore the assumption of homogeneity of age distribution for both subject populations was met.

- Educational Characteristics of the Research Participants

The majority of subjects in both groups (15 / 21 Controls and 10 / 15 DAT participants) were aged fourteen years at the time of leaving school, and therefore the assumption of homogeneity was met with respect to educational characteristics.

The mean school leaving age for the Control group (14.25 years) was slightly lower than the mean for people with DAT (15.27 years).

The lower mean obtained for the Control group was attributable to the data from one participant who left school at the age twelve. In addition, one DAT participant pursued a university qualification and was 21 years old when completing education, and two DAT participants were eighteen years of age when completing their education, in contrast with only one subject from the Control group.

- Occupational Characteristics of the Research Participants

It was acknowledged that some diversity was observed within the Control and DAT populations with respect to past occupational background, such that a range of occupations was represented within each group.

A breakdown by occupations for individual research participants within the Control and DAT groups showed that the majority of Control subjects (9 / 21) had been employed in clerical and office posts, whereas within the DAT group there was greater variety, with the highest proportion of participants (4 / 15) having employment experience in factories and manual work.

- Premorbid Intelligence of the Research Participants

Beardsall and Brayne (1990) and Crawford, Parker, Allan, Jack and Morrison (1991) attest to the accuracy of the Short NART (Beardsall and Brayne, 1990) in estimating pre-morbid intelligence or IQ, which in turn can be used for gaining a measure of 'true cognitive decline' in dementia (Beardsall and Brayne, 1990).

The 25-item Short NART was therefore included as a cognitive measure in this research in order to fulfil the following objectives:

- to gain a measure of pre-morbid intellectual abilities in both groups
- to establish that the two research populations represented homogeneous groups

with respect to their intellectual abilities (IQ)

Having established the latter premise, it could then be concluded that decrements observed in the performance of the DAT group in relation to that of the Controls on the cognitive measures could be predominantly attributed to cognitive deficits consequent upon dementia.

The Short NART scores yielded a lower mean predicted IQ for the DAT participants (89.2 [range 75 - 101]) compared with the Control subjects (102.5 [range 90-101]). However, this observed difference in predicted IQ could be attributable in part to the previously noted variance between the two groups with respect to occupational background. Thus, although the DAT group completed a higher mean number of years of schooling than the Controls, nevertheless a higher proportion of the people with DAT represented the occupations of manual and factory work. This occupational trend could in turn have influenced the scores achieved by particular DAT research participants, for example in terms of their familiarity with the low-frequency vocabulary items included in the Short BPVS, and with words with irregular pronunciation of the type included in the Short NART.

Hypotheses with Respect to the Performance of the Control Subjects

The research expectations were for high levels of accuracy in the performance of the Control subjects on every test included in both research batteries. It was further expected that any decrements would be observed in the performance of the oldest Control subjects, those aged 85 years and older.

- The Baseline of Functioning Characterising Healthy Ageing

The Control subjects achieved ceiling or near-ceiling scores on every test in the research protocol. Comparative analysis between the test scores of the Control subjects within each of the three age-bands between 65 and 85+ years did not reveal significant performance decrements associated with advancing age.
These findings fulfilled the prediction that the standardised cognitive tests, and the semantic tests devised for the research, could be completed without difficulty by normally-ageing and functionally independent subjects over the age of 65 years.
Furthermore, the high levels of accuracy observed in the performance of the Control subjects on the tests of the Experimental Battery for Semantic Processing confirmed that the abilities tested by the semantic measures (naming objects from familiar semantic categories, free recall of items from those categories, and recognising objects from those categories by their attributes of category and distinctive feature) remain well-preserved during the normal ageing process.

Therefore, any deficits exhibited by the people with Alzheimer-type dementia on the semantic tests in relation to the baseline established by the Control subjects could be attributed to the presence of Alzheimer-type dementia, indicating that these tests are sensitive to the semantic processing deficits which accompany the disease process.

Hypotheses with Respect to the Performance of the DAT Participants

It was predicted that the people with DAT would demonstrate significant performance deficits in relation to the Controls on the cognitive and linguistic measures relating to orientation to time, place and events (CAPE Orientation Test), level of dependence in functional activities (CAPE Physical Disability Scale), the comprehension of low-frequency vocabulary (British Picture Vocabulary Scale) and the free recall of nouns belonging to semantic categories (Set Test).

It was also expected that the DAT participants would show a further performance decrement at retest, in relation to initial test performance, on the cognitive measures relating to level of orientation and level of dependence in functional activities.

- Evaluation of Orientation Levels using the CAPE Orientation Test

Statistical analysis confirmed the prediction of a significant decrement ($p < 0.01$) between the test scores of the DAT participants and the normally ageing subjects.

As predicted, the Control group obtained near-ceiling scores on the CAPE Orientation Test (Control mean = 11.57) showing that everyday orientation (place, current date) and autobiographical memory (name, age, date of birth) can be expected to remain intact through each decade of normal ageing.

Furthermore, the Control group showed consistency in their errors as the only two items missed on this test were those of naming 'The Prime Minister' and 'The President of the United States of America'.

Analysis of the performance of Control subjects by age-bandings failed to detect a significant decrement in test scores associated with advancing age on this test.

In accordance with the experimental prediction of increasing performance deficits on the CAPE Orientation Test with advancing severity of dementia according to the GDS, an overall decrease in mean CAPE score with progression of dementia was confirmed. Thus, the most severely cognitively impaired subgroup (GDS 5) achieved scores representing only 33% of those obtained by the least cognitively impaired subgroup (GDS 2). However, these differences in mean CAPE scores between each of the severity subgroups were not statistically significant.

Although a high positive correlation was established between the duration of DAT and GDS rating of cognitive decline, a non-significant correlation coefficient was obtained in a comparison which examined for any association between duration of dementia and CAPE Orientation Test score. Taken together, the findings reflect the variability in progression and manifestations of the dementia process with respect to the cognitive functioning of individuals who may be clinically evaluated as being at the same stage of cognitive decline.

Approximately half (46%) of all responses to the CAPE test items from the DAT group were erroneous responses. A qualitative analysis of the types of errors made by the DAT participants on the CAPE Orientation Test provided further confirmation of specific decrements in relation to normally ageing individuals.

Thus, the people with DAT made errors on every one of the twelve test items except the first item 'Your Name' to which every participant responded correctly both on initial testing and at retest. The majority of the DAT participants were unable to respond correctly to questions assessing knowledge of the current day, month, and year; similarly, the majority of the group were unable to correctly respond to the question about their age. In contrast, all the normally-ageing patients responded correctly to these test items.

These findings are in accordance with descriptions of the cognitive decline in Alzheimer-type dementia which identify memory deficits as the earliest noticed signs of disease (Jorm, 1987), with disorientation to events in the environment and recent activities an early feature of the condition (Bennett, 1989).

- Analysis of CAPE Physical Disability Scale Ratings

The CAPE Physical Disability Scale (PD Scale) incorporates a total of six measures relating to mobility, self-care and behaviour during the day.

All the Control subjects were maintaining independent routines in their own homes and confirmed the experimental expectation of independent everyday functioning in the normal elders. They were all evaluated as fulfilling the criteria for Dependency Grade A (No Impairment) on the CAPE PD Scale.

In accordance with the research expectation, the people with DAT demonstrated increased dependence in everyday functioning in relation to the normal subjects. None of the group fulfilled the criteria for Grade A (no impairment; independent elderly living without support in the community) on the CAPE PD Scale.

At initial testing with the CAPE PD Scale, all except one of the DAT participants were rated as low (Grade B) to medium dependency (Grade C). When initially approached, all these participants were either supported by a main carer in their own homes, or resident in sheltered (warden controlled) accommodation. In addition, all except two of the DAT group were supported by at least once weekly attendance at a local day centre.

One participant (Participant D9) was rated as high dependency (Grade D) at entry to the research and was resident in a nursing home, thus demonstrating the reduction in functional abilities which can be consequent upon disease progression (duration of DAT at initial testing was 36 months).

- Comparative Analysis Between Initial and Retest CAPE Sub-tests Performance

The prediction was put forward that the DAT participants would show a decline in both orientation scores and level of functional independence (as measured by the CAPE) at retest, which occurred at a mean interval of nine months after initial testing, and that this decrement would be attributable to disease progression over time.

Earlier analysis of the relationship between the duration of dementia and scores on the CAPE Orientation Test, carried out at initial testing, had yielded a non-significant Pearson Correlation Coefficient (-0.127) from which it was concluded that duration of dementia was not a strong indicator of performance on this cognitive measure.

Ten of the DAT participants were able to proceed at retest with the CAPE Orientation Test and CAPE Physical Disability Scale measures. The prediction of a deterioration in orientation levels over time was only partially fulfilled, as only 60% of the DAT retest group achieved a lower CAPE Orientation Test score. Three participants actually maintained their initial test performance scores at retest, while one participant (Participant D9) achieved a higher orientation score (one point increase) at retest. This outcome was unexpected as Participant D9 was nearly four years post-onset when approached for retest and was also one of the three most severely cognitively impaired participants at entry to the research, presenting at GDS 5 (moderately severe cognitive decline).

On the CAPE Physical Disability Scale , only two DAT participants were evaluated as having progressed to a higher dependency level at retest.
One of these two was Participant D9 (duration of DAT at retest was 45 months) who moved from High Dependency (Grade D) to Maximum Dependency (Grade E). The other, Participant D10 (duration of DAT at retest was 48 months) moved from Medium Dependency (Grade C) to High Dependency (Grade D).

Therefore for both these individuals an overall duration of dementia of about four years was associated with observable decline in daily life coping skills and, as a consequence, a high level of dependence on caregiver support.

This was confirmed by a move from home into respite care, and eventually nursing home admission, for Participant D10. Participant D9 was being cared for in a nursing home at entry to the research. Neither of these individuals was able to complete the full research procedure at retest.

The same findings were not observed, however, with respect to the progress of two other participants in the group with a comparable duration of dementia at retest. These patients (Participant D3: duration of dementia at retest was 45 months; Participant D13: duration of dementia at retest was 47 months) maintained their initial CAPE Physical Disability Scale ratings at retest (Participant D3 : Grade C [Medium Dependency]; Participant D13 : Grade B [Mild Dependency]) and both were able to complete the full research procedure at retest.

Thus for both these individuals with Alzheimer-type dementia a duration of disease of about four years was not accompanied by a deterioration in daily life functioning of sufficient level to necessitate a change in living circumstances, and both individuals continued to live in their existing residential settings: Participant D3 in warden-controlled accommodation and Participant D13 at home with their principal carer.

The remaining six participants who were evaluated at retest presented with a duration of dementia which ranged from 18 months to 34 months. All were rated with reference to the CAPE Physical Disability Scale as remaining at their previous level of physical dependency (Grade B or Grade C), even though three were rated as having progressed to a greater level of cognitive decline at retest according to the GDS.

In summary, over the retest time interval of eight months or more, nine of the ten participants retained a level of independence which enabled them to continue managing in their existing residential circumstances (in their own home or in sheltered accommodation) with carer support. For one participant, the deterioration measured in level of functional dependence between initial test and retest corresponded with a decline in that person's ability to manage in existing residential circumstances and ultimately made a move into an alternative care setting necessary.

Evaluation of the Severity of Cognitive Decline (GDS Ratings) at Retest

With respect to GDS ratings of severity of cognitive decline, at retest three of the ten participants had progressed to the next stage of the GDS, representing a greater level of cognitive decline. All three participants were in the earlier stages of cognitive decline (GDS 2 - 3) at entry to the research. Two participants who initially presented at GDS 3 (Mild) progressed to GDS 4 (Moderate), and the remaining participant progressed to GDS 3 (Mild) from an initial presentation of GDS 2 (Very Mild).

This decline in cognitive status according to GDS rating was also accompanied by a decline in CAPE Orientation Test score for the participant who progressed from GDS 2 to GDS 3, and for one of the two participants who progressed from GDS 3 to GDS 4, thus confirming a deterioration in cognition which was clinically measurable. As these participants completed the retest procedure within an interval of ten months after initial testing, these findings showed a relatively fast pace of DAT progression with respect to clinically measurable decline.

However, those participants who presented as more severely cognitively impaired (GDS 4 [Moderate] and GDS 5 [Moderately Severe]) at entry to the research were noted to maintain their GDS ratings for the duration of their participation in the research. Also included in this subgroup were the two individuals (Participant D9 and Participant D10) who were rated as being the most severely cognitively impaired (GDS 5) at initial testing, and were the only individuals in the group to demonstrate a deterioration with respect to their CAPE Physical Disability Scale ratings at retest.

Thus it may be concluded that for some of the DAT group, a time interval of around eight to nine months was associated with a deterioration in cognitive functioning which was measurable in terms of a clinical evaluation rating tool (the GDS).
These collective findings again verify the variability of progression of dementia of the Alzheimer type in individuals in relation to its effects on both cognition and daily life functioning.

Other Considerations with Respect to the Retest Performance of the DAT Group

Further changes in the responses of the DAT participants to testing were observed at retest. As previously pointed out, not all of the original DAT group participants were able to complete the full procedure at retest.

In some cases this appeared to be due to a combination of reduced attention span and reduced tolerance to testing, despite the same participants having completed the full test procedure at about nine months previously.

In accordance with the principles of testing applied throughout the research procedure, testing was abandoned if the participant showed signs of fatigue, or anxiety due to difficulty in responding to the test items.

Some DAT group members were unable to participate at retest due to sudden deterioration in their health, cognitive and functional status, which necessitated admission to hospital or a move into respite care. As a result of such deterioration it was not appropriate to continue participation in the research procedure.

Heterogeneity of Disease Progression in the DAT Participants

Examination of the findings from individual DAT participants with respect to disease progression and patterns of performance as evaluated by clinical rating tools (CAPE, GDS Scale), confirmed the heterogeneity which has been noted to characterise Alzheimer-type dementia in both in its rate and manner of progression.

The following case examples from the research demonstrate that increasing duration of disease is not a reliable predictor of either level of disease severity or level of success on measures of cognitive and functional ability.

Case Example : Participant D13

Despite a reported duration of 34 months at entry to the research, this participant was evaluated as being at GDS Stage 2 (very mild) and obtained a perfect score on the CAPE Orientation Test (12 / 12) and a low dependency score (Grade B) on the CAPE Physical Disability Scale. At retest one year later at a duration of nearly four years post-onset (47 months), this participant maintained high levels of performance as evident from a score of 10 / 12 on the CAPE Orientation Test and ratings of very mild cognitive impairment (GDS 2) and low dependency (Grade B).

Case Example : Participant D14

This participant presented with the shortest reported duration of disease at initial testing (6 months post-onset) and achieved a score of 8 / 12 on the CAPE Orientation Test but was evaluated as GDS Stage 4 (moderate cognitive impairment) and medium dependency level (Grade C) according to the CAPE Physical Disability Scale.
This individual was unable to participate in the research procedure when approached approximately eight months later for retest, due to a sudden overall decline in health and cognitive abilities which necessitated admission to hospital and the possibility of a future move into a residential care setting.

Case Example : Comparison between Participant D7 and Participant D3

Participants D7 and D3 presented with a difference in time span of 24 months with respect to duration of disease at entry to the research; thus the duration of disease was 12 months for Participant D7 and 36 months for Participant D3.
Both individuals participated in retest after a time interval of nine months. At retest, both were evaluated as being moderately severely cognitively impaired (GDS 4) and both demonstrated comparable levels of success with respect to the CAPE Orientation Test, obtaining a score of 3 / 12 which was the lowest within the DAT group and indicative of severe disorientation. The two participants shared this score despite great variability in duration of disease at retest (21 months for Participant D7 and 45 months for Participant D3). However, neither participant was found to have deteriorated with respect to initial CAPE Physical Disability Scale rating at retest.

Clinical diversity has been widely acknowledged in the research literature as an essential characteristic of the disease entity of dementia of the Alzheimer type (Schwartz, 1990; Bryan & Maxim, 1996). Research has shown Alzheimer-type dementia to be clearly heterogeneous in terms of its presentation, progression and neurological deficit profile (Chertkow and Bub, 1990). Furthermore, there are increasing indications that Alzheimer's disease is not one but a complex of disease states. Thus, people with DAT at a comparable stage of impairment may show qualitatively different profiles characterised by impaired function in one cognitive domain but preserved abilities and skills in another. Such findings have been taken to support the existence of a taxonomy of neuropsychologically defined subgroups comprising clusters of individuals with common profiles (Martin, 1990).

It has been suggested that the clinical manifestations of DAT are a function of the locus, density, pace and pattern of spread of degenerative changes; these changes may be quite selective in their sites and mechanisms of action, and such selectivity has important functional consequences (Schwartz, 1990).

The observed heterogeneity of presentation of Alzheimer-type dementia has implications for both research methodology and clinical interventions with this disease (Martin, 1990). Thus any study of DAT must allow for qualitatively different patterns of impairment, both in the performance of individuals who obtain extreme scores within a group, and also in the identification of sub-groups with similar patterns of impairment.

This research attempted to control for both aetiological and disease severity factors in order to obtain a homogeneous group of people with a diagnosis of probable dementia of the Alzheimer type, reached by the exclusion of other possible causes of dementia. In so far as this objective was met by the chosen DAT group participants, then it may be concluded that the research findings with respect to rate and manner of disease progression attest to the variability of this type of dementia in its pattern of manifestation in individual cases.

Qualitative differences were evident in the cognitive and functional performance profiles of the participants both at initial testing and at retest, therefore supporting the heterogeneity which has been argued in the recent literature on Alzheimer-type dementia.

The identification of subgroups is a further consideration in the evaluation of the DAT participants' performance on the tests comprising the Standard Measures Battery for Cognitive and Language Function and the Experimental Battery for Semantic Processing of this research.

Performance of the DAT Participants on the Remaining Standard Measures

Three tests included in the Standard Measures Battery for Cognitive and Language Function provided measures of lexical recognition and recall by the DAT participants, specifically :

- the ability to select the correct pictorial representation of a low-frequency lexical item on presentation of its spoken name (Short British Picture Vocabulary Scale)
- the ability to infer a semantic association between pictured nouns (Pyramids and Palm Trees Test)
- the ability to recall nouns from a specified semantic category (Set Test)

The research expectations were for significant performance deficits in the performance of the DAT participants in relation to the Controls on these cognitive measures. As predicted, statistical analysis showed that the performance of the DAT group was significantly lower than that of the Control group at a significance level of $p < 0.01$ on the Pyramids and Palm Trees and all four categories of the Set Test; the analyses were significant at $p <0.05$ for the Short BPVS.

