# *Sorry, what was your name again*, or how to overcome the *tip-of-the tongue problem* with the help of a computer?

Michael Zock
LIMSI-CNRS, B.P.133
91403 Orsay-Cedex, France
zock@limsi.fr

**Abstract**

A speaker or writer has to find words for expressing his thoughts. Yet, knowing a word does not guarantee its access. Who hasn't experienced the problem of looking for a word he knows, yet is unable to access (in time) ? Work done by psychologists reveals that people being in this so called tip-of-the-tongue state (TOT) know a lot about the word : meaning, number of syllables, origine, etc. Speakers are generally able to recognize the word, and if they produce an erroneous word, that token shares many things with the target word (initial/final letter/phoneme, part of speech, semantic field, etc.). This being so, one might want to take advantage of the situation and build a program that assists the speaker/writer by revealing the word that's on his/her mind (tongue/pen). Three methods will be presented, the first one being implemented.

## 1 The context or starting point

I'm currently involved in a project (PAPILLON)[1] whose goal is to build a huge multilingual lexical data-base (English-French-Japanese, Thai) from which one can extract digital bilingual dictionaries. The latter can be customized to fit different needs: dictionaries to be *used by people* vs. dictionaries to be *used by machines* (e.g. automatic translation).

One of the ideas is to enhance this dictionary by adding certain functions, in order to capitalize on the data. Rather than being a component supporting a single task, the dictionary is at the centre, supporting the user in a variety of tasks like reading, writing, memorization of words or automation of syntactic structures. Particular emphasis will be given to *word access*, the topic of this paper, because, what is a dictionary good for, if one cannot access the data it contains? The approach taken is generic, hence, it applies not only within this particular context.

Word access being a fundamental task in language production, one might wonder what could be learned by gleaning at work done in the context of automatic text generation.

## 2 *Word access* in Natural-Language Generation

A lot of (natural language generation) researchers have been interested in lexical issues during the last fifteen years or so.[2] Yet despite this enormous body of work, the issue of word **access** has not been addressed at all within this community, not even in Ward's extensive ***problem catalog*** (Ward 1988). While from a strict *computational linguistic point of view*, the whole matter may be a non-issue,[3] however, if we address the problem of lexicalization from a psycholinguistic or *man-machine interaction* point of view

[1] http://www.papillon-dictionary.org

[2] For excellent surveys see (Robin, 1990; Wanner 1996).

[3] Most programs running serially, there is no such thing as competition. Hence, problems like *interference*, *confusion* or *forgetting* do not occur. Furthermore, computers having a perfect memory, stored information can generally be easily accessed. The situation is quite different for people.

(spontaneous discourse or writing on a computer), things are quite different. Just as "**knowing** a word" does not imply "**being able** to **access** it", 'choosing a word' does not imply 'being able to find the set of candidates from which to choose'. The situation is somehow different in psycholinguistics. Again, there is an enormous body of research (Marslen-Wilson, 1989; Aitchinson, 1987; Levelt, 1992, to name just those). While all these authors take up the issue of word access, they do not consider the use of computers for helping people in their task. Yet this is precisely what I do here.

## 3 What prevents us from finding a word?

In order to answer this question, let us take a look at the time course of lexicalization. According to psychologists (Butterworth, 1989:110; Levelt 1989), *lexical access* takes place in two temporally distinct stages. In the first stage the speaker checks the *semantic lexicon* for a lemma expressing the conceptual input.[4] If he can find one, he will take it and consult then the *phonological lexicon* in order to find the appropriate phonological form.[5]

Errors can occur at both ends. Yet, since the two stages are independent, errors belong to either category, but never to both. Errors at the semantic level will yield a wrong lemma (e.g. *hate* instead of *love*), while errors at the phonological level may result in the wrong phonological form. For example, the intented *relegate* may surface as *re**n**egate* or ***d**elegate* (/l/ and /n/ as well /r/ and /d/ being phonologically relatively close), *turn on the heater switch* may result in turn on the ***sw**eeter **h**itch* (Clark & Clark, 1977), etc. As one can see, these words are all phonologically reasonably close to the target word, yet, it is precisely this proximity that prevents the speaker to access the "right" word.

[4] Suppose you wanted to refer to a *castor*, then there could be a competition between the lemmata "otter, beaver".

[5] If the chosen lemma were "beaver" then all words starting with "b-e-a" or "b-e-e" could be considered as candidates.

