# Tip-of-the-tongue in dementing speech

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## Abstract

We study speech production difficulties in speakers with dementing illnesses by inducing tip-of-the-tongue (TOT) states. We found that dementing speakers experienced TOTs but were unable to supply any information about the target, unlike an age-matched control group. We distinguish between items generated by the subjects as relatives of the targets, subjects' own-target words, and what we call "constructive search" words that subjects use in their search for the target. When related words came to mind, they were almost all semantic relatives of the target, whereas in non-dementing adults, phonological relatives are also reported. We interpret the results in terms of a three-level interactive account of lexicalization. We propose that the retrieval deficit in dementia occurs in the first stage of lexicalization, that of retrieving abstract lexical forms from a semantic specification, rather than in a second stage of retrieving phonological forms.

## Introduction

Speech disturbance has long been a noted feature of dementia (e.g. Pichot, 1955). Problems are particularly evident in naming (Kirshner, Webb & Kelly, 1984; Schwartz, Marin, & Saffran, 1979; Whitaker, 1976). This is most noted in dementia of the Alzheimer type (DAT) where impairment is severe (see for example, Bayles, 1982; Bayles, Tomoeda & Trosset, 1990; Shuttleworth & Huber, 1988), rather than in dementia resulting from multiple infarctions (Hier, Hagenlocker, & Shindler, 1985; Kontiola, Laaksonen, Sulkava, & Erkinjuntti, 1990; Powell, Cummings, Hill, & Benson, 1988).

Recent accounts of speech production hypothesize that there are two stages of lexical retrieval (see Levelt, 1992). Lexicalization involves moving from the semantic specification of what a speaker wants to say to a phonological form. The first stage is the retrieval of an abstract lexical item (the *lemma*) from a semantic specification. This is followed by retrieval of the detailed phonological form of the word. The particular model that we use postulates interaction between the two stages and includes within-level inhibitory connections at the lexical and phonological levels (see Figure 1). Further details are given in Harley (in press) and Harley and MacAndrew (1992); evidence for this architecture from normal speech errors is discussed in Harley (1984) and Stemberger (1985). In naming, the semantic specification is activated by recognition of the item. We conceptualize the semantic specification as features that in combination direct the retrieval process to a particular lemma. Only then can the phonological form of a word be retrieved.

In the dementia literature, performance on confrontation naming tasks, which require subjects to provide verbal labels for visually presented stimuli, is poor, but is often accompanied by appropriate gestures. This implies that the targets are correctly recognized. Furthermore, poor naming performance is often found alongside good performance on picture-word matching (Chertkow & Bub, 1990; Schwartz et al., 1979), suggesting that unnamed pictures are indeed recognised. These findings suggest that in DAT objects are correctly recognized, but breakdown occurs before retrieval of the lemma (Bayles, 1982; Bayles & Tomoeda, 1983; Henderson, Mack, Freed, Kempler, & Andersen, 1990; Hier et al., 1985; Hodges, Salmon & Butters, 1991, 1992). The naming problem could be due either to difficulty formulating a semantic specification or in moving from this to the corresponding lemma.

There is debate as to the precise nature of the semantic breakdown in DAT. It has been suggested that superordinate category knowledge is preserved relative to subordinate knowledge. This results in the loss of specificity between individual items in a category (Hodges et al., 1992; Martin & Fedio, 1983; Schwartz et al., 1979). However, there is contradictory evidence from confrontation naming that suggests that there is no tendency to produce superordinates when production of individual items fails (Bayles et al., 1990).

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Additionally, Blanken, Dittmann, Haas, & Wallesch (1987) found semantic substitutions by both superordinates and co-ordinates to be of about equal distribution. Currently most attention is focused on whether there is a loss of access to semantic information, or whether the information itself is lost, and therefore no longer available (e.g. Bayles et al., 1990; Bayles, Tomoeda, Kaszniak, & Trosset, 1991; Chertkow & Bub, 1990; Chertkow, Bub, & Caplan, 1992; Henderson et al. 1990; Hodges et al., 1991, 1992).