- Performance on the Short British Picture Vocabulary Scale (BPVS)

The shortened version of the BPVS examines knowledge of a range of vocabulary (nouns, verbs, adjectives, adverbs) in the context of 32 spoken word-to-picture-matching test stimuli and requires participants to select the target word from a choice of four picture stimuli upon hearing only the target word, that is in the absence of further cueing.

It was predicted that the DAT participants would show a significant decrement on this test due to difficulties with auditory recognition of the lower-frequency, relatively 'uncommon' vocabulary items which are included in this test.
The statistical analyses for the Short BPVS were based on the scores of only eleven participants; for four participants testing was ceased due to their extreme difficulty in responding to test items, or their indication that they did not wish to proceed further.

Examination of initial Short BPVS scores showed that for the majority of DAT participants vocabulary comprehension remained preserved at a high level (74% or higher) relative to the baseline performance established by the Control subjects.
Thus, seven participants from the test group of eleven achieved scores representing 91% or higher of the Control mean for this test.
However, for two participants, vocabulary comprehension skills were severely impaired. They achieved scores representing 50% or less of the Control mean.
Thus, Participant D9 scored at 50% of the Control mean and Participant D7 scored at 24% of the Control mean. The variant scores achieved by these individuals may have accounted for the findings of statistically significant decrements in relation to the Control group. Examination of the performance of these two participants on the CAPE Orientation Test also confirmed correspondingly low scores indicating severe disorientation (Participant D7 scored 4 / 12 and Participant D9 scored 3 / 12).
Participant D9 was evaluated at GDS Stage 5 (moderately severe cognitive decline) at entry to the research, which could explain the low score on the Short BPVS.

However, Participant D7 was rated at GDS Stage 3 (mild cognitive impairment) at entry to the research and therefore a receptive vocabulary score of 24% of the Control mean was indicative of a specific impairment of picture processing abilities which compromised spoken word recognition in the context of picture selection. This participant was noted to experience consistent difficulties with the processing of picture stimuli, a pattern of impairment which was maintained throughout the research.

- Qualitative Analysis of Errors made by the DAT Participants on the Short BPVS

The Short BPVS gives the opportunity to observe word frequency effects. Examination of the frequency and type of errors on this test revealed that the Control group made a total number of errors representing only 6% of total possible responses (total responses = 32 items x 21 subjects). The majority of these errors (75.6%) occurred on the final four test items, which are the lowest frequency words on the test and relatively uncommon items of vocabulary. The final test item, "saltation", has particularly low imageability.

The four final items are :

Item 29 = ambulation

Item 30 = apparition

Item 31 = emission

Item 32 = saltation

The number of errors made by the DAT participants (93 errors) represented one quarter or 26.4% of all responses (total responses = 32 items x 11 participants) which represented a proportion four times greater than the number of errors made by the Controls. In addition, analysis of the error distribution for the DAT participants revealed that errors occurred on nearly every vocabulary item (23 items from a total of 32) on the test. None of the participants scored incorrectly on the first six test items, which consisted of five common objects (ball, bucket, camera, car, envelope) and one familiar adjective (wooden).

Following the pattern established by the Control subjects, the DAT participants were also noted to make the highest frequency of errors on the final four, lowest-frequency vocabulary items.

These results demonstrate the vulnerability of receptive language skills, specifically the comprehension of lower-frequency lexical items, during the course of Alzheimer-type dementia. Research has confirmed the relative vulnerability of low-frequency vocabulary to the effects of DAT. For example, word frequency has been shown to have an important effect on naming skills, with individuals with dementia showing greater impairment when required to recall less frequent words in naming tasks (Barker and Lawson, 1968; Funnell,1990; Kirshner et al, 1984; Skelton-Robinson and Jones, 1984).

- Performance on the Pyramids and Palm Trees Test

The set of thirty stimuli selected from the picture to picture matching subtest of this test comprised nouns which are paired associates and whose semantic relationship can be readily inferred by individuals with intact semantic processing abilities.
This expectation was confirmed by the performance of the Control subjects, as all except two of the Control group performed without error, and the two subjects who did not achieve a perfect score produced a combined total of only three errors.
A significant performance decrement at $p < 0.01$ was evident in the mean score achieved by the DAT group at initial testing relative to the Control baseline.
This significant decrement relative to the Control baseline suggested an underlying impairment in the ability of individuals with a mild to moderately severe level of cognitive decline to infer associative links between pictorially presented nouns.

However, examination of individual scores showed that, with the exception of two low-scoring participants, all of the group actually achieved scores representing 60% or greater of the Control baseline, and two participants obtained perfect scores.
The very low levels of success obtained on the Pyramids and Palm Trees Test at initial testing by two of the group, Participant D7 and Participant D10, in relation to both the Control baseline and the DAT group mean, suggested the existence of an underlying impairment in the ability to deduce semantic associations between pictorially presented noun stimuli.

However, such a deficit did not characterise the performance of every DAT participant, as confirmed by the performance of the remainder of the group and in particular the two participants who performed without error, Participant D8 and Participant D15.

The case examples which follow illustrate the above points.

Case Example : Participant D7

Participant D7 presented with a mild level of cognitive decline (GDS 3) and low dependency (Grade B) at initial entry to the research, at which time duration of dementia was 12 months. However, the score achieved by this participant on the Pyramids and Palm Trees Test was the lowest in the group, representing only 9.4% of the Control mean and 13% of the DAT mean. Participant D7 was also previously noted to obtain the lowest score within the group on the Short BPVS at initial testing, thus indicating the existence of specific difficulties on tests which utilised picture stimuli to access lexical knowledge.

Qualitative analysis of this participant's responses showed a tendency to focus on small details and selected parts of picture stimuli, and a difficulty in collating what was perceived in order to both derive a meaningful composite picture from the stimulus and retrieve the appropriate lexical item.

The following examples demonstrate this participant's tendency to focus on isolated parts of the target object rather than processing the perceived object as a whole:

Pictured Noun	Response from Participant D7
ice skate :	"looks like a *toy rail* for children"
ladybird :	"lots of little ones with these *blobs on*"
slipper with bobble top :	"with *hair* around"
woodpecker :	"Who's this man in *black*; they've got *goggles*"

Case Example : Participant D10

Although this participant obtained a higher Pyramids and Palm Trees Test score than Participant D7, nevertheless the score of 9 / 30 represented only 28% of the Control mean and 38.6% of the DAT group mean. However, Participant D10 was evaluated with reference to the GDS as being one of the three most severely cognitively impaired participants in the group (GDS 5: moderately severe cognitive decline) at entry to the research. This participant also presented with the longest duration of DAT both at initial entry to the research (42 months) and at retest (48 months).

Case Example : Participant D15

The performance of this participant demonstrated that severity of dementia is not an accurate indicator of levels of success on linguistic cognitive measures, and that knowledge of semantic associations may remain intact despite apparently advanced cognitive impairment with reference to a clinical rating tool (GDS).

Participant D15 achieved perfect scores on both the Pyramids and Palm Trees Test, and the Short BPVS , that is on both tests of lexical comprehension which were based on picture stimuli, despite being rated as GDS 5 (moderately severe cognitive decline) at entry to the research (duration of dementia at initial testing was 24 months) and obtaining a score of only 1 / 12 correct on the CAPE Orientation Test , the lowest score in the group and one indicating a very severe deficit in orientation levels. This participant was subsequently unable to take part at retest due to sudden and widespread deterioration in health status, which indicated a rapid progression of disease during the time interval of eight months since initial testing.

Case Example : Participant D8

This participant, who had a duration of dementia of 24 months at entry to the research and was rated with reference to the GDS as presenting a very mild level of cognitive decline (GDS 2), scored highly on the CAPE Orientation Test (11 / 12) indicating preserved orientation skills. This participant also achieved a high score on the Short BPVS, in addition to performing without error on the Pyramids and Palm Trees Test. These high levels of success were maintained at retest which occurred at ten months after initial testing.

- Qualitative Analysis of DAT Group Responses to the Pyramids and Palm Trees

Analysis of the types of errors made by the DAT group in response to the Pyramids and Palm Trees Test items revealed that a frequently-occurring response type consisted of the selection of both stimuli presented in the noun triad (the correct semantic associate and the distractor noun) as associates for the target noun. Participants with a high frequency of errors on the test were noted to repeatedly ask the examiner for reiteration or confirmation of the task instructions, suggesting that this task drew heavily upon attention and recall strategies.

The variations in performance noted amongst the DAT group participants again confirmed the heterogeneity in individual deficit profiles within the group with respect to lexical processing abilities.

- Performance of the DAT Participants on the Set Test

The statistical analyses for the Set Test fulfilled the prediction of a decrement in performance of the DAT participants relative to the Controls in generating exemplars for each of the semantic categories of 'Colours', 'Animals', 'Fruits', and 'Towns'. The Control subjects generated a mean number of 12 to 14 items in response to each category (overall mean 13.12), whereas the DAT participants generated a mean of 5 to 9 items for each category (overall mean 7.32) demonstrating that the people with DAT were able to recall only half the number recalled by normals.

Furthermore, whereas the Controls generated a similar mean number of items for each of the test categories (Range = 12.4 - 13.6 items) the mean number of items generated by the DAT participants showed a progressive decline between categories in the following direction :

Colours (9.1) Animals (8.2) Fruits (6.5) Towns (5.5)

This pattern indicated that the participants were able to recall the names of 'Colours' with the greatest ease, while the category of 'Towns' caused the greatest difficulty. Examination of individual DAT participant responses confirmed a progressive and ordered decrease in the number of items generated according to the previously-mentioned group trend (Colours, Animals, Fruits, Towns) for six participants. The following case examples demonstrate the great amount of variability which was noted within the DAT group in response to this test.

Case Example : Participant D13

This participant, who presented at 34 months post-onset at initial testing, generated items for two categories at a level of response (Animals = 17; Towns = 19) which exceeded not only the number of items generated by every other DAT participant in response to any of the four categories, but also exceeded the number of items generated by the majority of the Control subjects in response to those categories.

Case Example : Participant D1

This participant exhibited severe deficits in generative naming, and was unable to generate any items (score = 0) for the two categories of 'Fruits' and 'Towns', and generated only two items for the category of 'Animals'. This participant achieved an overall individual mean score of 2.2 items for each category, as compared with the minimum average of 12 items generated by the Controls. Similar levels of performance were observed at retest which occurred after an interval of 16 months, at which time Participant D1 was unable to recall any items for any of the four categories (overall individual mean score was 0).

Case Example : Participant D7

Participant D7, whose performance across the cognitive screening tests was indicative of global deficits in both lexical comprehension and visual perceptual skills, likewise exhibited severe difficulty on the generative naming test. This participant recalled an overall mean of only 3.0 items for each semantic category on the test, thereby achieving the lowest individual mean score within the DAT group after Participant D1. Like Participant D1, Participant D7 also performed at similar levels at retest which occurred nine months later, scoring five or fewer items for each category, which yielded an overall mean of 4.25 items per category.

In summary, the Set Test confirmed that the DAT participants as a group experienced significant decrements in performance relative to the Controls under test conditions which required lexical items to be recalled from semantic memory in the absence of picture or written cues to aid recall. These findings are in accordance with reports in the literature from sources which confirm impaired performance of people with DAT on tests of word fluency. For example, Miller and Hague (1975) found that individuals with Alzheimer-type dementia generated fewer words and a differential paucity of lower frequency words on a word fluency task. Martin and Fedio (1983) also found that their patients with mild to moderate dementia generated fewer categories of supermarket items and fewer exemplars per category than normal individuals. However, the present findings with respect to individual DAT participants again confirmed the existence of unique patterns of performance which were at variance with the group trend, and highlighted specific deficits in the cognitive skills under test.

- Retest Performance of the Patients on the Lexical Recognition and Recall Tests

In accordance with the experimental finding that the DAT participants performed at a significant decrement relative to the normal subjects on the standardised measures relating to lexical comprehension, word association and free recall - the Short BPVS, Pyramids and Palm Trees Test, and Set Test, respectively - it was predicted that the DAT participants would show further decline on these cognitive measures after the interval of eight to nine months between testing and retest.

Contrary to expectation, however, analysis of the performance of the participants at retest failed to reveal significant decrements in relation to initial testing, therefore demonstrating that the lexical knowledge involved in these tests did not deteriorate significantly over the given time period.

This finding correlates with the previously discussed findings that at retest 60% of the DAT group (6 / 10) were evaluated as maintaining their initial GDS ratings of level of cognitive decline. Furthermore, examination of individual test profiles also demonstrated that in some cases, performance on these lexical measures improved at retest.

Such observed variability in levels of success between test occasions demonstrates that for some DAT participants in this research the difficulties noted at initial testing were not a conclusive reflection of the permanent loss of lexical knowledge. Rather, the level of success in accessing lexical information under particular test conditions may be expected to vary between test occasions, which in turn may reflect fluctuations in the symptoms and progression of Alzheimer-type dementia.

The Performance of the DAT Participants on the Visual Screening Measures

Two tests which focus on visual discrimination and visual perceptual abilities (Shape Discrimination Test and the Dot Counting Test) were included in the research procedure in order to :

- establish a baseline of visual discrimination abilities in normal ageing
- establish intact visual discrimination in the DAT participants as a basis for

proceeding with the presentation of the test stimuli

The ability to name correctly requires initial recognition of the perceived stimulus and retrieval of the correct word. The role of visual perceptual deficits, as opposed to linguistic-semantic factors, in the naming disorder of DAT, has received much speculation in the literature. Rochford (1971) concluded from the errors made by patients with dementia when naming line drawings of relatively unfamiliar objects, that they often failed to recognise the stimulus correctly.
Kirshner, Webb and Kelly (1984) concluded that the naming errors of individuals with dementia were most commonly perceptual, based on findings that naming accuracy decreased with increased degradation of the visual stimulus, with the direction of decline progressing from real objects to object photographs, line drawings and finally masked line drawings. These findings suggested that naming success may be correlated with the amount of visual information available in the stimulus.

Grist and Maxim (1992) found highly significant differences between the naming scores achieved by normal elderly subjects and elderly individuals with probable dementia of the Alzheimer type, in response to degraded line drawings of household objects, which were built up in stages to black and white photographs of the objects. When the stimuli consisted of simple outline shapes of familiar objects, the individuals with dementia demonstrated an ability to make correct responses even in the degraded stages of stimulus sets. The authors attributed the high levels of naming success in response to five 'dominant sets' (boot, mug, milk bottle, teapot, shoe) to the familiarity and functional importance of the objects concerned, their high frequency names, and their particular outline shape. From the research findings it was suggested that individuals with DAT appeared unable to look for links between degraded representations and stored lexical items in their memory, and may need significantly more cues of depth and perspective than normals to enable them to retrieve single words.

Stevens (1989) found that elderly individuals with dementia of the Alzheimer type experienced greater difficulty naming black and white drawings than coloured photographs of common objects. Stevens also reported "wide variations in individual performance under the umbrella group label [of dementia]" (1989, p89), a finding which attests to the importance of looking at individual as well as group performances. In accordance with findings in the literature with respect to imageability and familiarity of picture stimuli, the semantic tests devised for the present research utilised picture representations of familiar and highly imageable nouns presented as black and white line drawings. Furthermore, the dimensions of the picture and printed word test stimuli were enlarged in order to be of optimum size for visual clarity. The research hypothesis was put forward that the DAT participants would perform at levels not significantly different from the baseline established by the Controls on the visual screening measures; this finding would be then used to argue that any difficulties demonstrated by the DAT participants with respect to the processing picture stimuli were based on difficulties in accessing lexical-semantic information from the visual stimuli as opposed to deficits in visual discrimination of the picture stimuli.

The performance of the Control subjects on both visual screening tests confirmed that the stimuli were within the visual processing abilities of normally ageing individuals within the age span of from 65 to over eighty years of age, including individuals whose vision was aided by the use of spectacles.
Every Control subject achieved a perfect score (20 / 20) on the Shape Discrimination Test, and only one subject failed to achieve a perfect score on the Dot Counting Test, making one error (scoring 9 / 10).

The research hypothesis with respect to the DAT participants' visual processing abilities was confirmed, as their performance was not found to differ significantly, at the chosen significance level, from that of the Control group on either test.

Nine of the DAT participants (60%) matched the levels of success achieved by the Controls, achieving a no-error score on both tests. Two more participants obtained a perfect score on one of the two visual tests.

In terms of error frequency, with the exception of one participant, all the DAT participants obtained scores of 70% to 90% of the Control mean on the Dot Counting Test (making only 1 - 3 errors) and scores at 80% or higher of the Control mean on the Shape Detection Test (making only 1 - 4 errors).

The performance of Participant D7 was again highlighted as being exceptional in relation to that of the rest of the group with respect to visual processing abilities. Participant D7 performed at a distinctively lower level than other DAT participants on both visual tests, obtaining scores which represented only 40% of the Control baseline, and less than 50% of the DAT group means on both tests (44% of DAT group mean on the Dot Counting Test and 43% of DAT group mean on the Shape Discrimination Test).

Participant D7's performance profile demonstrates that in some individuals, Alzheimer-type dementia may be accompanied by a visual-perceptual processing deficit which impairs even basic skills such as the ability to discriminate dot stimuli and to detect shapes from against a background.

In summary, for the majority of the DAT participants in this research, the performance trend on both visual discrimination tests was in the direction predicted, that is at a comparable level to the Controls. The performance of one participant was exceptional and was characterised by deficits in basic visual discrimination abilities and persistent difficulties with pictorially presented materials throughout the Cognitive Screening Battery.

Martin (1990) demonstrated specific and identifiable visual perceptual difficulties in subgroups of patients with Alzheimer-type dementia. Martin also proposed the double dissociation of visuospatial and linguistic components of the Alzheimer's symptom complex, arguing for the existence of three distinct subgroups of patients in the early stages of DAT, characterised by contrasting patterns of deficit in three primary domains of functioning which include visuospatial and constructional skills, episodic memory, and semantic knowledge, especially for naming and category fluency. Two of the subgroups proposed by Martin were characterised by directly opposing profiles of dysfunction and sparing of word-finding abilities and visuospatial skills. The third subgroup experienced equal impairments to word-finding abilities and visuospatial skills.