## 4 The speaker's problem: *choosing* words, *finding* them, or *both*?

Obviously, there is more to lexicalisation than just *choosing* words: one has to *find* them to begin with. No matter how rich a lexical database may be, it is of little use if one cannot access the relevant information in time.

Work on memory has shown that *access* depends crucially on the way information is organized (Baddeley, 1982). From speech error literature (Fromkin 1973) we learn that ease of access depends not only on ***meaning relations*** (word bridges, i.e. associations) or the *structure* of the lexicon (i.e. the way words are *organized* in our mind),— but also on **linguistic form**. Researchers collecting speech errors have offered countless examples of phonological errors in which segments (phonemes, syllables or words) are added, deleted, anticipated or exchanged. Reversals like /a**m**i**n**al/ instead of /a**n**i**m**al/, or /**k**arpsi**h**ord/ instead of /**h**arpsi**k**ord/ are not random at all, they are highly systematic and can be explained. Examples such as *grastly*, a blend of **gr**izzly + gha**stly**, or **F**atz and **K**odor (instead of **K**atz and **F**odor) clearly show that knowing the *meaning* of a word does not guarantee its *access*.

The work on speech errors also reveals that words are *stored* in two modes, by ***meaning*** and by ***form** (sound)*, and it is often this latter which inhibits finding the right token: having recombined inadvertently the components of a given word (syllable scrambling), one may end up producing a *word*, which either does not exist or is simply different from the one in mind. This kind of *recombination*, resulting from bookkeeping problems due to time pressure, parallel processing and information overload, may disturb or prevent the access of words. Hence the usefulness of a tool that allows to **revert** the **process**.

## 5 Three methods for enabling the computer to guess the right word

I shall present here three methods (one based on *form*, another based on *meaning*, the last one based on a combination of both) for helping the writer to find the word he is looking for. So far, only the first method is implemented.

### 5.1 Access by *form*

The component described below is part of a larger system PIC (Fournier & Letellier, 1990). For its adaptation to the problem of lexical access see Zock & Fournier (2001).

The system has two basic mechanisms for finding the right word: ***anacodes*** and ***phoneticodes***. The former deals with errors due to permutations, while the latter deals with homophones. Since an *anacode* is equivalent to the set of letters composing the word, scrambled letters (unwanted permutations) are not a problem at all. The system would still find the right word, provided that there is such a candidate in the dictionary, and provided that the user didn't omit, add or replace one character(s) by another. For example, if the input were **aclibrer** instead of **calibrer**, the system would have no difficulty to find the target word (calibrer), since both words are composed of the same set of letters (a/b/c/e/i/l/r). If the user added letters outside of the anacode, the system would need several runs to check alternative spellings by making local variations (delete or add a character by making systematic permutations).

The second technique (phoneticodes) consists in converting *graphemes* into *phonemes*, which allows the system to deal with spelling errors due to homophony, a very frequent phenomenon in French (see figure 1).

| FRENCH | ENGLISH | SYNT. CAT. | DOMAIN |
|---|---|---|---|
| vingt | twenty | Adjective | NUMBER |
| vin | wine | Noun-*singular* | BEVERAGE |
| vins | wines | Noun-*plural* | BEVERAGE |
| je vins | I came | Verb-*past tense* | MOUVEMENT |
| tu vins | you came | Verb-*past tense* | MOUVEMENT |
| il vint | he came | Verb-*past tense* | MOUVEMENT |
| …qu'il vînt | …that he came | Verb-*subjonctif* | MOUVEMENT |
| je vaincs | I win | V-*pres. tense* | COMPETITION |
| tu vaincs | you win | V-*pres. tense* | COMPETITION |
| il vainc | he wins | V-*pres. tense* | COMPETITION |
| vaincs | win | V-*Imperative* | COMPETITION |
| en vein | in vain | Adverb | UTILITY |

*Figure 1* : The many ways of writing /vɛ̃/

For example, the system would be able to deal with errors like **vin, vins, vein, vint, vaincs,** etc. instead of **vingt**. If the system cannot find directly a candidate, it will perform local changes by performing permutations of phonemes or syllables. Hence it would have no problem to find the word *poteau* (pole) instead of *topos* (topic), both words being composed of the same syllables (/po-to/), the only difference being their order.

The situation is more complex and may even become intractable if extraneous material is added, or if the correction yields an existing, yet semantically different word from what was intended. Suppose that the target word were "maison" (house), while the user typed “masson”. Relying on the *phoneticode*, the system might suggest "maçon" (bricklayer), a word that exists, but which is not at all what was intended. Relying on the *anacode*, it would fail, because none of the permutations would result in the target word.