An alternative explanation for the breakdown in processing in dementia was proposed by Miller (1979). She suggested that the decline of retrieval abilities is due to the disinhibition of plausible alternatives. The target word is then at least partially dependent on the successful inhibition of rivals. A gradual decrease in inhibition could account for retrieval difficulties and the production of relatives. This is supported by evidence from selective-attention tasks in older adults suggesting that the efficiency of inhibitory mechanisms decreases with increasing age (Hasher, Stoltzfus, Zacks, & Rypma, 1991). This explanation is well suited to current connectionist two-stage accounts of lexicalization where within-level inhibition is an important processing mechanism. This account predicts that reduced inhibition will increase the activation and production of semantic relatives of the target. Such a breakdown should be reflected in subjects' performance in tasks requiring verbal responses.

One such task is the experimental induction of the TOT state. The TOT phenomenon is the subjective feeling of knowing a word that one wants to say, but being unable to produce it. TOTs have been induced experimentally using the method developed by Brown and McNeill (1966). This requires participants (usually young adults) to supply rare target words in response to spoken definitions. Brown and McNeill divided the TOT responses into those that were either phonologically or semantically related to the target. Examples of these with the target of SAMPAN include SARONG (a phonological relative) and JUNK (a semantic relative). They found that 70% of the relatives produced were phonologically related to the target. In addition, young adults are often able to provide the number of syllables (Lovelace, 1987) and the initial letter of the target word (Brown & McNeill, 1966; Koriat & Lieblich, 1974; Rubin, 1975; Yarmey, 1973). Sometimes the syllabic stress (Rubin, 1975), the final letter, and the positions of additional letters are also available (Brown & McNeill, 1966; Koriat & Lieblich, 1974; see also A. S. Brown, 1991).

It is possible to account for the occurrence of TOTs as follows. The definition provides a semantic specification, directing retrieval to the correct lemma. However, phonological retrieval then fails, or is only partly successful. This accounts for the subjective feeling of knowing the word, the higher incidence of phonological relatives to semantic neighbours, and the partial availability of phonological and structural information in TOT states.

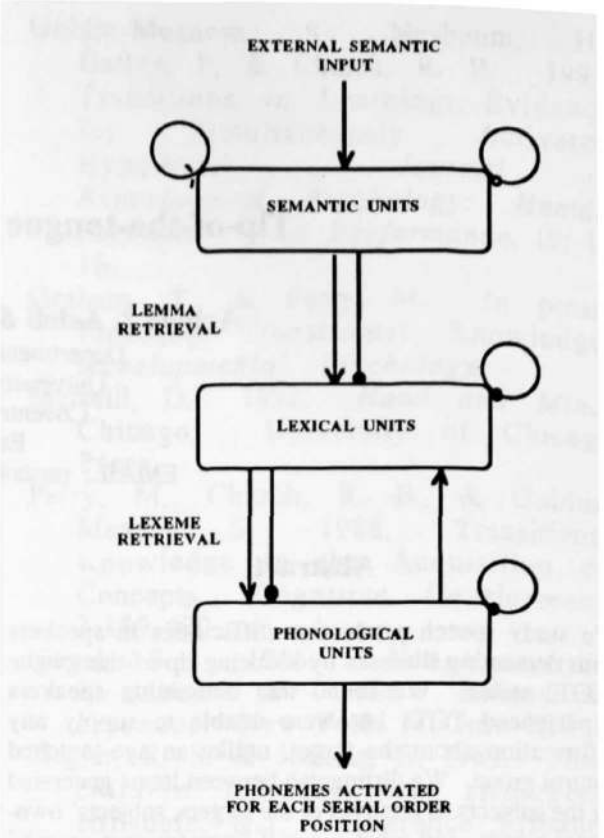


*Fig. 1.* Architecture of our model of lexicalization. Inhibitory connections are shown by a circle, excitatory connections by an arrow.