The performance profile of Participant D7 in this research group corresponded to Martin's (1990) description of a subgroup of patients with difficulties in both visual and lexical processing domains, as evident from extremely low scores on both visual screening tests, and on the tests of lexical recognition and recall, specifically the Short BPVS, the Pyramids and Palm Trees Test and the Set Test.

- Patterns of Visual Performance at Retest

The research further predicted that the DAT participants would not exhibit a significant decline in visual discrimination abilities at retest. This prediction was confirmed, as comparisons between initial and retest scores on both visual screening measures did not yield statistical significance for the core group of nine participants who took part in both test sessions.

The general finding was that the DAT participants maintained their initial visual performance scores or varied by only one point, therefore remaining at performance levels within 80% of the Control mean despite an interval of approximately nine months subsequent to initial testing.

This pattern was also observed in the performance of Participant D7, who maintained performance within one point of initial test scores at retest.

On the basis of their performance on the visual screens at both initial testing and at retest it was apparent that the majority of the DAT participants in this research maintained intact visual discrimination skills, despite variation within the group with respect to both duration of dementia (Range 8 - 42 months at initial test; 16 - 48 months at retest) and severity of cognitive decline (GDS 2 - GDS 5).

The two visual screening measures employed in this research (Dot Counting Test and Shape Discrimination Test) assessed the ability to recognise and localise individual shapes, specifically dots and a figure 'X', and therefore did not investigate the perception of more complex visual stimuli such as line drawings of objects.

Nevertheless the findings from the picture-based lexical recognition and semantic association tasks (Short BPVS and Pyramids and Palm Trees, respectively) attest to the ability of the majority of the DAT participants to locate and recognise pictured nouns to spoken request.

The research findings may be taken to confirm previous observations that people with Alzheimer-type dementia can match objects and shapes without error during the earlier stages of the disease, with confirmed visual agnosia rare except in profound DAT (Bryan and Maxim, 1996). In support of this premise, a subgroup of nine participants was identified from within the present DAT research group who performed at normal levels on both visual tests, demonstrating unimpaired discrimination of shapes and forms, despite being heterogeneous with respect to duration of disease (Range 12 to 24 months) and level of cognitive decline (GDS 2 [very mild] to GDS 5 [moderately severe]).

Group Performance on the Experimental Battery for Semantic Processing

The research prediction that the Control subjects would achieve high levels of accuracy on all the tests comprising the Experimental Battery for Semantic Processing was fulfilled. No significant performance decrements were found between the three age bands represented within the Control group, thus confirming that the lexical-semantic skills under test remain intact during normal ageing and across the age span represented in this research, that is from 65 to over 85 years of age.

The statistical analyses yielded significant decrements at $p < 0.01$ between the performance of the DAT group in relation to the Control mean on every test comprising the Semantic Processing Battery.

The research hypotheses raised for the performance of the DAT participants on the semantic tests will be considered with respect to the findings for the tests of lexical recognition (Recognition by Unique Feature Test and Recognition by Category Test) and the tests of lexical production (Picture Naming Test and Generative Naming Test)

The Recognition Tests of the Experimental Battery for Semantic Processing

- The Performance of the Control Group on the Lexical Recognition Tests

The Control group scored highly on the Recognition by Unique Feature tests. Twenty of the 21 subjects performed without error on both picture and written versions of the test. One subject, who was from the youngest age band (65 - 74 years), made four errors on the written test (scoring 26 / 30), therefore yielding a marginally lower group mean for the written version of the Recognition by Unique Feature test.

The performance of the Control group on the Recognition by Category tests was characterised by greater within -group variability. Thus, only 52% of the group (11 / 21) performed without error on both picture and written versions of the test.
A greater number of subjects (14 / 21) achieved error-free scores on the picture test, as compared with only 11 / 21 subjects for the written test. The overall group trend was therefore towards achieving greater success on the picture version of the category test (group mean=14.3) than on the written version (group mean = 13.6).

Statistical comparison between the mean scores obtained by each of the three age bands did not establish significant decrements associated with increasing age. In fact, the subjects in Age Band III (85+ years), who were the oldest, achieved the highest mean scores on both versions of the Recognition by Category Test (picture version = 14.6; written version = 14.6) while the youngest subjects, those in Age Band I (65 - 74 years) achieved the lowest mean scores on both tests (picture version = 14.0; written version = 13.1).

These findings with respect to the Recognition by Category Test indicate that in normally ageing individuals the skills involved in associating pictured or written nouns on the basis of shared semantic category may be relatively more effortful than the skills involved in identifying objects by their specific semantic attributes. The findings also suggest that the ability to categorise objects may be easier with respect to pictorial representations of objects than their written names.

- The Performance of the DAT Group on the Lexical Recognition Tests

This research raised specific hypotheses with respect to the performance of the DAT participants on the individual lexical recognition tests. It was proposed that participants at each of the levels of severity of cognitive decline would achieve their best relative performance, in relation to the baseline norm established by the Control subjects, on both picture and written presentations of the Recognition by Unique Feature Test.

This test evaluated the ability of individuals with Alzheimer-type dementia to utilise information consisting of very specific identifying attributes of objects, labelled in this research as 'unique features', in order to distinguish pictured objects, or their written names, from amongst distractor stimuli varying in their level of semantic association with the target object.

The demonstration of relatively preserved performance on such a test would in turn attest to the availability of knowledge of individual concepts and their specific identifying features within semantic memory, and the accessibility of this lexical information, in both the picture and written modality, to cued search.

Building on the premise that the Recognition by Unique Feature Test not only provided very specific information in the form of spoken attribute cues to guide and facilitate recognition, but also only required participants to indicate their recognition of the target object, it was further hypothesised that the DAT participants may achieve lower levels of less success on the Recognition by Category Test, which required them to actively select nouns in response to a spoken general category cue. On this basis it was therefore suggested that the Recognition by Category Test may involve more effortful search processes.

The performance of the Control group verified such a trend with respect to the lexical recognition tests. Therefore, if the pattern of linguistic and cognitive functioning in Alzheimer-type dementia reflects an 'over-accelerated' decline in relation to the patterns which accompany normal ageing, then we would expect the DAT participants to demonstrate relatively better performance on the Recognition by Unique Feature tests than on the Recognition by Category tests, in accordance with the performance trend established by the Control group in this research.

In accordance with the research predictions, the DAT group did achieve higher levels of success on the Recognition by Unique Feature tests than on the Recognition by Category tests. The findings of a statistically significant performance decrement between the Control and DAT group scores on both the Recognition by Unique Feature and the Recognition by Category tests was unexpected, and indicated that both the ability to recognise nouns by their specific attributes of feature, and by their more general attribute of semantic category, are compromised in individuals with DAT in relation to healthy elders. However, the DAT group consistently achieved success levels at a very high percentage (above 90%) of the Control baseline on both versions of the Recognition by Unique Feature Test at initial testing.

These performance trends were clearly evident in conversions expressing the DAT group scores on each of the four lexical recognition tests as a relative percentage of the Control mean. Thus, the DAT group achieved their highest level of success on the written version of the Recognition by Unique Feature Test (94.8% of Control mean) with performance slightly lower on the picture version of the test (92.9% of Control mean).

In contrast, the DAT group performance on the Recognition by Category tests in relation to the Control mean was at 72.1% (picture test) and 62.9% (written test).

Furthermore, the dispersion of scores obtained on both picture and written presentations of the Recognition by Unique Feature Test was noted to be small. The majority of individuals (11 / 15) made two or fewer errors on each 30-item test. The lowest score achieved within the DAT group was 24 / 30 (80% success) on the written test and 23 / 30 (77% success) on the picture test.
Examination of the dispersion of scores obtained on the Recognition by Category Test confirmed a wide variation between maximum and minimum scores on both written and picture versions of the test (picture test Range of scores = 5 - 15;. written test Range of scores = 3 - 15). Levels of success therefore varied between 33% (for the lowest score of 5 / 15 on the picture test) and 20% (for the lowest score of 3 / 15 on the written test), which again confirmed that the categorisation test in both modalities presented was particularly difficult for certain individuals.

In investigating for any effects of modality of stimulus presentation upon performance, it was found that while the DAT group achieved higher scores in the picture modality on the Recognition by Category Test, a similar trend to the Controls, they performed in the reverse direction on the Recognition by Unique Feature Test, achieving a higher level of success in the written modality.
However, no significant effect of modality was found with respect to either of the recognition tests.

- Performance of the DAT Participants at Retest on the Lexical Recognition Tests

The core DAT group retest scores on each lexical recognition test showed some deterioration in performance over time in relation to initial testing. The observed decreases in test scores were not, however, statistically significant.

The core DAT group retest scores on both versions of the Recognition by Unique Feature Test represented levels of success above 75% of the Control mean, with improved performance on the written presentation of this test over the picture test (88.9% written test; 77.1% picture test). Therefore the trends in performance noted at initial testing with respect to stimulus modality were maintained at retest.

As at initial testing, retest performance on the Recognition by Category Test remained at a lower percentage of the Control mean compared to performance on the Recognition by Unique Feature Test. Retest success levels were equivalent at near 58% of the Control mean on both presentations of this test (58.9% written test; 58.4% picture test), whereas at initial testing core group performance on the picture category test had been slightly higher (69.9% of Control mean) than performance on the written category test (62.6% of Control mean).

These findings confirmed that the DAT group did not decline significantly in their performance on the lexical recognition tests despite a time lapse of nearly one year, which for some participants was associated with a decline in cognitive abilities with reference to the GDS rating system. Again, the rate and manner of deterioration within the group was heterogeneous and participant-specific, rather than occurring in an "across the board" manner.

- Severity of Cognitive Decline in Relation to Recognition Test Performance

Performance on the Recognition by Unique Feature and Recognition by Category tests was not found to be consistently sensitive to advancing severity of disease with respect to the performance of individuals at Mild (GDS 3) through to Moderately Severe (GDS 5) levels of cognitive decline. These comparisons yielded random significance on the tests, rather than consistently increasing decrements in function associated with advancing severity of cognitive decline.

However, consistently significant differences were detected between the performance of participants with the mildest level of cognitive decline (GDS 2 - Very Mild), and participants within all three remaining severity subgroups on the written version of the Recognition by Unique Feature Test.

The written Recognition by Unique Feature Test therefore appeared particularly sensitive to advancing severity of cognitive decline.

From the research findings it may be concluded that the abilities tested by the lexical recognition tests, specifically recognising nouns associated by semantic category, and recognising nouns by the specific attributes which distinguish them from other nouns in the same semantic category, did not consistently deteriorate in DAT with advancing severity of cognitive decline, with an important exception being with respect to the written presentation of the Recognition by Unique Feature test.

The findings therefore point to the potential clinical application of this test with respect to both assessment and monitoring of disease progression.

- Analysis of Errors made on the Lexical Recognition Tests

The Recognition by Unique Feature Test

The Recognition by Unique Feature Test required the research participants to utilise the unique feature attributes, presented as spoken semantic cues, to facilitate the identification of target objects from amongst other objects bearing varying strengths of semantic association to the target.

Expressed as a percentage of total possible responses, the DAT group errors at initial testing represented 6% of total possible responses on the written test and 7% of total possible responses on the picture test.

At retest, the total number of errors was noted to increase to 12% of total possible responses on both versions of the test (11.7% written test; 11.9% picture test); this represented a doubling in the percentage of errors on the written test. However, these increases in error rate did not reach statistical significance. The slightly greater proportional increase in frequency of errors on the written Recognition by Unique Feature Test may be taken as a further indication of the sensitivity of this test to advancing duration (and for some participants severity) of dementia.

The predominant error type at both initial test and retest consisted of selecting the close semantic distractor. This error type represented a near-equivalent percentage of total responses in each modality both at initial testing (65.6% picture test; 62% written test) and at retest (56% picture test; 57% written test).

In the picture modality the distant semantic distractor and the visual distractor were selected with equivalent 'second place' frequencies of 12.5%.
In the written modality the distant semantic distractor was the second most frequently occurring error type (23%), being selected up to three times more frequently than the visual distractor (a phonetically similar word) at 8%.

The selection of the unrelated distractor did not occur as an error type on the written test at either test session. The small percentage (6%) of occurrence of unrelated distractors on the picture test indicated that some random selections had occurred in response to the picture stimuli.

Both "Don't Know" and 'No Response' error types occurred infrequently as a percentage of total responses in both modalities, with greater instances on the written than the picture test on both test occasions; this suggested that the DAT participants usually felt able to make a response on the Recognition by Unique Feature Test.

At retest, despite the passage of time and associated disease progression, a consistent pattern with respect to relative frequency of each error type was maintained. Accordingly, the overwhelming error tendency in both the picture and written modality was in favour of selecting the closely related semantic distractor. The distant semantic and visual distractors occurred with equivalent frequency at retest on the picture test, a pattern retained from initial testing.

Also of note in the picture modality at retest was the finding that the unrelated distractor doubled in relative frequency of occurrence. In the written modality, the distant semantic distractor remained the second most frequently occurring error type at retest, as at initial testing. A small increase in relative frequency of occurrence was observed with respect to the phonetically similar distractor relative to initial testing (8% initial test; 11% retest).

Finally, although "No Response" and 'Don't Know' replies did not occur in the picture modality at retest, their relative frequency remained equivalent in the written modality at both test sessions. This may indicate that verbal stimuli presented as written words may remain consistently difficult to process in the presence of a dementing condition, and point to the sensitivity of the written test to disease progression.

The research findings therefore identified separate and distinct patterns of error with respect to the pictorial and written versions of the Recognition by Unique Feature Test, which were maintained over time, that is at retest.

The differences with respect to the frequency of selection of the visually related distractors in each test modality indicate that visually similar stimuli in the picture modality (a pictured object sharing perceptual features of outline and detail with the target) have potentially more interference value in noun recognition paradigms than visual distractors in the written modality (a word sharing features of number of letters, number of syllables, spelling and phonology, with the target).

- The Recognition by Category Test

The 21 Control subjects produced only 14 error responses on the picture test and 30 error responses on the written test. The maximum number of errors made by any subject on the picture test was four. The written categorisation test emerged as more likely to cause difficulty, as evident from the greater frequency of errors and the wider dispersion of error frequency at between one and seven errors.

The predominant error response for the Control subjects on both versions of the test (93% of errors on the picture test and 90% of errors on the written test) consisted of the selection of the semantic distractor and two of the three target category members (Type I). All remaining errors consisted of selecting the unrelated distractor and two of the three target category members (Type II).

At initial test, erroneous responses by the DAT participants constituted 31% of possible responses on the picture test (70 errors) and 43% of possible responses on the written test (97 errors) representing, respectively, a fivefold and threefold increase in errors in relation to the Control group on each test.

These relative proportions of erroneous responses were upheld at retest for the smaller core group of seven DAT participants. Thus, errors constituted 36% of possible responses on the picture test and 39% of possible responses on the written test.
A smaller margin of difference was therefore evident at retest between success levels in the picture and written modality.

These findings showed that at least one third of the responses made by the DAT participants on each version of the Recognition by Category Test were incorrect. Their error pattern followed the same trend established by the Controls, in that the majority of errors on both versions of the test consisted of selection of the semantic distractor and two of the three target category members (Type I). This error type accounted for 67% of errors on the picture test and 61% of errors on the written test.

Two error types which occurred with equivalent frequency on the picture Recognition by Category Test consisted of the selection of the unrelated distractor together with two targets (Type II: 10%), an error type also noted in the responses of the Control group, and the selection of both distractors (semantic and unrelated) with one target category member (Type III: 11%). The latter error type was not observed in the Control group responses.

On the written version of the test, the second and third most frequent error types consisted of the selection of the semantic distractor together with all three targets (Type IV: 14%), followed by the selection of both distractors and one target category member (Type III: 10% of errors). Neither of these error types were produced by the Control group. Type IV errors did not occur in the DAT group responses at retest. On each version of the Recognition by Category Test, a small number of individuals produced a "Don't Know" or 'No Response' error type. One participant (Participant D7) produced two such errors on the written test and one error on the picture test, while two other participants each made five or six such responses on the picture test (Participant D11) and the written test (Participant D9).

It was also noted that the DAT participants generally did not show awareness of their errors or attempt to revise their responses.

These findings point to difficulty experienced by both the normal individuals and the people with DAT, not only in associating each set of three target nouns as belonging together by representing a single semantic category, but also in being able to distinguish between the semantic distractors, which were associates of the target nouns, and the actual category members.

The observation of greater relative levels of difficulty on the Recognition by Category Test than on the Recognition by Unique Feature Test, characterised by the erroneous selection of semantic and unrelated distractors, and for some individuals the occurrence of "Don't Know" responses, appears contrary to previous reports of relatively preserved categorisation skills in people with Alzheimer-type dementia.

Research findings have previously demonstrated the interference caused by semantic distractors in single word recognition paradigms. For example, Skelton-Robinson and Jones (1984) and Huff, Corkin and Growden (1986) reported that individuals with dementia demonstrated difficulty in recognising the correct name of an object in the presence of distractors consisting of the names of items from the same semantic category.

Observed difficulties in selecting between nouns from the same semantic category, in this case between the target noun and the close semantic distractor, have been taken to indicate an impairment in DAT participants' knowledge of the specific semantic attributes (such as physical features and functions) which delineate concept meanings (Bayles and Tomoeda, 1983; Flicker, Ferris, Crook and Bartus, 1987; Huff et al., 1986; Martin and Fedio, 1983). What has remained to be determined is whether the observed difficulties are specific to the test occasion, that is, inaccessible at the time of testing, or consistently replicated over time, in other words permanently lost to search.

The data from the lexical recognition tests in this research (Recognition by Unique Feature Test and Recognition by Category Test) were therefore examined for evidence of consistencies in errors between initial testing and retest. However, no evidence was found to support the regular occurrence of consistency in errors on the lexical recognition tests over time.

The occurrence of consistencies in recognition errors between the two test sessions was infrequent, particularly on the Recognition by Unique Feature tests. Overall, the instances of item-specific errors were greater on the picture versions of both lexical recognition paradigms.

Furthermore, when consistencies were noted to occur on test items, the majority were noted in the responses of one individual in the group; this finding was particularly the case for the Recognition by Category tests.

On the Recognition by Unique Feature tests, only seven instances of error consistency were noted on the picture version of the test; five of these errors were made by a single individual (Participant D9). On the written test, only three instances of error consistency were observed, produced by three participants who each produced one item-consistent error.