### 5.2 Access by meaning: navigation in a huge associative network

As mentionned before, words are stored by meaning and by form (sound). Therefore we need a method to access words in both modalities. This is all the more necessary, as the speaker starts from a meaning representation (concept, message). We plan to experiment with the following two methods. In the first case search is done by propagation in a dynamically built network. In the second case search is done by filtering (5.3).

The fact that the dictionary is organized as a web rather than a taxonomy, has obvious advantages : there is more than one way to reach the goal. Hence, if ever one has gone in the « wrong » direction, one may still recover later on. To illustrate this last point, let's take an example. Suppose you played chess and you wanted to find the French equivalent for the word « knight » (**cavalier**). If the dictionary were structured along the lines suggested, than one could access the word via any of the following links or associations : *horseman* (cavalier-noun), to be *nonchalant* (être cavalier), to be a *loner* (faire cavalier seul), but also *to bolt* (cavaler), *King Arthur* (chevalier), famous French singer (Maurice Chevalier). Note, that while in the first three cases we get homonymes of the target word (cavalier), *to bolt* produces a similarly sounding word (*cavaler* instead of *cava-lIer*). The last association (Maurice Chevalier) results in a perfect match, except for the first syllable and the first name, which would have to be dropped, of course.

### 5.2.1 Search by progagation in the network

I start from the assumption that the mental dictionary is a huge semantic network composed of words (nodes) and associations (links), either being able to activate the other.[6] Finding a word amounts thus to entering the network and to follow the links leading to the target word. Being unable to *access* the desired word, a speaker being in the TOT-state may still be able to *recognize* it in a list. If the list doesn't contain the exact word, he is generally able to decide which word leads in the right direction, i.e. which word is most closely connected to the target word.

Suppose you wanted to find the word `nurse` (*target word*), yet the only token coming to your mind were `hospital`. In this case the system would build (internally) a small semantic network with `hospital` in the center (Figure 2a) and as immediate satellites all the words having a direct link with it (Figure 2b).[7] This process is recursive: satellites can become the center, thus triggering a new search, and since the speaker knows the concept/word he is looking for, he is likely to encounter it sooner or later.

Figure 2b shows the candidates from which the user is supposed to choose. If he finds in any of these groups the word he is looking for, the process halts, otherwise it goes on. As you can see words are presented in clusters. Each cluster corresponds to a specific link. The assumption is that the user will use this information in order to jump quickly from one group to the next.

This approach might work fine provided : 1) the speaker is able to come up with a word reasonably close to the target; 2) The dictionary contains (or allows to infer) all the relations/ associations a speaker typically uses. This second condition hardly ever holds. Hence, we need to find out what these assocations are.

Also, while a single piece of information (a word, a relationship or part of the definition) can be useful, it is obviously better to provide more information (number of syllables, sound, origine, etc.) as it will reduce the search space.

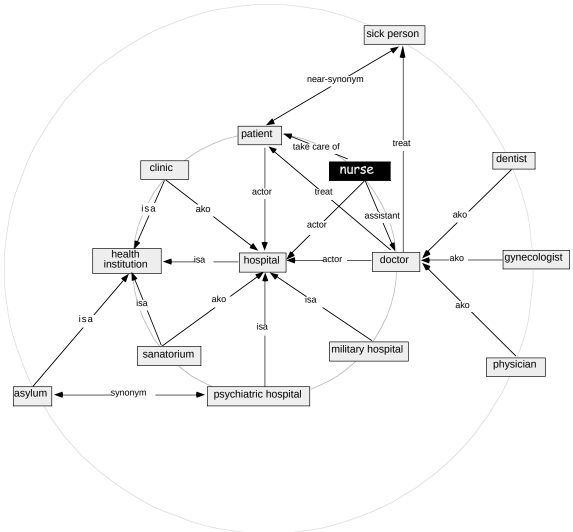


Figure 2a : Search based on propagation in a network (*internal* representation)

[6] The idea according to which the mental dictionary (or encyclopedia) is basically an associative network, composed of nodes (words or concepts) and links (associations) is not new. Actually the very notion of *association* goes back at least to Aristotle (350 before our time), but it is also inherent in work done by *philosophers* (Locke, Hume) *physiologists* (James & Stuart Mills), *psychologists* (Galton, 1880 ; Freud, 1901 ; Jung & Riklin, 1906) and *psycholinguists* (Deese, 1965 ; Jenkins, 1970, Schvaneveldt, 1989 ). For surveys in psycholinguistics see (Hörmann, 1972 ; chapters 6-10), or more recent work (Spitzer, 1999). The notion of association is also implicit in work on *semantic networks* (Sowa, 1992), *hypertext* (Bush, 1945), the *web* (Nelson, 1967), *connectionism* (Stemberger, 1985 ; Dell, 1986) and of course *Word-Net* (Miller, 1990, Fellbaum, 1998).