A different pattern of responses in the TOT state has been found in elderly subjects. TOTs occur more frequently with age, and elderly subjects are more likely than young or mid-age adults to supply little or no phonological information about the target word (Burke, MacKay, Worthley, & Wade, 1991; Cohen & Faulkner, 1986; Maylor, 1990). They are less likely than younger adults to produce alternative words (Burke et al., 1991; Cohen & Faulkner, 1986) and are more likely to give up pursuing the target and think about something else (Burke et al., 1991). Older adults are less likely to provide the sort of phonological and structural information that is commonly supplied by younger adults, such as number of syllables and the last letter. It is possible to account for these findings as follows. The different characteristics of older adults' TOTs suggest that in this population TOTs no longer result simply from a failure at the lexical to phonological stage. This breakdown might be combined with difficulties elsewhere in the system, or may reflect a shift to failure earlier in the process, between the semantic and lexical levels. As this is where it seems individuals with DAT have difficulties in speech production, we would expect to find a similar pattern to that seen in elderly subjects. Specifically, it is predicted that any related words produced are more likely to be semantic rather than

phonological relatives of the target. These would be expected to occur alongside reduced (if any) phonological and structural target information.

## Method

**Subjects.** The experimental group comprised 16 patients with dementia, 12 female and 4 male, with an age range of 68 to 92 years. Of these 13 were diagnosed as having senile dementia of the Alzheimer's Type and 3 multi-infarct dementia (MID). The diagnoses were based upon assessment of their mental state by a psychogeriatric or psychiatric consultant, by consideration of their behavioural presentation by nursing staff, and by application of assessment measures including the MMSE (Mini-Mental State Examination of Folstein, Folstein, & McHugh, 1975) and the CAPE (Clifton Assessment Procedure for the Elderly of Pattie & Gilleard, 1979). The control group comprised 12 volunteer non-dementing adults, 9 female and 3 male, age range 72 to 84 years. None of the participants had uncorrected visual or hearing difficulties.

**Materials.** Two lists, each of 12 words were used. Both consisted of 6 high frequency nouns, each occurring more than 25 times per million (mean 49), and 6 low frequency words each occurring less than 10 times per million (mean 3.5) according to Kuçera and Francis (1982). Examples of each type of definition are: "it has a white and a yolk and is laid by birds" (high frequency), and "sea creature with eight tentacles" (low frequency).

**Procedure.** 12 subjects were tested on each list, but it was not possible to use the same twelve in the experimental group for both lists because of the deaths of four of the subjects. Consequently 8 did both lists and 8 did only one list. All subjects read the definitions unless they were unable or unwilling to do this, in which case the experimenter read them. They were usually read at least twice. Items were presented in a random order. Some of the subjects with dementia found the task very demanding and were only able to complete one list over two sessions. All the control subjects did both lists of words in one short session.

A subject was deemed to be in a TOT state only if they indicated that they knew the target word but were unable to retrieve it, and if they carried out an active search in an attempt to locate the target. They were often marked by phrases such as "it's on my tongue" and "I can't get my tongue round it". Sometimes subjects immediately said that they did not know the answer. If the subject produced a word in answer to the definition this was recorded and the next definition was given. When subjects failed to produce a response, or if they were in an unresolved TOT state, the target word was supplied. If subjects went into a TOT state they were asked to give any information that they could about the target for which they were searching. All subjects in a TOT state that was unresolved within three minutes were given the opportunity to have a second attempt following presentation of all the definitions. When given the target, subjects either spontaneously confirmed or were asked to confirm if the word supplied was the word that matched the definition and, for those subjects experiencing TOT states, if this was the word for which they were searching.

## Results

Responses other than the designated target fell into three groups. First, we call words produced while in a TOT state as an attempt at the target *relatives.* Second, we call words considered by subjects to be the appropriate response to the definition, either as an immediate response or as a resolution to a TOT state, *own-target words*. Third were words generated by the subjects either as guesses at the target or as part of a constructive search for it. We refer to these as *constructive search words.* Participants were not in a TOT state when they produced these and they generally discounted them as not being the ones for which they were searching.