A greater frequency of error consistencies was noted on the Recognition by Category tests, although the number of instances remained at a low level. On the picture test, a total of 20 instances of consistency were counted, made by seven of the fifteen DAT participants. One third of these errors were produced by one individual, Participant D3. The remaining six participants made between zero and four error consistencies. On the written test, only 13 instances of consistency were noted; the majority of these (10 / 13) were again made by Participant D3.

These results would indicate that the lexical semantic knowledge required to associate pictured objects and written object names on the basis of semantic category, and to identify object stimuli by their unique distinctive attribute, was not consistently degraded in the DAT participants on both test occasions, except with respect to individual cases.

The occurrence of item-specific errors has been stipulated by Warrington and Shallice (1979) and Shallice (1987) as one of the defining criteria in identifying a semantic storage degradation as distinct from an access disorder. It would appear that for repeated presentation of recognition paradigms, error consistency was not a significant feature for this group of people with DAT as a whole, again pointing out the variability between individuals and therefore the need to recognise variations between individual patterns of performance.

The findings confirm the main tenets of this research, that people with Alzheimer-type dementia would be able to access information about specific feature attributes of individual lexical items (nouns) in semantic memory, and that this ability could be demonstrated on semantic tests which incorporated competing distractor nouns with varying degrees of potential 'interference value' to the target noun.

The research findings also confirmed the hypothesis that people with Alzheimer-type dementia would perform at levels comparative to the baseline established by normal older individuals, on both the picture and written versions of the Recognition by Unique Feature Test, in preference to their performance on the Recognition by Category tests.

The present findings are in accordance with research findings (Bayles, Tomoeda and Trosset, 1990; Flicker at al., 1987; Grober et al., 1985; Nebes and Brady, 1988) which have demonstrated the availability of specific and detailed concept information in semantic memory, including findings by Bayles and Tomoeda (1983) that patients could give a description for items they were unable to name; reports from Flicker et al. (1987) that although unable to answer direct questions about an object's function, individuals with DAT could select items needed for a particular chore; reports from Nebes and Brady (1988) that individuals with DAT were accurate in deciding whether words were related to target stimuli, and finally the findings of Schwartz, Marin and Saffran (1979) that dementia patients could gesture the function of an object they could not name.

The present findings of high success rates on the Recognition by Unique Feature Test also support those of Grober, Buschke, Kawas and Fuld (1985) which suggested that individuals with dementia were able to select semantic attributes for target words from amongst other distractor words, even though they had difficulty when required to rank object attributes in terms of their relative importance to overall concept meaning.

The present findings are in contrast to previous reports that people with dementia demonstrate retained knowledge on tests such as category sorting, which draw upon superordinate or general knowledge about objects (Chertkow and Bub, 1990; Diesfeldt, 1985; Grober et al., 1985; Hart, 1985; Martin and Fedio, 1983; Schwartz, Marin and Saffran, 1979; Warrington, 1975), while being relatively more impaired on tests drawing upon more specific concept knowledge such as attributes.

The people with DAT in this research demonstrated high levels of accuracy in recognising which noun a given specific attribute was relevant to, despite the presence of nouns selected to be semantically or visually competing distractors. In relation to test demands, the Recognition by Unique Feature Test simply required participants to select, from amongst four distractors, a target noun upon hearing the spoken attribute cue. The specific attribute cues used in this research design were designed to capture unique physical features, descriptions, or in some cases characteristic actions of nouns, which are known by cognitively intact native speakers of the English language.

The descriptive attribute cues which formed the basis for the Recognition by Unique Feature Test were qualitatively different from many of the attribute cues utilised in previous studies, which required research participants to identify nouns from perceptual descriptions, or to carry out comparative analyses between nouns on the basis of physical features or other qualitative attributes, some fairly abstract in quality (for example, wild versus domestic animal; having claws or hooves; type of metal) (Chertkow and Bub, 1990; Warrington, 1975).

The present findings demonstrated that specific semantic knowledge about noun concepts, which was a major focus of the research, may be accessed under controlled conditions during the early to moderate stages of dementia of the Alzheimer type. Such demonstrations of the ability of participants with DAT to recognise, with relatively few errors, sixty target nouns by their unique descriptive attributes, can be used to argue for the presence and accessibility of detailed concept information in semantic memory. The retention of such a core knowledge base or basic information store about nouns would be relevant to the preparation of therapeutic strategies for people with a dementing condition. This could include for example the use of cues to facilitate recall and recognition of noun vocabulary in the context of daily activities, and also the use of circumlocutory descriptive strategies to reinforce rehearsal of existing lexical knowledge.

The evidence for accessibility of concept information during the early to moderate stages of DAT further suggests that the demonstration of naming difficulties in people with DAT may not always verify the coexistence of recognition difficulties for the same items.

Modality-Specificity of Semantic Knowledge

The question of modality-specificity in relation to the semantic difficulties of Alzheimer-type dementia has been addressed in the recent research literature by comparisons of performance in response to verbal and non-verbal stimuli. A number of theorists have argued for the existence of functionally distinct, modality-specific meaning systems in the brain, which allow for the possibility that semantic deficits in people with DAT may vary with the sensory form or modality of stimulus input.

For example, McCarthy and Warrington (1988) argued for the existence of deficits specific not only to modality (for example spoken) but also to category (for example living things) within that modality. This proposal refutes the notion of an amodal or 'all-purpose' meaning store.

Chertkow and Bub (1990) argued alternatively for an amodal but two-component semantic processing strategy: an initial pre-semantic, post-sensory or perceptual recognition of structure leading to semantic categorisation of the visual stimulus, and a second stage involving 'core' knowledge of concepts. They propose that the second stage, which is based on knowledge of functional and abstract properties, is distinct from knowledge based on perceptual or structural object attributes, and is relatively more susceptible to deterioration in DAT.

This model may be used to explain the relatively greater success of the DAT group in this research on the Recognition by Unique Feature Test compared with the Recognition by Category Test. The cues used in the former test may have drawn additionally upon perceptual or structurally based information about the target objects, therefore ensuring greater success, while the Recognition by Category Test was, in comparison, relatively unguided.

Furthermore, although the DAT participants in this research demonstrated some variability in performance on the two recognition paradigms according to whether the modality of stimulus presentation was pictorial or verbal, nevertheless the differential success rates between verbal and non-verbal test presentations were to a certain extent test-determined, as a greater performance gap was noted between the success rates for picture and written test presentations on the Recognition by Category Test.

Although the participants' performance was noted to be slightly enhanced on the written version of the Recognition by Unique Feature Test, this difference was minimal (2% difference) in relation to the Control baseline.

The finding that levels of success were upheld at retest indicated consistency in performance over time in relation to modality of stimulus presentation. However, it was not possible to comment on modality effects with respect to the processing of specific individual noun stimuli, as the stimulus sets comprising the picture and written versions of each lexical recognition test utilised a different set of nouns.

The Lexical Production Tests : The Picture Naming Test

- Age Effects on the Naming Performance of Normal Subjects

Examination of the mean number of items named successfully by the Control subjects within each age band showed a progressive but minimal decrease with advancing age, which was not statistically significant.

Therefore it may be concluded that even at the highest ages tested (Age Band III : 85+ years) the naming of familiar pictured objects was not reduced in comparison with subjects in the younger age bands, confirming that the test noun stimuli were within the naming abilities of normal elderly individuals.

- Effects of Severity of DAT on Naming Performance

The research prediction that the DAT group would be significantly impaired in their confrontation naming performance in relation to the Control group was fulfilled at $p < 0.001$. These findings confirm previous reports (e.g., Benson, 1979) of object naming deficits as a sensitive and strong marker for the presence of dementia.

Strong correlations between object naming deficits and the overall severity of dementia have been confirmed in the literature (Barker and Lawson, 1968; Kirshner, Webb and Kelly, 1984; Skelton-Robinson and Jones, 1984). The analyses in this research also demonstrated statistically significant decrements at $p < 0.01$ between the naming scores of each of the four dementia severity subgroups in relation to the Control mean.

Therefore in this research the naming performance of the people with DAT at even the very mild level of cognitive impairment (GDS 2) was significantly reduced in relation to normal elderly people.

This research predicted that naming success would decline significantly between each of the four severity subgroups, as a reflection of advancing severity of cognitive decline. A progressive decrease in naming success rates in relation to the Control mean was observed in association with advancing cognitive decline, from the mildest group (GDS 2 - 86% of Control mean) down to the most severely cognitively impaired group (GDS 5 - 68.5% of Control mean). Nevertheless the decrements between each severity subgroup were not found to be statistically significant, indicating that in the population tested, advancing cognitive decline as evaluated by the GDS was not associated with a significant deterioration in naming ability.

The research prediction that the DAT participants may show a significant decline at retest in relation to initial naming performance was not confirmed; thus an increase of approximately nine months in duration of disease was not associated with a significant deterioration in naming success for the core group of seven research participants who completed the Naming Test at both sessions.

- Success of Cueing in Facilitating Naming Performance

Following on from the research hypothesis that participants with DAT would be able to utilise specific attribute cues to facilitate noun recognition in the Recognition by Unique Feature Test, it was further hypothesised that presentation of the same attribute information in the form of semantic cues would facilitate Naming Test performance with respect to the same noun set, given that both tests utilised a common set of sixty noun stimuli.

The most striking observation from analysis of the Naming Test data was the contrast between the spontaneous naming success rates achieved by the Control and DAT groups, and their subsequent naming success rates in response to presentation of the semantic and phonemic cues devised for the research procedure.

The Control group successfully named nearly all test items (95.7%) spontaneously, without the presentation of cues. Any unnamed items were subsequently named successfully in response to presentation of the semantic cue. The phonemic cues were rarely presented, and being unable to name a picture stimulus was a rare occurrence (only one instance for 21 subjects).

These findings confirm that the noun picture stimuli were nearly always named correctly by the normally ageing subjects, and items not named on the first attempt were usually successfully named following the presentation of the semantic cue. This confirms previous findings that normal ageing produces relatively slight changes in the accuracy of object naming (Nicholas, Obler, Albert and Helm-Estabrooks, 1985).

In accordance with the research prediction that the DAT group would be significantly impaired on the Naming Test, misnamings constituted approximately one quarter of all initial naming responses from the DAT group.

Of the test stimuli not named at initial presentation, near-equivalent proportions were correctly named following the semantic (45%) and the phonemic (46%) cues. Therefore some noun stimuli required presentation of both types of cue in order to be successfully named. However, despite presentation of both types of cue, approximately (30%) remained unnamed by the DAT group, a response pattern which did not characterise the responses of the Control group subjects.

- The Success of Semantic Cueing

The experimental prediction that the semantic cue, consisting of a specific feature attribute of the target object, would facilitate naming success by the DAT participants, was not fully confirmed, as over 50% of items for which semantic cues were presented remained unnamed.

The specific feature cues were devised to capture a highly specific and strongly associated function for each target noun, in order to facilitate semantic activation of the target. Analysis in terms of individual participant responses revealed variations with respect to the facilitatory effects of the semantic cues.

Thus the semantic cues facilitated naming success rates of greater than 60% for three individuals at initial testing: Participant D3 (64%), Participant D8 (70%), and Participant D11 (73%).

The facilitatory effect of the semantic cues was smaller for the remaining twelve DAT participants.

Semantic context has been shown to affect the performance of people with DAT (Nebes, 1989) but not in situations that require lexical retrieval. In this research it appeared that the semantic cues maximally enhanced successful recognition of the target nouns in the Recognition by Unique Feature Test, but were relatively less effective in facilitating the effortful lexical search process demanded by the Naming Test.

- The Success of Phonemic Cueing

The need for the presentation of phoneme cues subsequent to the presentation of the semantic cues in order to facilitate naming was mainly observed in the DAT group, rather than in the Control group. The phoneme cues were noted to facilitate naming success by the DAT group for a further 46% of items which were not named in response to presentation of the semantic cues. However, within the DAT group the phoneme cues were noted to produce variable levels of success in facilitating naming, as evident from the performance of two of the participants, described in the case examples which follow.

Case Example : Participant D1

This participant, whose naming scores were extremely variant and were therefore not included in the group statistical analyses, was unable to name 26 of 30 stimuli either spontaneously or following the semantic cue (only half of the stimulus set was presented due to severe naming difficulties). However, naming success for 46% of the test items was facilitated by presentation of the phoneme cues.

Case Example : Participant D9

In extreme contrast was the low success rate of Participant D9 in response to the phoneme cues; this participant named only two items from 18 following the presentation of a phoneme cue for each item.

- The Success of Cueing at Retest

Whereas at initial testing the semantic and phonemic cues facilitated similar naming success rates (47% and 37% respectively) by the core group of seven participants, at retest the facilitatory effect of the semantic cues was reduced (28% success rate) both in relation to initial testing, and in relation to the phonemic cues (65% success rate at retest), indicating changes in the facilitatory effect of semantic cueing with an approximately nine-month progression of DAT. These findings also pointed to the relatively increased success of phonemic cues with progression of DAT.

- <u>Analysis of Misnaming Types for the Control and DAT Groups</u>

Qualitative analysis of initial misnaming responses revealed further details about the possible underlying cause of the naming difficulties and the role of visual perceptual processing in the naming deficit. Following on from the research expectation that the DAT participants would demonstrate retained knowledge of specific object attributes, it was expected that their semantic knowledge would be reflected in the quality of misnamings, manifest for example as descriptions of features of the object to be named.

- <u>Control Group Misnamings</u>

The Control subjects' misnamings consisted predominantly of semantic errors, specifically naming another noun in the same semantic category as the target object. The next most frequently occurring error type consisted of naming an out-of-category object which shared visual features with the target, although this misnaming type occurred with only one quarter frequency compared to the predominant semantic error type. Any other misnaming types occurred very infrequently in the responses of the Control group.

- <u>Analysis of DAT Group Misnamings</u>

Every DAT participant acknowledged word-finding errors and demonstrated the use of 'semantically empty filler words' to cover up gaps in speech when unable to recall content words. They were all noted to be at the stage whereby their spoken output was syntactically correct and they were communicating in relatively 'fluent' utterances.

All of the DAT participants except one were noted to produce phonetically correct speech; the exceptional participant, Participant D13, produced phoneme distortions such that spoken words were generally 'off-target', effortful in quality and characterised by single within-word phoneme substitutions.
Amongst the group of fifteen participants, consistent refusals on both of the lexical production tests (Naming and Generative Naming) were noted for only one individual, Participant D1, who was very aware of, and distressed by, the difficulties experienced and requested that the tests be abandoned after a few items.

Certain misnaming types were observed in the responses of the DAT group which did not occur in the responses of the Control subjects. These responses included the use of hand gestures or drawing in the air; negated responses "It's not a ..."; naming a noun from another semantic category, and the production of single or multi-word responses which bore no obvious relationship to the target noun or included unintelligible utterances. However, even when considered collectively these response types remained low in their overall frequency of occurrence within the DAT group. Furthermore, the latter misnaming type, that of unrelated or unintelligible responses, occurred predominantly at retest, and was generally noted in the responses of DAT participants whose cognitive abilities had declined in line with an overall decline in functional and coping skills.

Like the Control group, the predominant error type made by the DAT participants on both test occasions was semantic, specifically naming another noun from the same semantic category. This correlates with the findings of Bayles and Tomoeda (1983) that the misnaming responses of all their patients, who presented with dementias of different aetiologies and severity levels, were most likely to be words semantically associated to the target stimulus.

Other misnaming responses from the DAT participants in this research which were classified as 'semantically related misnamings', or semantic field errors, were those of naming the category label; describing a part or feature of the target object, and describing a function associated with the target object.

Such responses indicated preserved knowledge of attributes of the target objects.

Each of these three types of semantically related misnaming occurred as a relatively low proportion (less than 10% each) of the total number of semantically related misnamings for the DAT group at initial testing, and similarly occurred even less frequently in the semantically related responses of the Control subjects, although the research expectation had been for higher proportions of such responses in preference to other non-semantic misnaming types.

In further similarity to the Control group, the second most frequent misnaming response by the DAT group at initial testing consisted of naming an object which shared visual features with the target, but was not semantically related to the target. This type of misnaming occurred with equivalent frequencies for both the Control (17%) and DAT (16.5%) groups.

Bayles and Tomoeda (1983) also identified that many misnamings were related both visually and semantically to the target item; on this basis they argued that such errors suggest an interplay between perceptual and linguistic-cognitive mechanisms.
They propose that individuals with dementia may perceive incoming visual signals or features of objects normally, but be unable to match the intact visual signal with its lexical referent, either because the stimulus features are no longer meaningful or because the lexical referent is no longer available or no longer exists.

Another frequent misnaming type for the DAT participants, which occurred twice as frequently as for the Control group, was that of "Don't Know" or 'Unable to Name' responses. Some participants gave indications of recognising the target or knowing the name but being unable to recall the word.They made statements such as "I know it - it's there". Others stated they were simply unable to name the stimulus. These findings suggest that some lexical items remained inaccessible at the time of testing, as verified by the finding that 30% of items could not be named at initial test despite presentation of both types of cue.
At retest at an interval of mean nine months later, the misnaming responses of the core DAT group were again characterised by a predominance of semantically related responses, in the same relative proportions (51%) as at initial testing (54%).

However, a notable change in quality of responses consisted of a fourfold increase in the occurrence of 'Don't Know' and 'Unable to Name' response types, and also a corresponding reduction by half in the occurrence of out-of-category visually related misnamings.

In view of the fact that the picture stimuli chosen for the Naming Test depicted common objects selected from high frequency vocabulary, the findings show that the naming disorder of Alzheimer-type dementia is not confined to low-frequency nouns. This was evident from the relatively high frequency of occurrence of 'Unable to Name' or "Don't Know" responses noted, which also increased with increasing duration of DAT. This points to a potential for developing therapy activities to encourage the maintenance of high-frequency or 'core' vocabulary likely to be encountered in everyday activities and settings.

- Naming Test Performance of the DAT Group at Retest

The prediction that the DAT group would show further decline in naming ability at retest as a result of advancing duration of disease was not statistically confirmed. In relation to the Control mean, overall DAT group performance on the Naming Test was noted to improve at retest in relation to initial test. Thus the core DAT group of seven participants who completed the Naming Test at both test sessions did not demonstrate a significant deficit in spontaneous naming success at retest.

With respect to individual DAT participants, performance at retest was variable with respect to initial testing, with some individuals maintaining initial success levels and others actually improving with respect to initial test performance.