[7] Of course, in case of ambiguity the user would have to signal the specific meaning he has in mind.

| | | |
|---|---|---|
| clinic<br>sanatorium | military hospital<br>psychiatric hospital | doctor<br>patient<br>**nurse** |

Figure 2b: proposed candidates grouped according to the *nature* of the link

### 5.3 Search through a combination of conceptual and linguistic constraints

As mentionned already, a speaker finding himself in the TOT state knows generally many things about the object he is looking for: parts of the *definition*, *ethymology*, *beginning*/*ending* of the word, number of *syllables*, *part* of *speech* (noun, verb, adjectif, etc.), and sometimes even the *gender* (Brown et McNeill,1966 ; Burke et al. 1991 ; Vigliocco et al.,1997). We could use all this information as constraints. The interface for communicating this knowledge is somehow akin to what MEDLINE offers to researchers helping them to specify the kind of book they are looking for.

## 6 Conclusion

I have drawn the readers' attention to the importance of word ***access*** in the context of NLG: information must not only be *available*, it must also be *accessible*. While this problem may not be relevant for NLG in general, or in the strict computational linguistic's framework, it certainly is relevant when we look at generation as a machine mediated process (people using a word processors for writing), or from a psycholinguistic point of view: word access in writing or (spontaneous) discourse. Looking at some of the psycholinguistic findings, and looking at the work done on spell checking, it seemed that some of the techniques developed in the context of the latter could profitably be used in the domain of the former. While the use of certain spell checking techniques can certainly enhance word access in speaking and writing (hence the potential of electronic dictionaries associated with word processors), more work is needed in order to adjust the method to be in line with psycholinguistic data and in order to keep the search space small.

I have also tried to show that in order to support a speaker being in the TOT-state, we need to create an *associative memory*. That is, I've raised and partially answered the question what kind of information semantic networks need to have in order to be able to help a speaker being in this state. Actually, my basic proposal is to build a system akin to WordNet, but containing many more links — in particular on the horizontal plane. These links are basically associations, whose role consists in helping the speaker to find either related ideas to a given stimulus, (concept/idea/word - brainstorming), or to find the word he is thinking of (word access). Hence, future work will consist in identifying the most useful assocations, by considering relevant work in linguistics[8] and in collecting data by running psycholinguistic expermiments. For example, one could ask people to label the links for the words (associations) *they have given* in response to a stimulus (word) ; or one could also ask them to lable couples of words (eg. apple-fruit, lemon-yellow, etc.). A complementary approach would be to look for *lexical-data-base mining-strategies*, as the desired information may be distributed or burried deep down in the base. Finally, one can also look at texts and try to extract automatically co-occurences (see Rapp & Wettler, 1991 ; Wettler & Rapp 1992).

## References


Aitchinson, J. (1987) Words in the Mind: an Introduction to the Mental Lexicon, Oxford, Blackwell.

Aitchison, J., A. Gilchrist & D. Bawden (2000) Thesaurus construction and use : a practical ma-nual, Fitzroy Deaborn Pbs, Chicago

Aristotle (350 before JC) De memoria et reminiscentia. In Parva Naturalia, Vrin

Baddeley, A. (1982) Your memory: A user's guide. Penguin

Brown, R and Mc Neill, D. (1966). The *tip of the tongue* phenomenon. Journal of Verbal Learning and Verbal Behavior, 5, 325-337

Burke, D.M., D.G. MacKay, J.S. Worthley & E. Wade (1991) «On the Tip of the Tongue:What Causes Word Finding Failures in Young and Older Adults?», *Journal of Memory and Language* 30, 542-579.


[8] For example, have a look at Mel'cuk's lexical func-tion, (Mel'cuk et al. (1992) and Fillmore's FRAMENET approach (Johnson et al. 2001)

Bush, V. (1945) "As we may think". The Atlantic Monthly; Volume 176, No. 1; pp. 101-108

Butterworth, B. (1989) Lexical Acces in Speech Production. In, W. Marslen-Tayler (Ed.).