*Table 1*
Distribution of responses for the two groups.

| *Response* | *Group* | |
|---|---|---|
| | Control | Dementia |
| Target | 245 | 154 |
| Don't know | 0 | 66 |
| TOT | 17 | 25 |
| Own target | 18 | 22 |
| Con. search | 8 | 21 |
| TOTAL | 288 | 288 |

Across the 288 definitions, the control group made 245 (85%) correct responses to the target, and the dementia group 154 (53%), with means of 10.25 out of 12 for control subjects and 6.38 for experimental subjects on each list of 12 words (see Table 1). On both word sets the dementia group made significantly fewer correct responses than the controls (list 1: $t(22) = 6.19$, $p < 0.001$); list 2: $t(22) = 6.00$, $p < 0.001$). Both groups recorded small numbers of TOT states, 17 (6%) by controls and 25 (9%) by the dementia group. As a proportion of non-wrong responses, the dementia group made significantly more TOT responses than did the controls ($\chi^2$ (1, N = 430) = 6.486, $p < 0.01$). For the control group 10 of the TOT states were resolved, and for the dementia group, 9. The number of unresolved

TOTs did not differ significantly between the groups (list 1: $t(22) = 0.88$; list 2: $t(22) = 1544$). All the control TOTs were induced by low frequency targets whereas in the dementia group they were induced by both high and low frequency targets, although significantly more by low ($\chi^2$ (1, N = 24) = 16.81, $p <$ 0.01). Furthermore, the control group, where a target response was not given, were more likely to produce a word of their own to the definition (18/26, or 69%) than the dementia group (22/109, or 20%; $\chi^2$ (1, N = 135) = 24.2, $p < 0.001$). Hence, as predicted, the dementia group were poorer at lexical retrieval and made more TOTs.

**Dementia and control TOT responses.** The 3 MID subjects produced 7 of the 25 TOT states (range 1 - 3). The 13 SDAT subjects had a mean of 1.38 TOT states (range 0 - 6). In 12 of the 25 TOT states a total of 22 words other than the target word came to mind. Subjects mostly discounted these as not being the words for which they were searching. Table 2 contains the mean frequency of the targets and the words that came to mind in a TOT state. Analysis of these words is concentrated on frequency, imageability, syntactic category and semantic relationship as these factors are important in word substitutions in normal speakers (Harley, 1993). Frequency was taken from the Kucera and Francis (1982) norms, and imageability from the Oxford Psycholinguistic Database (Quinlan, 1992). This is a composite value arrived at by blending ratings from the Paivio (1968), Toglia and Battig (1970), and Gilhooly and Logie (1980) imageability norms. Semantic category membership was determined from the categories of Battig and Montague (1969), where applicable, by a two-stage process. The first stage considered if the two words had some semantic relationship. If they did, then their relationship was assessed in terms of whether the two words belonged to the same semantic category (co-ordinates), whether the word produced during searching was the label of a category to which the other belonged (superordinate), or whether the search word belonged to the category of which the target word was the label (subordinate).

There was no significant difference in frequency of the target and relatives produced by dementing speakers ($t(16) = 0.59$). Of the 22 words produced whilst searching in the TOT state, 21 were nouns, and 1 a gerund. Of these 22 relatives, 20 were judged to be semantically related to the intended target words, with the other two being a phonological relative and an unrelated word. The 20 semantically related words comprised 14 category co-ordinates, 1 superordinate, 2 subordinates, and 3 that were associated with the target but not in the same category in the norms.

In the control group, 10 of the 17 TOT states were resolved, of which 9 resulted in the production of the target. In only 7 of the 17 TOT states recorded by the control group did words other than the target come to mind. Too few of the pairings had both members with frequency ratings to analyze. Of these 10 related words produced by the controls, 5 were mixed semantic and phonological substitutes, 3 were semantic relatives of the target and 2 were phonological relatives. All words produced in TOTs were nouns.

In summary, the words produced by the dementia subjects when in a TOT state were of a similar frequency to the target words, were from the same syntactic categories, and were mainly semantic relatives of the intended targets. The responses made by the control group when in a TOT state were phonologically and semantically related to the target and from the same syntactic category.

*Table 2*

Mean freq(uency) and image(ability) ratings for the target and non-target response words. Mean calculated using only pairs where both members have a frequency rating of at least 1 per million.

| *response type* | *target* | | *response* | |
|---|---|---|---|---|
| | freq. | image. | freq. | image. |
| TOT | 13.65 | * | 21.71 | * |
| own-target | 16.36 | 5.63 | 36.81 | 5.27 |
| search | 19.11 | 5.53 | 129.80 | 5.61 |

* Too few word pairs with imageability ratings.