Evidence for Consistencies in Misnamings Between Initial Test and Retest

In order to clarify whether the naming difficulties could be attributable to consistent loss of semantic information or inconsistent access to the lexical items, instances of response consistency between initial test and retest were examined.

The pattern of results pointed to an overall absence of consistency with respect to the instances of naming success or failure between test trials. This was illustrated by the naming success rates of the core group at initial test and retest, whereby the proportion of items which could not be named despite presentation of both types of cue actually decreased from initial test (30%) to retest (25%).

The highest instances of response consistency were amongst misnamed items which were named successfully on both test trials following the presentation of either a semantic or a phonemic cue. This demonstrated that for those items, participants who were unable to spontaneously name specific items on both test sessions could nevertheless effectively use the same type of cue (either semantic or phonemic) on both occasions to facilitate recall. However, no other evidence of response consistency between trials was confirmed in the findings.

Thus, nouns which were not retrievable at one test session (Unable to Name) could nevertheless be recalled at the other in response to cueing. Interestingly, only five individual nouns (worm, spider, guitar, sandal, woodpecker) comprised the stimulus set of items which could not be named at both test sessions. Therefore the DAT group appeared to be demonstrating the features of a predominantly access disorder as the basis for their anomia.

The results would indicate the presence of an underlying problem in accessing the names of target items. The presence of, or loss of, priming effects has been used by Warrington and Shallice (1979) and Shallice (1987) as one of the criteria to differentiate between, respectively, semantic access or semantic storage disorders. Shallice (1987) argues that individuals with breakdown in the semantic system would not benefit from a priming event, because a representation which no longer exists cannot be primed. The term priming is used in this definition to refer to the process whereby a subject is able to use a verbal or pictorial prompt to facilitate the processing of a conceptually related item, rather than the passive or automatic semantic activation which primes recognition of a subsequent stimulus.

<u>The Lexical Production Tests : The Generative Naming Test</u>

The statistical analyses showed that the DAT group generated significantly fewer items than the Control subjects for every category in the <u>Generative Naming Test</u> at the significance level of $p < 0.001$ ($p < 0.01$ level for *Kitchen Tools* and *House Objects*). This confirmed the experimental hypothesis that the DAT group would be significantly impaired in relation to the Control group on the measures of category fluency.

These results replicate those from previous research (Ober, Dronkers, Koss, Delis, and Friedland, 1986; Martin and Fedio, 1983) showing that individuals with Alzheimer-type dementia show decreased ability to generate members of a given semantic category, in relation to normal individuals.

In previous research, Ober, Dronkers, Koss, Delis, and Friedland (1986) found that even patients with mild dementia generated only half the number of items produced by normals. Martin & Fedio (1983) and Ober et al (1986) found that on a fluency test requiring subjects to name items in a supermarket, Alzheimer patients not only named fewer items overall than normals, but also tended to produce only single items from each subcategory or to name the subcategory itself (for example "vegetables").

Comparative studies (Appell et al., 1982; Huff et al., 1986) have further highlighted word fluency performance to be more deficient than confrontation naming, lending support to the notion (Isaacs & Kennie, 1973) that category fluency measures are useful in screening protocols for dementia.

Analysis of the ability of individual participants within the DAT group confirmed variability in generative naming performance between individual participants.

The minimum number of items generated by any participant was 0 (nil). Participant D1 found the test particularly difficult and was unable to recall items for any of the categories, such that the test was abandoned in order to prevent the participant's distress. Other participants also named as few as 0 - 1 items in response to particular categories.

In contrast, some participants named as many as 15 - 18 items. These high numbers were generated predominantly for the category of *Body Parts*; for example, at retest the highest number of items generated by any DAT participant was 16, in response to this particular category.

- Performance of the Core group at Retest

Comparison of the mean number of items generated by the core DAT group for each target category at retest showed that fewer items were generated relative to initial testing for all except two (*Fruit* and *Footwear*) of the categories. The mean number of items generated ranged from minimum 3.2 items to maximum 8.0 items at initial test, and from minimum 2.3 items to maximum 7.8 items at retest.

This confirmed the trend for a decline in generative naming abilities with increasing duration of DAT; this observed decline was not however found to be statistically significant. Thus the experimental hypothesis that the DAT participants' fluency skills would decline significantly at retest was not confirmed.

- Trends According to Semantic Category

The responses of the research groups were examined in order to observe any trends according to semantic category, for example particular success or difficulty associated with categories. The rank orderings by semantic category showed that both the Control and DAT (at initial test) groups generated the highest number of items with respect to the category of *Body Parts.*

However, the groups differed with respect to the category for which the fewest items were generated: *Footwear* for the Control group and *Insects* for the DAT group. Both groups achieved identical rankings for the categories of *Body Parts, Clothing, Fruit* and *Furniture.*

This pattern changed for the core group of six DAT participants who took part in both initial test and retest sessions. The group generated the greatest number of items for *Clothes*, rather than *Body Parts*, which was ranked in second place. *Insects* remained the category for which the fewest items were produced.

The categories of *Insects* and *Tools* emerged as being consistently among the four lowest-ranking categories for all three research groups (Control group, DAT group at initial test and the core DAT group at retest).

Previous research has confirmed different response patterns for semantic categories comprising biological items or 'living things' (animals, fruits, vegetables) as compared with categories of non-biological or 'inanimate' items.

McCarthy and Warrington (1988) reported data from their patient (T.O.B) who presented a selective and consistent category-specific impairment in knowledge of the spoken names of animals. Furthermore, T.O.B.'s visual knowledge of the same items, tested by picture stimuli, was relatively unaffected.

Chertkow and Bub (1990) found that individuals with DAT showed greater impairment for objects from biological categories on 'semantic probe' tests of superordinate and subordinate knowledge.

When comparing the ease of recall of items on the Generative Naming tests in this research, it appears that the biological categories (for example fruit, vegetables, animals, body parts) were amongst the highest-ranking for the DAT participants as far as mean number of items generated, with the exception of *Insects*.

- Variety of Noun Responses Given in the Generative Naming Tests

The responses given by the Control and DAT research participants for each of the fifteen semantic categories were analysed to determine the frequency of occurrence of different individual nouns. The analyses showed that the responses of the DAT participants at initial test, and the responses of the core DAT group at retest, comprised a smaller variety of individual nouns for every semantic category, in comparison to the responses of the Control group.

The Control group consistently generated a variety of nouns which was two to three times greater than that generated by the DAT group for every semantic category.

- Commonality or Overlap of Noun Responses

As a further analysis, the two to three most frequently occurring nouns given by the core group of six DAT participants in response to each semantic category at initial test, and at retest nine months later, were compared in order to detect any similarities. It was found that for the majority of the fifteen categories the two or three most frequently cited noun responses were identical at both test sessions. For the category of *Kitchen Utensils*, the three most frequently cited nouns were identical (knife, fork, spoon).

These findings demonstrate that despite a reduced ability by the DAT participants, in comparison with the Control subjects, to generate a varied selection of noun exemplars for each semantic category tested, nevertheless the DAT participants showed evidence of retaining a 'core set' of nouns for each category. This core set comprised 'robust', high-frequency category exemplars which could be recalled under effortful, uncued test conditions despite a period of nine months of disease progression.

Although the variability between the DAT participants must also be acknowledged, as within the group there was evidence of individual participants being unable to cite member nouns for certain or any categories (for example Participant D1), nevertheless the findings are promising with respect to the ability of older people at varying levels of severity and progression of DAT to recall a high-frequency 'core vocabulary' of object names for functional use within their daily environment.

CONCLUSIONS AND CLINICAL IMPLICATIONS

The research pointed to three key findings with respect to semantic knowledge in older people with dementia of the Alzheimer type.

Firstly, the participants with DAT in this research demonstrated the ability to utilise highly specific information about distinctive attributes of objects, presented in the form of spoken semantic cues, to recognise a set of concrete nouns representing fifteen semantic categories, in the presence of competing noun distractors of varying semantic relatedness to the target. Recognition performance was not significantly influenced by mode of stimulus presentation - that is, pictures or written words.

Therefore, although the performance of participants with DAT on the Recognition by Unique Feature and the Recognition by Category tests was compromised in relation to normally ageing people, the specific feature cues facilitated performance significantly more successfully than category membership. The findings thus confirmed the research hypotheses with respect to the Recognition by Unique Feature Test. The observed performance trend with respect to this test was used to argue for the availability and accessibility of detailed concept information in semantic memory.

Furthermore, high levels of performance were upheld in both the picture and written modalities after a time interval of mean duration nine months, demonstrating that concept information remained accessible despite advancing disease severity evident as measurable cognitive and functional decline.

- Implications with respect to tracking disease progression and severity

The written version of the Recognition by Unique Feature Test was found to be sensitive to advancing severity of disease, such that consistently significant differences were detected between participants in the mildest severity group (Very Mild cognitive decline) and those in the remaining three severity subgroups (Mild, Moderate and Moderately Severe cognitive decline).

These findings highlight the clinical relevance of the Recognition by Unique Feature Test. The test could be applied in charting the progression of DAT, as it has been shown to be sensitive to severity of disease. Opportunities also exist with respect to its further development as an assessment tool in screening for dementing disease, specifically in the detection of semantic processing deficits in relation to the performance of normally ageing people.

The second key finding was the identification of a 'core vocabulary cluster' of high frequency nouns in the responses given by the DAT participants to each of the fifteen semantic categories at each test session. Although the research data showed a progressive overall decline in the number of individual noun exemplars recalled by the DAT participants on the Generative Naming Test at retest in relation to initial test scores, nevertheless the retention of a core vocabulary of noun concepts was apparent. The availability of a core lexical store is relevant to the development of therapeutic strategies for people with Alzheimer-type dementia, including the use of cueing techniques and circumlocutory or descriptive strategies to reinforce rehearsal and facilitate recall. The intra-group variability which was observed with respect to generative naming performance, and the emergence of particular DAT participants as experiencing severe difficulties with the uncued recall demanded by this test, are factors to be considered in devising such therapeutic strategies.

The third finding was that the DAT participants were able to utilise the distinctive feature attributes to facilitate picture confrontation naming of the set of sixty concrete noun stimuli utilised in the Recognition by Unique Feature tests. The participants with DAT exhibited a significant decrement in naming performance relative to the normal older people. However, at initial testing, presentation of the specific feature attribute cues facilitated naming of nearly 50% of objects which had not been named spontaneously, again attesting to the success of the semantic cueing techniques in facilitating lexical recall.

- Considerations with respect to normal ageing

The consistently high levels of success achieved by the Control subjects on the Experimental Battery for Semantic Processing confirmed that the semantic abilities under test are resistant to the normal ageing process. The lexical processing measures developed for the research may therefore have potential application in stimulating vocabulary recall and retention skills in older people, for example those for whom isolation and loss of opportunity to communicate has caused a reduction in spontaneous communicative efforts.

- Methodological Considerations

The method of testing attribute knowledge employed in this research was identified as a significant factor in promoting the high levels of success demonstrated by the DAT participants. Thus, the presentation of specific attribute information in the form of spoken cues, accompanied by additional cue stimuli specifically pictures of the target objects or their written names, was noted to facilitate guided recognition.

- Category Performance

The performance trends within both the Control and DAT research groups indicated that the tests drawing upon the ability to classify nouns according to shared semantic category membership (Picture and Written Recognition by Category tests) presented greater difficulty than the tests of specific feature recognition. The findings also indicated that the ability to categorise nouns was enhanced in the picture modality relative to the written modality. These findings are at variance with other reports that broader category-level knowledge remains less vulnerable to the effects of DAT, whereas specific attribute knowledge is subject to early breakdown in the disease process.

- Heterogeneity of Clinical Presentation

The performance of the DAT group highlighted the heterogeneity which has been described in the literature as a characteristic of this type of dementia.

Selected individuals were identified who presented unique profiles of cognitive, linguistic and functional abilities at variance from the performance of other research participants evaluated as being at the same level of cognitive decline with reference to a clinical rating tool. Analysis of individual performance profiles in relation to the Control baseline confirmed selective patterns of deficit and 'islands' of intact ability rather than global 'across the board' decline in cognitive and semantic skills.

With respect to visual processing, selective vulnerability was identified in individual DAT group participants although heterogeneity was observed and such visual deficits did not characterise the group as a whole.

Duration of disease, measured in reported time since onset of observable symptoms, was not found to be a reliable indication of either cognitive performance profile or likely rate of disease progression. A drop-out rate of 50% at retest also highlighted the variable rate and symptomatology of disease progression amongst people with DAT. For the core DAT group, that is those able to participate at both test sessions, the group tendency was for non-significant decline in cognitive and semantic performance relative to initial test.

The research findings therefore highlight the individuality of cognitive and linguistic impairment in older people with Alzheimer-type dementia. The findings also demonstrated that individual patterns of deficit can be masked by the group effect. This in turn confirms the value of single-case investigations which can map changes in performance as they arise with progression of dementia.

It is acknowledged that the research procedure involved a relatively small group of participants with DAT. The number of participants representing each level of dementia severity was not more than four, and the number who could participate at retest was smaller due to unavoidable events such as medical illness related to disease progression.

The Experimental Battery for Semantic Processing devised for the research procedure invites further application with larger groups of research participants with the opportunity to evaluate performance on a longitudinal basis.

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APPENDIX 1

INFORMATION AND CONSENT FORM

A Study of the Word Finding Difficulties Experienced by Elderly People with Memory Problems

I am a Speech and Language Therapist working with elderly people.

I am carrying out a research project to try and find out more about how words are associated to each other and remembered by English speakers who are aged over 65 years.

In this study, you will be asked to carry out several activities which involve written words and / or black and white drawings of everyday objects. In order that the procedure will not take too long in one single session, the activities have been divided into sets. This means that you will be asked to participate on at least two separate occasions.

As part of this research, you will also be asked to repeat the same procedure at a later interval (most likely six monthly).

This study does NOT involve any drugs. It is NOT intended to constitute or replace any form of treatment, and no personal details about the participants will be mentioned in the project report.

Please could you indicate your consent to take part in this study on the form overleaf.

Thank you for your help. Your participation in this project is greatly appreciated.

Kim Zabihi

APPENDIX 1 (continued)

INFORMATION AND CONSENT FORM

CONSENT

I, ...OF

....

agree to participate in the research project "A Study of Naming and Word Finding in Elderly People".

The nature and purpose of the project have been explained to me by Kim Zabihi.

SIGNED..

DATE...

ASSENT

I, ...

being next of kin / carer of ....

give my consent for him / her to participate in the project "A Study of Naming and Word Finding in Elderly People".

The nature and purpose of the procedure have been explained to me by Kim Zabihi.

I understand that participation in this project is incidental to any treatment which he / she may be receiving and that it will not alter that treatment.

SIGNED..

DATE...

APPENDIX 2

HEALTH SCREENING QUESTIONNAIRE

Please could you respond to the questions below as part of the project:

A Study of Naming and Word Finding in Elderly People

The information you give will be treated in confidence and used only for the purposes of this project. Thank you for your help.

Kim Zabihi

DATE OF BIRTH: ______________________

AGE AT WHICH YOU LEFT SCHOOL: ______________________

YOUR MAIN OCCUPATION: ______________________

DO YOU WEAR GLASSES? ______________________

DO YOU WEAR A HEARING AID? ______________________

HAVE YOU EVER EXPERIENCED ANY OF THE FOLLOWING MEDICAL CONDITIONS? ______________________

	YES	NO
• STROKE		
• PARKINSON'S DISEASE		
• HEART CONDITION		
• ASTHMA / BREATHING DIFICULTIES		
• DIABETES		
• EPILEPSY		
• SEVERE DEPRESSION		
• THYROID PROBLEMS		

APPENDIX 3

SHORT NART PREDICTED FULL SCALE IQ SCORES : CONTROL SUBJECTS

SUBJECT	SHORT NART Score	Predicted NART Score	Full Scale IQ Score
C1	23	27	97
C2	24	26	98
C3	23	27	97
C4	20	24	101
C5	25	25	100
C6	22	28	96
C7	15	33	90
C8	25	25	100
C9	24	26	98
C10	21	29	95
C11	23	27	97
C12	25	25	100
C13	23	27	97
C14	16	31	92
C15	25	25	100
C16	24	26	98
C17	25	25	100
C18	25	25	100
C19	25	25	100
C20	25	25	100
C21	23	27	97
MEAN	22.90	26.57	102.5

APPENDIX 4

SHORT NART PREDICTED FULL SCALE IQ SCORES : DAT PARTICIPANTS

PARTICIPANT	SHORT NART Score	Predicted NART Score	Full Scale IQ Score
D1	22	28	96
D2	11	39	82
D3	14	34	89
D4	14	34	89
D5	24	26	98
D6	18	28	96
D7	24	26	98
D8	21	29	95
D9	5	45	75
D10	12	38	84
D11	14	34	89
D12	20	24	101
D13	18	28	96
D14	15	33	90
D15	19	26	98
MEAN	16.73	31.47	89.2

APPENDIX 5

Short NART PREDICTED FULL SCALE IQ SCORES : PILOT GROUP

	SHORT NART Score	Predicted NART Score	Full Scale IQ Score
CONTROL GROUP			
PC1	25	25	100
PC2	11	39	82
PC3	24	26	98
PC4	21	29	95
PC5	5	45	75
MEAN	20.25*		112.5

(* data from PC5 omitted from analyses)

	SHORT NART Score	Predicted NART Score	Full Scale IQ Score
DAT GROUP			
PD1	19	26	98
PD2	17	30	94
PD3	16	31	92
MEAN	17.33		94.7

APPENDIX 6

THE RECOGNITION BY UNIQUE FEATURE TEST STIMULI : PILOT STUDY

The 30 nouns utilised in the Recognition by Feature Test and Picture Naming Test.

ANIMALS
cat
sheep

BIRDS
chicken
peacock

BODY PARTS
mouth
foot

CLOTHING
gloves*
hat

FOOTWEAR
boot
slipper

FRUIT
lemon
banana

FURNITURE
fireplace*
wardrobe

BUILDINGS**
church
castle

INSECTS
spider
bee

JEWELLERY
ring
medal

KITCHEN TOOLS
cup
rolling pin

MUSIC
piano
guitar*

TOOLS
paintbrush*
saw

TRANSPORT
ship
bus*

VEGETABLES
onion
mushroom

* indicates stimuli incorporated into the written test or changed in the main study
** this category was changed to that of 'Household Objects' for the main study

APPENDIX 7

THE WRITTEN RECOGNITION BY CATEGORY TEST : PILOT STUDY

The five categories for the Recognition by Category Test and Generative Naming Test.