Clark, H & Eve V. Clark, (1977) *Psychology and Language*.Harcourt, Brace, Jovanovich, New York

Crouch, C. (1990). An approach to the automatic construction of global thesauri. Information Processing and Management, vol. 26, no. 5, pp. 624-640

Deese, J.(1965) The structure of associations in language and thought. Baltimore

Dell, G. S., Chang, F., and Griffin, Z. M. (1999), "Connectionist Models of Language Production: Lexical Access and Grammatical Encoding," *Cognitive Science*, **23/4**, pp. 517-542.

Fellbaum, C. ( Ed.) 1998, *WordNet : an electronic lexical database*, Cambridge (Massachusetts), The MIT Press.

Fournier, J.P & S. Letellier. (1990) PIC: a Parallel Intelligent Corrector. Artificial Intelligence Application & Neural Networks AINN'90, pp 38-41, Zürich

Freud, S. (1901) Psychopathology of everyday life. Paris : Payot, 1997.

Fromkin, V. (1973) (Ed.) Speech errors as linguistic evidence. The Hague: Mouton Publishers

Galton, F. (1880). Psychometric experiments. *Brain*, 2, 149-162.

Hörmann H. (1972). Introduction à la psycholinguistique. Paris: Larousse

Jenkins, J.J. (1970). The 1952 Minnesota word association norms. In: L. Postman, G. Keppel (eds.): *Norms of Word Association.* New York: Academic Press, 1-38.

Johnson, R, C. Fillmore, E. Wood, J. Ruppenhofer, M. Urban, M. Petruck, C. Baker (2001) The FrameNet Project: Tools for Lexicon Building, http://www.icsi.berkeley.edu/~framenet/

Jung, C.G., Riklin, F. (1906). Experimentelle Untersuchungen über Assoziationen Gesunder. In: C.G. Jung (ed.): *Diagnostische Assoziationsstudien.* Leipzig: Barth, 7-145.

Levelt, W. (1992). Accessing Words in Speech Production: Stages, Processes and Representations. Cognition 42: 1-22.

Marslen-Taylor, W. (Ed.) (1979) Lexical Representation and Process, Bradford book, MIT Press, Cambridge, Mass.

Mel'cuk, I. et al. (1992) Dictionnaire Explicatif et Combinatoire du français contemporain. Recherche lexico-sémantique III. Les presses de l'université de Montréal.

Miller, G.A., ed. (1990). WordNet: An On-Line Lexical Database. *International Journal of Lexicography*, 3(4).

Nelson, T. (1967) Xanadu Projet hypertextuel, http://xanadu.com/

Palermo, D., Jenkins, J. (1964). *Word Association Norms.* Minneapolis, MN: University of Minnesota Press.

Perreault, J. (1965). Categories and relators: a new schema. In Rev.Int. Doc., vol. 32, no.4, pp.136-144

Rapp, R. & M. Wettler (1991) A connectionist simulation of word associations. Int. Joint Conf. on Neural Network, Seattle

Robin, J. (1990) A Survey of Lexical Choice in Natural Language Generation, *Technical Report CUCS 040-90*, Dept. of Computer Science, University of Columbia

Schvaneveldt, R. (Ed.) (1989) Pathfinder Associative Networks : studies in knowledge organization. Ablex, Norwood, New Jersay

Sowa, J. (1992) "Semantic networks," *Encyclopedia of Artificial Intelligence*, edited by S. C. Shapiro, Wiley, New York

Spitzer, M. (1999). The mind within the net : models of learning, thinking and acting. A Bradford book. MIT Press, Cambridge

Stemberger, J. P. (1985) "An interactive activation model of language production." In A. W. Ellis [ed] Progress in the Psychology of Language, Vol. 1, 143-186. Erlbaum.

Vigliocco, G., Antonini, T., & Garrett, M. F. (1997). Grammatical gender is on the tip of Italian tongues. *Psychological Science, 8*, 314-317.

Wanner, L. (1996). Lexical Choice in Text Generation and Machine Translation: Special Issue on Lexical Choice, Machine Translation. L. W. (ed.). Dordrecht, Kluwer Academic Publishers. 11: 3-35.

Ward, N. (1988). Issues in Word Choice. COLING-88, Budapest.

Wettler, M. & R. Rapp (1992) Computation of Word associations based on the co-occurences of words in large corpora

Wettler, M. (1980) Sprache, Gedächtnis, Verstehen. Berlin, de Gruyter

Zock, M. & J.-P. Fournier (2001). How can computers help the writer/speaker experiencing the Tip-of-the-Tongue Problem ?, Proc. of RANLP, Tzigov Chark, pp. 300-302