**Remaining control data.** Correct responses and TOT states accounted for 262/288 (91%) of all control responses. The remaining 26 were distributed as 18 own-target words and 8 constructive search attempts. There were only sufficient own-target responses to analyze. The target and own-targets did not differ significantly in frequency ($t(12) = 1.13$). Comparison of imageability ratings was not possible because of small sample size. All own-target responses were nouns, and the majority were semantic relatives of the targets.

**Dementia group's own-target words.** Own-target words constituted 22 out of the 68 (32%) non-target attempts at responses immediately following the definition. Table 2 shows the mean frequencies and imageabilities for targets and own-words. There was no difference in frequencies ($t(27) = 1.11$, where the highly skewed frequencies were logarithmically transformed), or imageabilites ($t(7) = 1.457$). Of the own-target words produced by the subjects 24/29 (82%) were nouns, 3 were proper nouns and 2 were verbs. Again the majority of non-target words were semantically related to the target; 3 had episodic association with the target words for the participants, or relating to the way they interpreted the definition. Two of the non-target words

had no semantic relationship to the targets, and one was both semantically and phonologically related.

To summarize, subjects' own target words did not differ significantly in frequency or imageability from the intended target words. The majority were nouns and most were semantically related to the target words.

**Dementia group's constructive search words.** There were 32 different words produced in the 21 constructive search responses made by subjects. These were significantly higher in frequency than the target words, after logarithmic transformation ($t(25) = 2.556$, $p = 0.01$; raw mean for target words = 19.11; for constructive search words, 129.80). There was no significant difference between the target and search words on imageability ($t(9) = 0.406$; mean of 5.53 for the target words and 5.61 for the words produced during constructive search). All search words were nouns. All the words generated by the subjects were semantically related to the target words, with the majority as category co-ordinates, with two superordinates and one a strongly associated pair from two closely related semantic categories (*banana* for "carrot").

In summary, words produced while subjects were involved in a constructive search for the target word were of a higher frequency than the target words but did not differ in imageability. They were also from the same syntactic category as the target words and all were semantic relatives.

## Discussion

Overall the dementia group performed worse than their age-matched controls. The most important finding from the non-target responses is that most of the substitutions made by both groups were semantic relatives of the target. Only two words with any phonological relationship to the target were offered by the dementia group; they offered no partial phonological information. The control group also substituted only a few pure phonological relatives but they did give several combined semantic and phonological relatives and were also able to provide some partial phonological information. These results are as predicted if the problem lies between the semantic and lexical levels. They suggest that the lexical item cannot be retrieved and that semantic relatives of the target become active. This could be because the target lexical item does not receive sufficient activation. This contrasts with the account proposed for TOTs in younger adults, which holds that it is the target phonological representation that is not successfully retrieved.

Within the framework of the two-stage model of lexicalization, there are three explanations for this failure to access the lemma. First, that semantic-to-lexical links weaken, eventually becoming lost. Second, that relatives are not successfully inhibited. If this were happening at the semantic level then just semantic relatives should be produced. If it were at the lexical level then both semantic and phonological relatives would be expected. Third, that units, such as distinguishing semantic features, are themselves lost, leaving the features that remain being shared by more than one item, any of which could become output. The final account predicts consistency in responding across tasks, and there is certain evidence that supports this (Chertkow & Bub, 1990; Hodges et al., 1991, 1992). In these studies this is allied with the co-occurrence of superordinate knowledge preservation in the face of subordinate knowledge loss, two characteristics specified by Shallice as indicating a disorder of semantic storage (Shallice, 1987). Results from Bayles et al. (1990) and from this present study do not support this. In the Bayles study, subjects with dementia were more likely to supply attributes of objects they failed to name rather than superordinate category names. In our study, most semantic substitutions were category co-ordinates of the target item. Further research using a battery of tasks to distinguish between these necessary accounts is ongoing. This includes a measure of error consistency across tasks, a measure of how items are arranged within semantic categories, an investigation of retrieval and utilization of defining features and a probe for the continued existence of items within semantic storage that cannot be retrieved at will.

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