The target stimuli are in bold (targets and distractors not listed in presentation order).

GIRLS' NAMES
ALICE
HANNAH
SUSAN
TEAPOT
DRESS
NECKLACE

BOYS' NAMES
ARTHUR
GEORGE
DAVID
PIPE
CAR
TIE

RELATIVES
MOTHER
SISTER
UNCLE
HAND
DOLL
HOUSE

OCCUPATIONS
CLERK
TEACHER
DOCTOR
TABLE
BREAD
WHEEL

SPORTS
TENNIS
CRICKET
BOXING
BALL
SHOE
GRASS

APPENDIX 8

ORDER OF TEST PRESENTATION : EXPERIMENTAL BATTERY FOR SEMANTIC PROCESSING

ORDER A

1. Generative Naming Test
   (Animals, Clothing, Kitchen Utensils, Transport, Musical Instruments)

2. Recognition by Unique Feature Test : Picture Version

3. Recognition by Category Test : Written Version

4. Generative Naming Test
   (Birds, Fruit, Jewellery, Footwear, Household Objects)

5. Recognition by Category Test : Picture Version

6. Recognition by Unique Feature Test : Written Version

7. Generative Naming Test
   (Body Parts, Furniture, Insects, Tools, Vegetables)

8. Picture Naming Test

ORDER B

1. Generative Naming Test
   (Animals, Clothing, Kitchen Utensils, Transport, Musical Instruments)

2. Picture Naming Test

3. Recognition by Category Test : Picture Version

4. Recognition by Unique Feature Test : Written Version

5. Generative Naming Test
   (Birds, Fruit, Jewellery, Footwear, Household Objects)

6. Recognition by Unique Feature Test : Picture Version

7. Recognition by Category Test : Written Version

8. Generative Naming Test
   (Body Parts, Furniture, Insects, Tools, Vegetables)

APPENDIX 9

INSTRUCTIONS PRESENTED TO THE RESEARCH PARTICIPANTS FOR EACH SEMANTIC PROCESSING TEST

- Recognition by Unique Feature Test (Picture and Written versions)

I am going to show you some pictures (words), five on each page. Please look at all of the pictures (words). Then I will give you a clue describing one of the pictures (words), and I'd like you to show me which picture (word) matches the description you hear.

On presentation of each test display :

"Which one is for ...?" and present spoken unique feature cue.

- Recognition by Category Test (Picture and Written versions)

I am going to show you some pictures (words), five on each page. Please look at all of the pictures (words). Then I'd like you to show me which three pictures (words) belong together, or belong to the same group of things.

On presentation of each test display :

"Which three belong together?".

APPENDIX 9 (continued)

INSTRUCTIONS PRESENTED TO THE RESEARCH PARTICIPANTS

FOR EACH SEMANTIC PROCESSING TEST

- Picture Naming Test

I am going to show you some pictures, one at a time. I'd like you to name each picture for me. If you cannot remember the name, I will give you a clue to help you, and then I will give you another clue.

On presentation of each stimulus picture :

"Can you tell me the name of this picture".

- Generative Naming Test

I am going to give you some groups of things, and I would like you to name as many things from that group as you can. I will give you one minute for each group, and tell you when to stop.

On presentation of each stimulus semantic category :

"Can you tell me as many (...) as you can think of".

APPENDIX 10

THE FIFTEEN SEMANTIC CATEGORIES UTILISED IN THE RESEARCH

CLUSTER 1	CLUSTER 2	CLUSTER 3
Animals	Birds	Body Parts
Clothing	Fruit	Furniture
Kitchen Tools	Jewellery	Insects
Transport	Footwear	Tools
Musical Instruments	Household Objects	Vegetables

APPENDIX 11

THE RECOGNITION BY UNIQUE FEATURE TEST : PICTURE VERSION

TARGETS			DISTRACTORS			
ITEM	TARGET	UNIQUE FEATURE CUE	CLOSE SEMANTIC	DISTANT SEMANTIC	VISUAL	UNRELATED
1	SHEEP	For wool	cow	lion	ostrich	trousers
2	MOUTH	For talking	nose	ankle	fish	dress
3	HAT	For wearing on the head	scarf	shirt	cake	flower
4	CAT	For catching mice	dog	elephant	teddy bear	gift box
5	WARDROBE	For hanging your clothes in	drawers	chair	window	lion
6	CUP	For drinking tea	saucer	wine glass	bucket	pig
7	PEACOCK	Proud of its plumage	swan	penguin	tree	bus
8	HAMMER	For banging nails	screwdriver	scissors	razor	dress
9	HARP	For plucking the strings	violin	xylophone	hoover	cow
10	BANANA	Grows in bunches	pineapple	apple	dolphin	shoe
11	ROLLING PIN	For preparing pastry	whisk	frying pan	truncheon	trousers
12	SPIDER	For spinning webs	fly	worm	palm tree	shoe
13	BOOT	For walking in puddles	shoe	clog	leg	tiger
14	ONION	Makes your eyes water	potato	radish	acorn	fork
15	FOOT	For walking	hand	ear	glove	kettle

APPENDIX 11 **(continued)**

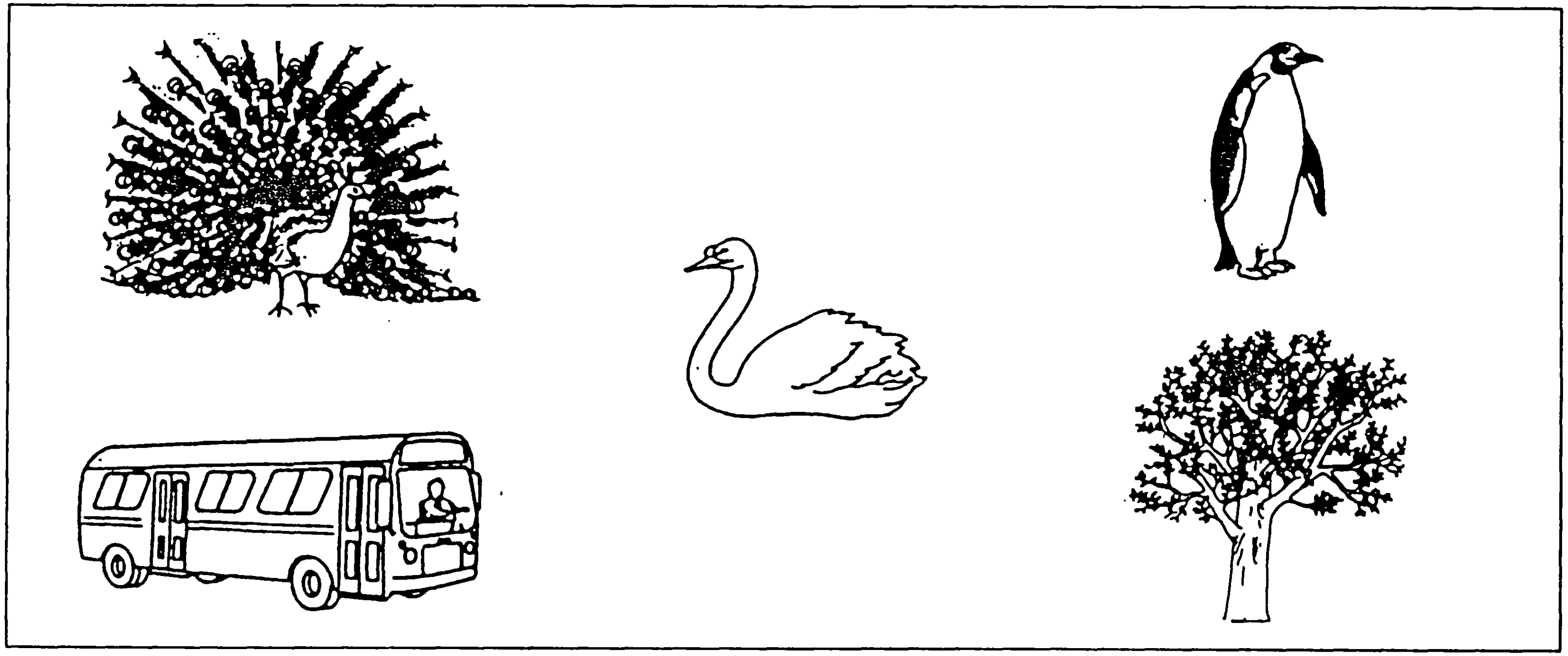
THE RECOGNITION BY UNIQUE FEATURE TEST : PICTURE VERSION

TARGETS			DISTRACTORS			
ITEM	TARGET	UNIQUE FEATURE CUE	CLOSE SEMANTIC	DISTANT SEMANTIC	VISUAL	UNRELATED
16	RING	For wearing on the finger	watch	locket	apple	spoon
17	AIRPLANE	It carries people in the sky	train	boat	dragonfly	watch
18	LEMON	For squeezing over pancakes	orange	cherries	fish	spanner
19	FOUNTAIN PEN	It uses ink	paper	envelope	knife	sock
20	CHICKEN	For laying eggs on the farm	duck	peacock	pitcher	handbag
21	SCARF	For keeping the neck warm	gloves	skirt	snake	chair
22	MEDAL	Given for bravery	crown	earring	vase	dog
23	MUSHROOM	It can sometimes be poisonous	peas	asparagus	bonnet	boot
24	SAW	For cutting wood	hammer	clamp	key	handbag
25	PIANO	It's played with keys	violin	maraccas	sink unit	duck
26	BEE	For making honey	butterfly	caterpillar	woolly hat	leg
27	SHIP	It carries passengers across the water	train	ambulance	transistor radio	trousers
28	SLIPPER	For wearing at bedtime	shoe	ice skate	ball in hand	watch
29	BED	For sleeping in	armchair	bookcase	dining table	elephant
30	KEY	For opening doors	lock	chain	saw	mouth

APPENDIX 12

THE RECOGNITION BY UNIQUE FEATURE TEST : PICTURE SAMPLE

Unique Feature semantic cue : "proud of its plumage"



* stimuli reduced from original size

APPENDIX 13

THE RECOGNITION BY UNIQUE FEATURE TEST : WRITTEN VERSION

TARGETS			DISTRACTORS			
ITEM	TARGET	UNIQUE FEATURE CUE	CLOSE SEMANTIC	DISTANT SEMANTIC	VISUAL	UNRELATED
1	DOG	Man's best friend	cat	mule	doll	table
2	WATCH	For telling the time	ring	beads	wrench	table
3	GUITAR	For strumming	drum	flute	garter	spider
4	BOAT	It moves with oars	ship	train	bait	nose
5	KNIFE	For slicing bread	fork	ladle	knee	sheep
6	APPLE	It grows in an orchard	pear	melon	ankle	chair
7	GLOVE	For keeping the hands warm	scarf	vest	glue	onion
8	WORM	It's good for the soil	beetle	locust	storm	violin
9	KETTLE	For boiling water	cup	toaster	cattle	dog
10	WOODPECKE R	It bores holes in trees	owl	hawk	wallpaper	skirt
11	SKATE	For gliding on ice	shoe	sandal	kite	tiger
12	PEA	It grows in a pod	carrot	artichoke	pear	watch
13	LION	King of the jungle	tiger	wolf	lawn	shoe
14	SUITCASE	For packing clothes in	basket	purse	seahorse	donkey
15	AXE	For chopping wood	drill	rake	ape	spoon

APPENDIX 13 (continued)

THE RECOGNITION BY UNIQUE FEATURE TEST : WRITTEN VERSION

TARGETS			DISTRACTORS			
ITEM	TARGET	UNIQUE FEATURE CUE	CLOSE SEMANTIC	DISTANT SEMANTIC	VISUAL	UNRELATED
16	COT	For babies to sleep in	bed	hammock	coat	sheep
17	LADYBIRD	It has a spotted back	spider	mosquito	landlord	finger
18	TRAIN	It runs on rails	coach	submarine	stain	rabbit
19	KNEE	For bending the leg	elbow	tongue	knife	pen
20	GRAPE	It grows in the vineyard	orange	fig	grate	table
21	BELL	For ringing in church	organ	drum	ball	chair
22	CORN	It grows on the cob	potato	spinach	coin	dress
23	SPADE	For digging	rake	axe	spire	nose
24	SANDAL	Your toes peep out of them	boot	moccasin	satchel	rabbit
25	CROWN	Worn by a king	tiara	bracelet	crane	violin
26	DESK	For sitting at in the office	bookcase	sofa	nest	foot
27	SHAWL	For draping around the shoulders	tie	sock	shell	horse
28	THIMBLE	It protects the fingers when sewing	needle	scissors	thistle	horse
29	HAND	For holding things	foot	nose	wand	duck
30	TURKEY	Traditionally eaten at Christmas	duck	ostrich	turtle	bed

APPENDIX 14

THE RECOGNITION BY UNIQUE FEATURE TEST : WRITTEN STIMULUS SAMPLE

Unique Feature semantic cue : "for keeping the hands warm"

VEST	GLUE
GLOVE	
SCARF	ONION

* stimuli reduced from original size

APPENDIX 15

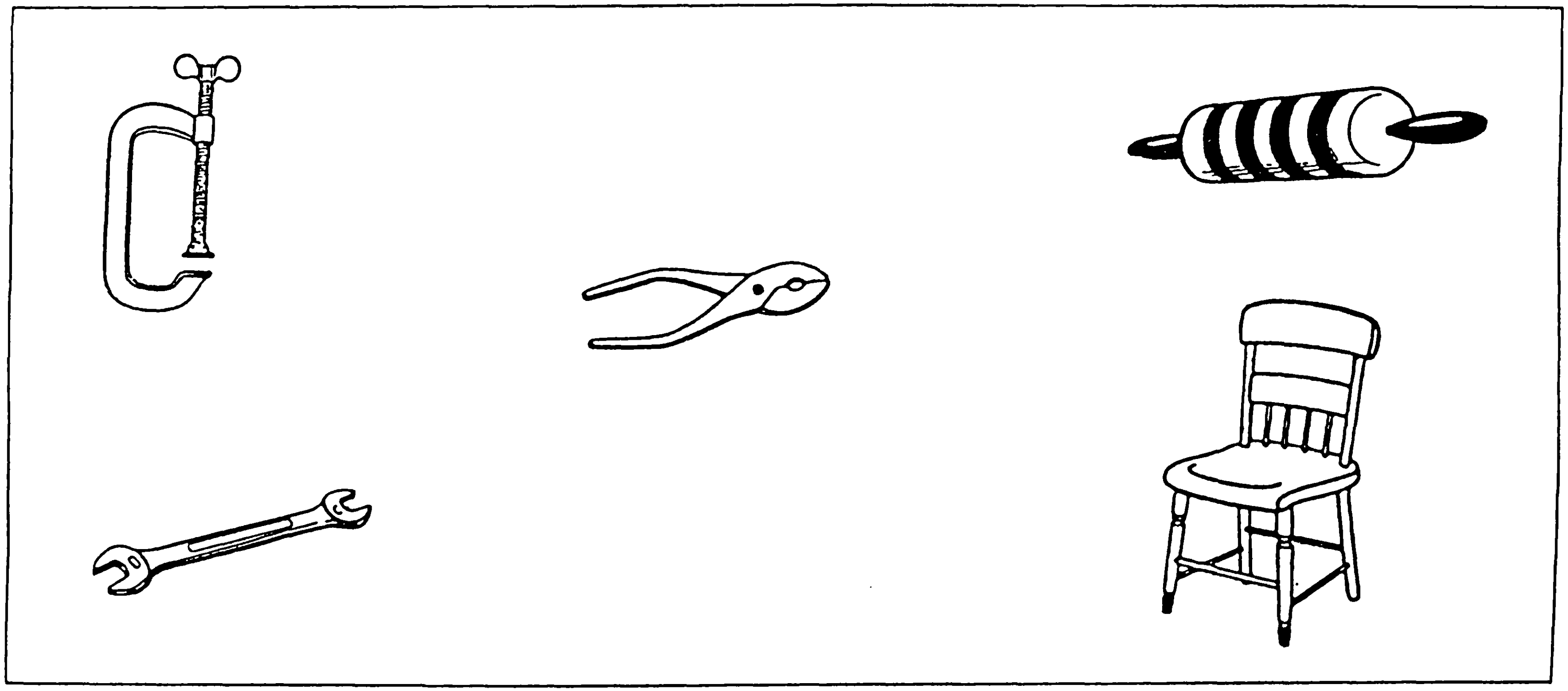
THE RECOGNITION BY CATEGORY TEST : PICTURE VERSION

ITEM	CATEGORY	TARGET CATEGORY ITEMS			SEMANTIC DISTRACTOR	UNRELATED DISTRACTOR
1	FRUIT	orange	strawberry	pineapple	tree	drum
2	BODY PARTS	eye	ear	nose	glasses	feather
3	CLOTHING	trousers	skirt	shirt	coathanger	guitar
4	JEWELLERY	necklace	locket	earring	belt	kettle
5	FURNITURE	chair	bed	sofa	stairs	bus
6	INSECTS	butterfly	fly	dragonfly	bird	grapes
7	TRANSPORT	car	coach	lorry	pram	hammer
8	FOOTWEAR	brogue	court shoe	boottee	glove	saw
9	FRUIT*	pear	grapes	cherries	carrot	horse
10	BIRDS	sparrow	swan	eagle	worm	finger
11	MUSICAL INSTRUMENTS	violin	drum	xylophone	whistle	dress
12	ANIMALS	elephant	tiger	giraffe	peacock	tree
13	KITCHEN UTENSILS	colander	scale	frying pan	pliers	boot
14	TOOLS	spanner	pliers	clamp	rolling pin	chair
15	VEGETABLES	carrot	cabbage	potato	cherries	spade

*The category of FRUIT was utilised in the place of EVERYDAY OBJECTS

APPENDIX 16

THE RECOGNITION BY CATEGORY TEST : PICTURE SAMPLE



* stimuli reduced from original size

APPENDIX 17

THE RECOGNITION BY CATEGORY TEST : WRITTEN VERSION

ITEM	CATEGORY	TARGET CATEGORY ITEMS			SEMANTIC DISTRACTOR	UNRELATED DISTRACTOR
1	ANIMALS	bear	monkey	fox	fur	kettle
2	FRUIT	apricot	plum	peach	seed	chair
3	BIRDS	pigeon	owl	seagull	feather	bed
4	CLOTHING	coat	blouse	dress	button	chicken
5	HOUSEHOLD OBJECTS	pencil	ruler	paper	school	rabbit
6	KITCHEN UTENSILS	plate	bowl	saucer	rim	cat
7	VEGETABLES	cabbage	carrot	potato	soil	scarf
8	INSECTS	moth	fly	wasp	wing	sock
9	FURNITURE	chair	stool	table	hinge	spider
10	FOOTWEAR	sandal	clog	brogue	buckle	nose
11	TRANSPORT	motorbik e	van	taxi	tyre	dress
12	JEWELLERY	bracelet	beads	tiara	clasp	paper
13	TOOLS	pliers	wrench	drill	steel	sheep
14	MUSICAL INSTRUMENTS	clarinet	oboe	trumpet	string	rabbit
15	BODY PARTS	elbow	wrist	ankle	bone	bus

APPENDIX 18

THE RECOGNITION BY CATEGORY TEST : WRITTEN SAMPLE

BEAR

MONKEY

FUR

FOX

KETTLE

* stimuli reduced from original size

APPENDIX 19

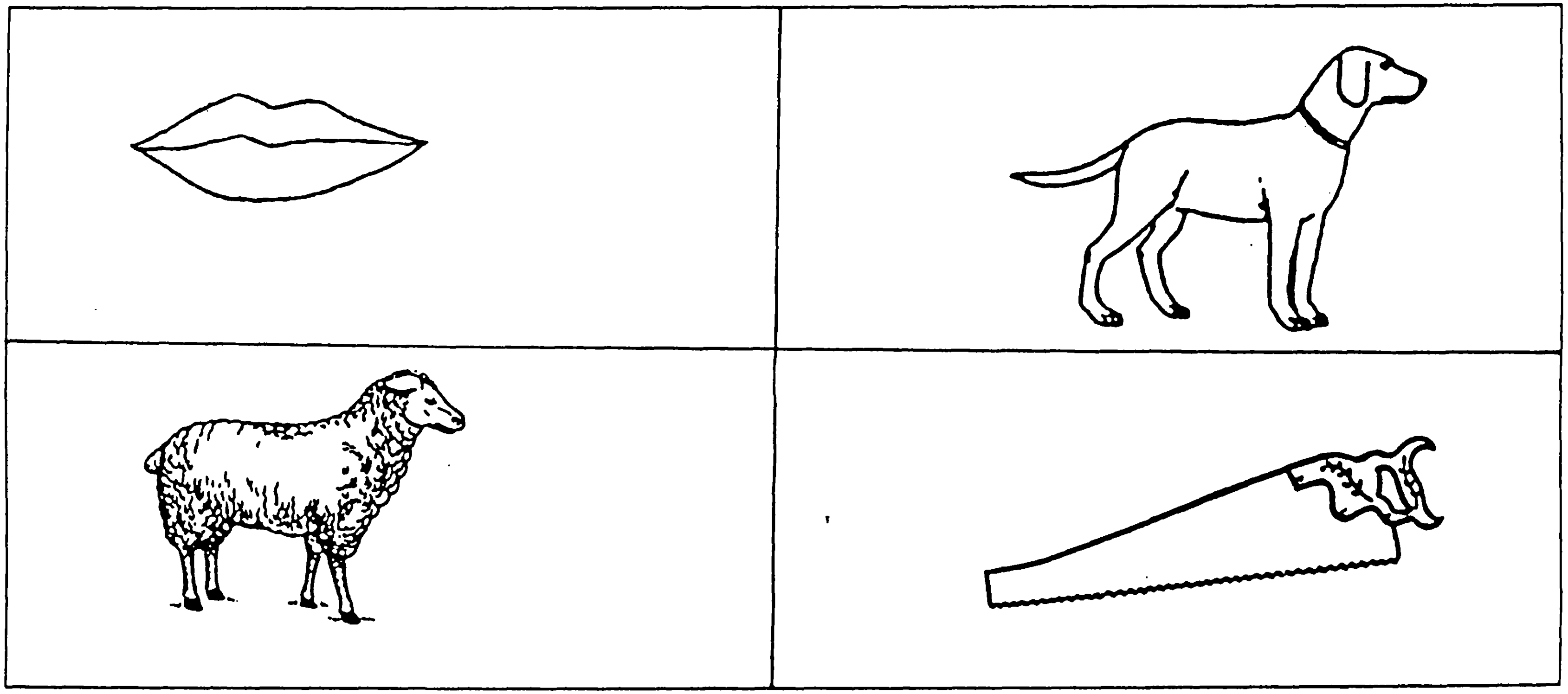
THE PICTURE NAMING TEST STIMULI : IN ORDER OF PRESENTATION

Practice : swan
Practice : chair

1. sheep
2. mouth
3. hat
4. cat
5. wardrobe
6. cup
7. peacock
8. hammer
9. harp
10. banana
11. rolling pin
12. spider
13. boot
14. onion
15. foot
16. ring
17. airplane
18. lemon
19. fountain pen
20. chicken
21. scarf
22. medal
23. mushroom
24. saw
25. piano
26. bee
27. ship
28. slipper
29. bed
30. key
31. dog
32. watch
33. guitar
34. row boat
35. knife
36. apple
37. gloves
38. worm
39. kettle
40. woodpecker
41. ice skate
42. pea
43. lion
44. suitcase
45. axe
46. cot
47. ladybird
48. train
49. knee
50. grapes
51. bell
52. corn
53. spade
54. sandal
55. crown
56. desk
57. shawl
58. thimble
59. hand
60. turkey

APPENDIX 20

THE PICTURE NAMING TEST : SAMPLE STIMULI



* stimuli reduced from original size

APPENDIX 21

TEST DATA FOR THE STANDARD MEASURES BATTERY FOR COGNITIVE AND LANGUAGE FUNCTION : THE CONTROL GROUP

Participant	CAPE	VISUAL 1	VISUAL 2	SHORT NART	SHORT BPVS	PYRAMIDS & PALM TREES	COLOURS	ANIMALS	FRUITS	TOWNS
C1	12	10	20	23	31	30	16	16	16	19
C2	12	10	20	24	31	30	18	17	19	21
C3	12	10	20	23	29	30	10	11	10	9
C4	11	10	20	20	31	30	10	13	11	15
C5	12	10	20	25	31	30	18	18	16	19
C6	12	10	20	22	27	30	10	14	10	10
C7	11	10	20	15	24	29	11	12	12	11
C8	12	10	20	25	31	30	11	19	14	15
C9	12	10	20	24	31	30	12	17	16	14
C10	12	10	20	21	30	30	11	8	11	10
C11	12	10	20	23	31	30	12	14	11	14
C12	11	9	20	25	28	30	11	15	12	12
C13	11	10	20	23	31	30	10	11	10	12
C14	11	10	20	16	29	30	14	13	14	13
C15	12	10	20	25	31	30	12	11	11	11
C16	12	10	20	24	30	30	13	12	13	20
C17	11	10	20	25	31	28	16	8	10	13
C18	11	10	20	25	29	30	13	13	14	13
C19	12	10	20	25	32	30	11	16	18	18
C20	12	10	20	25	31	30	10	12	12	11
C21	10	10	20	23	24	30	12	16	12	6

APPENDIX 22

TEST DATA FOR THE STANDARD MEASURES BATTERY FOR COGNITIVE AND LANGUAGE FUNCTION : THE DAT GROUP

Participant	CAPE	VISUAL 1	VISUAL 2	SHORT NART	SHORT BPVS	PYRAMIDS & PALM TREES	COLOURS	ANIMALS	FRUITS	TOWNS
D1	4	10	20	22	no data	26	7	2	0	0
D2	8	10	20	11	no data	25	13	13	11	4
D3	5	10	20	14	29	25	9	7	6	3
D4	8	10	20	14	27	20	8	13	5	8
D5	9	10	20	24	29	28	14	8	7	11
D6	8	8	20	18	29	28	13	11	9	7
D7	4	4	8	24	7	3	3	2	3	4
D8	11	10	20	21	27	30	10	12	14	7
D9	3	7	16	5	15	22	6	8	5	1
D10	6	10	20	12	23	9	9	4	7	3
D11	6	9	19	14	22	26	7	5	8	6
D12	5	10	20	20	27	23	11	9	7	2
D13	12	10	20	18	no data	26	8	17	7	19
D14	8	10	16	15	no data	28	10	8	5	7
D15	1	8	19	19	30	30	9	4	4	1

APPENDIX 23

TEST DATA FOR THE EXPERIMENTAL BATTERY FOR SEMANTIC PROCESSING : THE CONTROL GROUP

Participant	RECOGNITION BY FEATURE-PICTURE	RECOGNITION BY FEATURE-WRITTEN	RECOGNITION BY CATEGORY-PICTURE	RECOGNITION BY CATEGORY-WRITTEN	PICTURE NAMING
C1	30	30	15	15	59
C2	30	30	15	15	60
C3	30	30	14	13	55
C4	30	26	11	11	57
C5	30	30	15	13	58
C6	30	30	11	8	59
C7	30	30	15	13	55
C8	30	30	15	15	59
C9	30	30	15	15	59
C10	30	30	13	12	59
C11	30	30	15	11	57
C12	30	30	15	15	60
C13	30	30	15	15	54
C14	30	30	14	11	58
C15	30	30	15	15	54
C16	30	30	15	15	58
C17	30	30	15	15	57
C18	30	30	14	14	57
C19	30	30	15	15	58
C20	30	30	15	15	56
C21	30	30	14	14	57

APPENDIX 24

TEST DATA FOR THE EXPERIMENTAL BATTERY FOR SEMANTIC PROCESSING : THE DAT GROUP

Participant	RECOGNITION BY FEATURE-PICTURE	RECOGNITION BY FEATURE-WRITTEN	RECOGNITION BY CATEGORY-PICTURE	RECOGNITION BY CATEGORY-WRITTEN	PICTURE NAMING
D1	28	29	13	11	4
D2	30	29	14	14	26
D3	29	27	5	3	49
D4	30	27	5	7	49
D5	30	30	10	9	53
D6	29	30	14	13	42
D7	23	25	8	9	33
D8	30	30	14	11	49
D9	24	24	9	3	37
D10	24	29	8	3	36
D11	29	28	6	5	50
D12	28	28	14	10	48
D13	30	30	15	15	54
D14	29	29	8	9	51
D15	25	29	12	6	45

APPENDIX 25

GENERATIVE NAMING TEST DATA : THE CONTROL GROUP

	Animal	Clothes	Kitchen Tools	Transport	Music	Bird	Fruit	Jewellery
C1	18	20	12	14	16	17	18	13
C2	19	18	14	11	13	17	17	8
C3	14	13	13	11	9	15	13	9
C4	11	11	9	12	11	9	12	6
C5	21	16	13	15	14	13	14	13
C6	10	12	9	12	11	10	8	9
C7	13	15	15	12	10	7	11	7
C8	15	11	13	10	14	14	11	8
C9	15	17	10	12	15	15	14	9
C10	16	14	8	8	11	10	10	7
C11	14	12	10	9	13	11	10	7
C12	16	13	10	11	12	10	14	8
C13	13	15	9	8	10	11	13	8
C14	15	16	13	13	8	13	10	6
C15	13	16	13	10	8	11	12	7
C16	20	17	16	14	18	17	16	10
C17	10	15	7	9	8	6	8	8
C18	11	15	9	9	11	11	13	9
C19	22	19	16	14	12	18	15	9
C20	18	14	7	9	8	11	12	6
C21	14	18	10	10	12	12	16	9

APPENDIX 25 (continued)

GENERATIVE NAMING TEST DATA : THE CONTROL GROUP

	Footwear	House Object	Body Parts	Furniture	Insect	Tools	Vegetable
C1	8	17	28	15	15	7	16
C2	8	19	26	16	12	7	18
C3	7	11	16	10	10	10	12
C4	6	5	15	10	12	10	8
C5	10	17	24	14	14	12	21
C6	7	8	19	9	7	7	10
C7	7	14	18	14	8	7	10
C8	8	13	18	14	14	6	16
C9	7	13	21	11	10	10	12
C10	7	8	16	9	9	6	10
C11	6	17	20	14	11	8	10
C12	7	11	23	13	11	13	9
C13	7	15	16	9	12	7	12
C14	6	12	15	12	10	10	13
C15	8	14	19	7	10	7	13
C16	6	12	23	14	12	11	18
C17	9	13	23	10	7	7	9
C18	4	13	13	9	9	5	13
C19	11	17	19	12	8	12	16
C20	9	10	11	9	8	7	13
C21	10	13	22	11	10	4	14

APPENDIX 26

GENERATIVE NAMING TEST DATA : THE DAT GROUP

	Animal	Clothes	Kitchen Tools	Transport	Music	Bird	Fruit	Jewellery
D1	no data	no data	no data	no data	no data	no data	no data	no data
D2	no data	no data	no data	no data	no data	no data	no data	no data
D3	5	6	5	6	5	5	7	3
D4	10	14	14	8	8	12	11	8
D5	6	10	6	10	8	5	5	5
D6	8	12	10	6	6	6	6	9
D7	7	10	10	2	4	4	2	5
D8	11	13	11	8	9	7	12	9
D9	2	4	3	1	1	1	4	3
D10	4	6	6	3	0	3	6	3
D11	9	6	8	7	5	5	6	4
D12	9	12	8	6	5	6	5	6
D13	no data	no data	no data	no data	no data	no data	no data	no data
D14	9	6	5	6	7	6	8	4
D15	4	2	3	4	0	1	5	0

APPENDIX 26 (continued)

GENERATIVE NAMING TEST DATA : THE DAT GROUP

	Footwear	House Object	Body Parts	Furniture	Insect	Tools	Vegetable
D1	no data	no data	no data	no data	no data	no data	no data
D2	no data	no data	no data	no data	no data	no data	no data
D3	4	11	5	5	0	3	6
D4	6	13	18	4	6	4	8
D5	4	7	15	7	5	6	6
D6	5	8	15	7	7	10	10
D7	3	6	3	5	3	3	1
D8	5	14	17	10	9	7	9
D9	3	2	3	4	1	2	5
D10	3	6	7	5	2	2	6
D11	5	7	6	6	3	2	7
D12	7	13	13	7	9	6	10
D13	no data	no data	no data	no data	no data	no data	no data
D14	5	11	10	4	7	4	6
D15	3	5	4	1	0	4	2

APPENDIX 27

RETEST DATA FOR THE STANDARD MEASURES BATTERY FOR COGNITIVE AND LANGUAGE FUNCTION :
THE CORE DAT GROUP

Participant	CAPE	VISUAL 1	VISUAL 2	SHORT NART	SHORT BPVS	PYRAMIDS & PALM TREES	COLOURS	ANIMALS	FRUITS	TOWNS
D1	4	no data	no data	no data	17	20	0	0	0	0
D3	3	10	20	20	13	25	7	4	5	3
D5	9	10	19	24	29	30	7	6	7	8
D6	8	8	20	19	29	28	9	9	7	8
D7	3	5	7	23	24	16	5	3	4	5
D8	10	10	19	22	27	27	9	9	8	7
D9	4	10	19	12	14	20	7	5	4	2
D10	4	3	20	4	13	14	6	3	3	3
D11	4	10	18	15	22	26	9	6	7	7
D13	10	9	18	no data	29	29	6	6	6	7

APPENDIX 28

RETEST DATA FOR THE EXPERIMENTAL BATTERY FOR SEMANTIC PROCESSING : THE CORE DAT GROUP

Participant	RECOGNITION BY FEATURE-PICTURE	RECOGNITION BY FEATURE-WRITTEN	RECOGNITION BY CATEGORY-PICTURE	RECOGNITION BY CATEGORY-WRITTEN	PICTURE NAMING
D1	25	22	11	10	0
D3	23	21	6	3	53
D5	27	30	12	12	53
D6	28	29	no data	14	51
D7	no data	28	8	no data	33
D9	24	25	8	4	47
D11	28	27	9	8	52
D13	30	30	13	13	48

APPENDIX 29

INITIAL TEST and RETEST DATA FOR THE GENERATIVE NAMING TEST : THE CORE DAT GROUP

Initial Test

	Animal	Clothes	Kitchen Tools	Transport	Musi c	Bird	Fruit	Jewellery
D3	5	6	5	6	5	5	7	3
D5	6	10	6	10	8	5	5	5
D6	8	12	10	6	6	6	6	9
D7	7	10	10	2	4	4	2	5
D9	2	4	3	1	1	1	4	3
D11	9	6	8	7	5	5	6	4

Retest

	Animal	Clothes	Kitchen Tools	Transport	Music	Bird	Fruit	Jewellery
D3	3	3	3	2	0	0	4	2
D5	9	10	9	9	6	6	6	3
D6	8	13	11	5	6	4	6	7
D7	4	6	1	1	2	3	2	3
D9	5	3	1	3	1	2	5	4
D11	7	12	8	5	4	5	11	3

APPENDIX 29 (continued)

INITIAL TEST and RETEST DATA FOR THE GENERATIVE NAMING TEST : THE CORE DAT GROUP

Initial Test

	Footwear	House Object	Body Parts	Furniture	Insect	Tools	Vegetable
D3	4	11	5	5	0	3	6
D5	4	7	15	7	5	6	6
D6	5	8	15	7	7	10	10
D7	3	6	3	5	3	3	1
D9	3	2	3	4	1	2	5
D11	5	7	6	6	3	2	7

Retest

	Footwear	House Object	Body Parts	Furniture	Insect	Tools	Vegetable
D3	2	2	2	3	1	0	1
D5	6	10	16	7	5	3	7
D6	7	8	11	6	6	3	6
D7	2	4	0	0	0	0	0
D9	3	5	5	4	0	3	3
D11	6	0	9	7	2	5	7

APPENDIX 30

NAMING TEST RESPONSES FROM INDIVIDUAL DAT PARTICIPANTS

Participant	Target Object	Naming Response
D1	peacock	know what it is; got a lot of feathers
D3	peacock	a bird
D3	woodpecker	a bird
D6	turkey	chicken; hen; peacock
D12	woodpecker	blackbird; cuckoo; crow
D3	violin	guitar
D4	guitar	fiddle; banjo ; guitar
D7	guitar	more music; people using their fingers; gitten; (strumming gesture)
D12	guitar	saxophone; violin
D14	guitar	have them on top of the pops; strumming gesture
D6	harp	a thing they play
D7	harp	he's musical - is it plucking?
D15	harp	pong. pong, pong
D3	axe	hammer; chisel
D1	wardrobe	you put clothes in ; shower
D4	desk	cabinet; cupboard; chest of drawers
D7	desk	where things are being put away

NAMING TEST RESPONSES FROM INDIVIDUAL DAT PARTICIPANTS

Participant	Target Object	Naming Response
D8	lion	sheepdog
D8	worm	snake
D7	ladybird	lots of little ones with these blobs on
D11	ladybird	beetle; spider
D8	thimble	a bucket or mold
D12	thimble	little glass upside down
D13	thimble	fez; helmet;
D6	ring	a plug in a bathroom ; a keyring
D13	crown	on the head; (gesture to head)
D4	medal	reward; you get it for honour
D10	medal	bottle of some sort; cup
D11	medal	an ornament
D14	medal	vase; clock
D9	suitcase	when you go on your honeymoon or holidays
D13	scarf	[karf]
D13	slipper	[klipper]
D7	sandal	like things that people walking around at moment; absolutely flat; peep toes

ANIMALS

CONTROL GROUP				DAT GROUP - INITIAL TEST	DAT GROUP - RETEST
alligator	deer	jaguar	puma	antelope	**cat**
anteater	dog	kangaroo	rabbit	bird	chimpanzee
antelope	dingo	koala bear	ram	camel	**cow**
baboon	donkey	lamb	rat	**cat**	**dog**
badger	dormouse	leopard	rhino	**cow**	**donkey**
bear	dromedary	lion	sheep	**dog**	**giraffe**
beaver	elephant	lizard	shrew	**donkey**	gorilla
bison	ewe	llama	snake	elephant	**horse**
boar	ferret	lynx	squirrel	fish	**kangaroo**
buffalo	fox	mole	stag	**giraffe**	**lion**
bull	gazelle	monkey	stoat	**horse**	mice
bullock	gerbil	mouse	tiger	**kangaroo**	**monkey**
calf	giraffe	mule	vole	kitten	orangutan
camel	goat	orangutan	wallaby	lamb	**pig**
cat	gorilla	otter	weasel	**lion**	pony
cheetah	guinea pig	panda	wildebeest	**monkey**	rabbit
chimp	hamster	panther	zebra	**pig**	rat
cobra	hare	pig		**tiger**	seals
colt	hippo	platypus		walrus	sheep
cougar	horse	polar bear		zebra	**tiger**
cow	hyena	polecat			
crocodile	jackal	porcupine			

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

BIRDS

CONTROL GROUP				DAT GROUP - INITIAL TEST	DAT GROUP - RETEST
blackbird	guineafowl	pelican	woodpigeon	**blackbird**	**blackbird**
bluetit	hawk	penguin	woodwarbler	bluebird	budgie
budgie	hen	pheasant	wren	bluetit	**canary**
buzzard	heron	pigeon		**canary**	cuckoo
canary	housemartin	puffin		crow	**nightingale**
chaffinch	jackdaw	quail		dove	**owl**
chick	jay	raven		**nightingale**	**parrot**
chicken	kestrel	robin		**owl**	**pigeon**
cockerel	kingfisher	rook		**parrot**	**robin**
cockatoo	lovebird	seagull		penguin	**sparrow**
crow	magpie	sparrow		**pigeon**	**swallow**
cuckoo	moorhen	starling		raven	**swan**
dove	nightingale	stork		**robin**	**thrush**
duck	owl	swallow		**sparrow**	tits
eagle	osprey	swan		**swallow**	
emu	ostrich	swift		**swan**	
falcon	parakeet	thrush		**thrush**	
finch	parrot	toucan		woodpecker	
flamingo	partridge	turkey		wren	
goose	peacock	woodpecker			

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

BODY PARTS

CONTROL GROUP

abdomen / tummy	finger	nails	waist
ankle	fingernail	neck	wrist
arm	foot	nose	
back	forearm	pelvis	
bladder	forehead	ribs	
bones	hair	shin	
bottom	hands	shoulder	
bowels	head	shoulder blade	
brain	heart	skin	
breast	heel	skull	
buttocks	hips	spinal cord	
calf	intestines	spleen	
chest	instep	stomach	
cheek	jaw	teeth	
cheekbone	kidney	thigh	
chest	knee	throat	
colon	knuckles	thumb	
ears	leg	toe	
elbow	lips	toenails	
eyebrows	liver	tongue	
eyelashes	lungs	tonsil	
eyes	mouth	torso	
face	muscles	vertebrae	

DAT GROUP - INITIAL TEST

ankle	stomach
arm	teeth
back	thigh
bust	toes
chest	waist
chin	
ears	
eyes	
elbows	
face	
feet	
fingers	
hands	
head	
heart	
hip	
knee	
leg	
lungs	
mouth	
neck	
nose	
shoulders	

DAT GROUP - RETEST

ankles
arms
back
chest
ears
elbow
eyes
face
feet
fingers
hands
head
hip
joints
knees
legs
neck
nose
spine / backbone
stomach
thigh
toes
wrist

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

CLOTHING

CONTROL GROUP				DAT GROUP - INITIAL TEST		DAT GROUP - RETEST	
anorak	dressing gown	scarf	woolly hat	apron	tunic	anorak	**shoes**
belt	evening dress	shirt	y-fronts	bag	underwear	bedsocks	**stockings**
blazer	garter	shoes		**blazer**	**vest**	**blazer**	suit
blouse	girdle	shorts		**blouse**		**blouse**	trousers
boiler suit	gloves	skirt		bra		boots	**vest**
bowler hat	gown	slip		**cardigan**		**cardigan**	
boxer short	hankie	socks		**coat**		**coat**	
bra	hat	souwester		**corset**		**corset**	
bowtie	headband	sports jacket		costume		**dress**	
camisole	jacket	stockings		**dress**		dressing gown	
cap	jeans	suit / two piece		**hat**		gloves	
cape	jumper / jersey	sweater		jumper / jersey		**hat**	
cardigan	knickers / pants	tank top		kilt		jacket	
chemise	mittens	tie		**knickers**		**knickers**	
cloak	mac	tights		**mac**		**mac**	
collar	nightdress	top hat		overalls		nightdress	
coat	overall	trilby		**pants**		pinafore	
corset	petticoat	trousers		petticoat		**pants**	
cravat	popsocks	t-shirt		**shoes**		pullover	
cummerbund	pullover	veil		shorts		sandals	
dinner jacket	pyjama	vest		skirt		scarf	
donkey jacket	raincoat	waistcoat		**stockings**		slip	
dress	ribbons	windcheater		trousers		socks	

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

FOOTWEAR

CONTROL GROUP		DAT GROUP - INITIAL TEST	DAT GROUP - RETEST
ballet shoe	slippers	ankle boot	**boots**
bedsocks	snowshoe	**boot**	galoshes
boots	socks	court shoe	laceups
boottees	sports shoes	**mocassin**	**mocassin**
brogues	stilettoe	**sandals**	**sandals**
clogs	stockings	**shoe**	**shoes**
courtshoe	tapshoe	**slippers**	**slippers**
cowboy boot	tennis shoe	socks	stockings
dance shoe	tights	**Wellington**	sunshoe
flip flop	trainers		**Wellington**
football boot	Wellington boots		
galoshes			
gym shoe			
hiking shoe			
mocassin			
mules			
plimsolls			
riding boots			
running shoe			
sabot			
sandals			
shoes			
skate			

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

FRUIT

CONTROL GROUP

apple
apricot
avocado
banana
blackberries
blackcurrant
blueberry
cherries
cranberry
damson
dates
elderberry
fig
grapefruit
grapes
gooseberry
guava
kiwi
lemon
loganberry
lychee
mango
mandarin
melon
nectarine
orange
passion fruit
peaches
pear
pineapple
plum
pomegranate
quince
raspberries
redcurrant
strawberries
tangerine
tomato

DAT GROUP - INITIAL TEST

apple
banana
blackcurrant
cherry
gooseberry
grapes
greengage
melon
orange
peach
pear
pineapple
plum
strawberry
tangerine
tomato

DAT GROUP - RETEST

apple
banana
blackcurrant
cherry
fig
gooseberry
grape
grapefruit
lemon
mango
orange
peaches
pear
plum
pomegranate
tangerine

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

FURNITURE

CONTROL GROUP		
armchair	curtain	radiogram
basin	cushions	rocking chair
bath	desk	settee
bed	dining chair	shelf
bedsettee	dining table	shower
bedside cabinet	divan	sideboard
bedside table	dresser	sink
bench	dressing table	sofa
blinds	fire	sofabed
bookcase	fireplace	stool
cabinet	fire surround	table
carpet	footrest	toilet
chair	footstool	T.V.
chaise longue	fridge	T.V. cabinet
chest	lamp	video
chest of drawers	microwave	wall unit
clock	mirror	wardrobe
coal scuttle	nest of tables	washing machine
coffee table	ottoman	washstand
cooker	piano stool	what not
couch	picture	
cupboard	radio	

DAT GROUP - INITIAL TEST	DAT GROUP - RETEST
armchair	**armchair**
bed	**bed**
chair	**chair**
coffee table	**coffee table**
cot	**cot**
cupboard	couch
door	**dresser**
dresser	dressing table
fire	**sideboard**
footstool	sofa
lamp	**table**
pouffee	wardrobe
settee	
sideboard	
stool	
suite (3 piece)	
table	

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

HOUSEHOLD OBJECTS

CONTROL GROUP

armchair	computer	hoover	paper towel	stool
bath	cooker	iron	pen	table
bathmat	cup	ironing board	pencil	tap
bathroom cleaner	cutlery	jug	pictures	tea strainer
bed	desk	kettle	pillow	telephone
breadboard	dish	keys	plate	toaster
blanket	dishrack	knife	plug	toilet paper
bleach	disinfectant	lights	polish	toilet roll
books	duster	loo / toilet	pots	toothbrush
bowl	dustpan	lotion	purse	toothpaste
broom	eyedrops	mats	razor / shaver	towel
brush	fire	microwave	rubber	T.V.
candles	flannel	mirror	ruler	vaccuum cleaner
carpet	flowers	mixer	saucepan	vases
carpet sweeper	fork	money	saucer washbasin	video
chair	fridge	mug	scales	wash-up bowl
chamois	frying pan	nailbrush	settee	washbasin
china	glasses	newspaper	sink	watch
chopboard	grill	ornaments	soap	window cleaner
cloth	hairbrush	oven	spade	wireless / radio
clock	handbag	pans	sponge	
colander	handtowel	paper	spoon	
comb	hankie	paper hankie	staples	
	table			

DAT GROUP - INITIAL TEST

broom	sideboard
brush	spoon
chair	sugar basin
clock	table
cloth	teapot
coathanger	telephone
comb	T.V.
cup	
cupboards	
dishcloth	
duster	
feather duster	
fork	
floorcloth	
frying pan	
glass	
handbrush	
jug	
knife	
plate	
saucepan	
saucer	
shoes	

DAT GROUP - RETEST

bed	toilet brush
brush	
bucket	
cans	
chair	
comb	
cups	
curtains	
dishcloth	
dishes	
duvet	
floor cloth	
forks	
handbrush	
kettle	
knives	
pans	
plates	
saucepans	
saucers	
scrubbing brush	
spoons	

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

INSECTS

CONTROL GROUP

ant
aphid
bee
beetle
blackfly
bluebottle
bug
butterfly
caterpillar
centipede
cockroach
daddy longlegs
deathwatch beetle
dragonfly
earwig
flea
fly
fruitfly
gnat
grasshopper
greenfly
hornet
hoverfly
ladybird
maggot
millipede
mosquito
moth
preying mantis
scorpion
silverfish
slug
snail
spider
spidermite
springtail
stag beetle
termite
tsetse fly
wasp
woodlouse
worm

DAT GROUP - INITIAL TEST

ant
bee
bug
butterfly
caterpillar
fly
gnat
mosquito
moth
snail
spider
wasp
worm

DAT GROUP - RETEST

ant
bee
butterfly
flea
fly
mosquito
spider
wasp
worm

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

JEWELLERY

CONTROL GROUP		DAT GROUP - INITIAL TEST	DAT GROUP - RETEST
ankle bracelet / anklet	nosering	anklet	**bracelet**
armlet	pearls	**bracelet**	**brooch**
bangle	pendant	**brooch**	**chain**
beads	pocketwatch	**chain**	**earring**
belly ring	ring	cross	locket
bracelet	signet ring	crown	medal
brooch	stud	**earring**	**necklace**
buckle	tiara	**necklace**	pearls
chain	tie pin	**ring**	**ring**
choker	toe ring	stud	scarf ring
costume jewellery	watch / wristwatch	tiara	**wrist watch**
cross and chain	wedding ring	**watch**	
crown			
cufflinks			
diamond ring			
earring			
engagement ring			
keychain			
locket			
medallion			
necklace			

KITCHEN TOOLS

CONTROL GROUP

baking tin
baking tray
basin
blender
bowl
breadbin
breadknife
brush
bucket
butterdish
cake tin
carving knife
casserole
cheesedish
chip pan
chopping board
chopping knife
coffee pot
colander
cooking tray
cup
cutlery
drying cloth
eggcup
eggtimer / mixer
food processor
fork
fridge
freezer
frying pan
grater
gravy boat
grill
grillpan
ice bucket
jug
kettle
knife
knife sharpener
ladle
lemon squeeze
masher
microwave
milk jug
mixing bowl
mop
mug
omelette pan
oven
oven cloth
pans
pastry brush
pie dish
plate
poacher
potato peeler
pots
pressure cooker
pudding basin
ramekin
roasting dish
roasting tin
rolling pin
sandwich tin
saucepan
saucer
scales
scourer
sieve
sink tidy
skewer
slicer
soufflee dish
spatula
sponge
spoon
steam cooker
strainer
teacloth
teapot
tea strainer
tin opener
toaster
tray
washing-up cloth
water filter
whisk

DAT GROUP - INITIAL TEST

baking tin
bowl
brush
chip pan
crockery
cups
dishes
forks
frying pan
glasses
jars
kettle
knives
pans
pen
plates
pot
saucepan
saucers
scales
scraper
scrub brush
sieve
spoons
towel
washing up bowl

DAT GROUP - RETEST

basins
carving knife
cups
dishes
fish slice
fork
frying pan
gas stove
grater
kettle
knife
ladle
masher
pans
plate
pots
saucepan
saucer
slicer
spoon
tablespoon
teaspoon
toaster

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

MUSIC

CONTROL GROUP		DAT GROUP - INITIAL TEST	DAT GROUP - RETEST
accordion	merumba	**accordion**	**accordion**
bagpipes	oboe	banjo	**bugle**
banjo	organ	**bugle**	**cello**
bassoon	penny whistle	**cello**	cornet
bugle	percussion	clarinet	**drum**
cello	piano	cymbal	**flute**
chimes	piccolo	**drums**	harp
clarinet	recorder	**flute**	horn
clavicord	saxophone	maraccas	**mouth organ**
concertina	spinnet	**mouth organ**	oboe
cornet	tambourine	**organ**	**organ**
cymbals	tenor sax	**piano**	**piano**
double bass	triangle	sax	triangle
drums	trombone	tambourine	**trumpet**
flute	trumpet	trombone	**violin**
guitar	tuba	**trumpet**	xylophone
harmonica	tubular bells	**violin**	
harp	viola	whistle	
harpsichord	violin		
horn / French horn	whistle		
keyboard	xylophone		
mandolin			

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

TOOLS

CONTROL GROUP		DAT GROUP - INITIAL TEST	DAT GROUP - RETEST
axe	plumbline	**chisel**	**chisel**
brace	rake	**drill**	chopper
braddle	rasp	hacksaw	**drill**
chisel	rawplugs	**hammer**	file
clamps	ruler	hoe	**hammer**
crowbar	saw	**nails**	**nail**
drill	scissors	**pliers**	**pliers**
file	screw	rake	**saw**
fork	screwdriver	ruler	**scissors**
hacksaw	scraper	**saw**	spanner
hammer	setsquare	**scissors**	torch
hoe	shears	screwdriver	
knife	shovel	scraper	
ladder	sidesquare	shears	
lawnmower	sledgehammer	spade	
level	spade		
malet	spanner		
nail	stanley knife		
paintbrush	strimmer		
pickaxe	tin opener		
pincer	trowel		
plane	vice		
pliers	wrench		

TRANSPORT

CONTROL GROUP			DAT GROUP - INITIAL TEST	DAT GROUP - RETEST
ambulance	LandRover	tricycle	**airplane**	**bicycle**
airplane / aircraft	liner	trolleybus	balloon	**boat**
balloon	lorry	truck	**bike**	**bus**
bicycle	minibus	tube	**boat**	canoe
boat	minicab	van	**bus**	**car**
bus	motorbike	wagon	**car**	**coach**
canoe	raft	yacht	caravan	glider
car	riverboat		**coach**	lorry
caravan	roller skates		**motorbike**	**motorbike**
catamaran	rowboat		**plane**	**plane**
coach	sailboat		pram	**train**
donkey	scooter		scooter	**tram**
fishing boat	ship		ship	
glider	skateboard		sled	
hangglider	sleigh		toboggan	
helicopter	speedboat		**train**	
horse	station wagon		**tram**	
horse and carriage / trap	steam train		trolley bus	
horse and cart	tandem			
hovercraft	taxi			
invalid carriage	train			
juggernaut	tram			

APPENDIX 31 THE VARIETY OF NOUNS GENERATED FOR EACH SEMANTIC CATEGORY

VEGETABLES

CONTROL GROUP

artichoke
asparagus
aubergine
avocado
beans
beetroot
broad bean
broccoli
brussels sprout
butterbean
cabbage
carrot
cauliflower
celery
chillies
corn on the cob
courgette
cucumber
endive
French beans
garlic
green beans
greens
haricot bean
kayle
leek
lentil
lettuce
mange tout
marrow
mushroom
onion
parsnip
peas
potato
radish
rhubarb
runner bean
savoy
shallot
spinach
spring onion
sweetcorn
sugar pea
swede
tomato
turnip
watercress

DAT GROUP - INITIAL TEST

artichoke
beans
beetroot
cabbage
carrots
cucumber
greens
onions
parsnips
peas
potatoes
sprouts
swede
tomato
turnip

DAT GROUP - RETEST

beans
beetroot
cabbage
cauliflower
carrots
cucumber
leeks
lettuce
marrow
onions
peas
potatoes
tomatoes
turnips