Knowing a Word vs. Accessing a Word: Wordnet and Word Association Norms as Interfaces to Electronic Dictionaries

Anna Sinopalnikova[1,2]
[1]Brno University of Technology
Božetěchova 2, 612 66 Brno, Czech Republic
[2]St. Petersburg State University
Universitetskaya 11,
199034 St. Petersburg, Russia
sino@fit.vutbr.cz

Pavel Smrž
Brno University of Technology
Božetěchova 2, 612 66 Brno
Czech Republic
smrz@fit.vutbr.cz

Abstract

Various groups of users, ranging from professional translators and writers to language learners, use dictionaries in their everyday work. The electronic form of the dictionaries facilitated and accelerated the access to their content considerably and brought new ways of the dictionary search. However, the current products are still unable to offer a full-featured search by meaning which would be advantageous in many cases. This paper describes our experiments on access-supporting enhancements of electronic dictionaries that are based on wordnets and word association norms. Results of evaluation experiments for two European languages - English and Russian - are presented. The comparison with the fulltext- and corpus-based access methods shows that the proposed ways of the dictionary search often provide the best word-access strategy.

Introduction

Psychologists usually include the ability to ***access a word*** into ***knowing a word*** [Cronbach, 1942], together with the ability to define the word's meaning, ability to recognize the situations and contexts for using it, knowledge of its alternative meanings, ability to recognize its incorrect uses etc. But in computational linguistics, when one deals with various 'external' repositories of lexical information (electronic dictionaries and thesauri, lexical databases, corpora, etc.), there prevails tendency towards opposing *word* ***accessing*** and ***knowing*** [Zock, 2002].

The common idea is that knowing a word does not guarantee the successful access to it. We may know what the word means, (sometimes) we know what the word looks like (its beginning, ending, number of syllables), its derivation model or etymology, we search for the word in our memory and still are unable to find it[1]. Even if we have at our disposal a dictionary, a thesaurus, or a corpus, we may face the same problems – in case we are unable to provide a perfect input, it is difficult to find a word in whatever resource we have. The reason is that however rich in content, modern dictionaries support only a limited set of possible ways to access the information they contain.

[1]In psychology, this phenomenon is known as TOT – Tip-of-the-Tongue state – a type of the word production failures, when a speaker is unable to produce a word he/she is absolutely certain that he/she knows (James 1890, Brown and McNeill 1966, Maylor 1990, Burke et al 1991).

Among the best elaborated and most frequently implemented access services is an **access by form** that is included into interfaces of most of the popular dictionaries [AHDAL, CALD, CCED, COED, LDOCE, MAD, MW]. It usually implies:

1. orthographic error correction, i.e. checking for any types of **misspellings**: reversing, adding, omitting, substituting letters etc, e.g. typing *ditionry, cidtionary* instead of *dictionary*.
2. **phonetic similarity** checking: dictionary interface may also control misspellings due to **homophony**, e.g. *wright* misspelled for *right, write,* or *rite* [Zock and Fournier, 2001], or having "**sound-like**" function check for more broader similarity [Bilac et al., 2003; MAD; MW; Lingea; OneLook].

Although being the most frequent example of the access problems dictionary users face[2], **access by form** is not a topic of the present paper. It is usually tackled by technical means with little linguistic support (if ever), and needs no substantial assistance of language resources, in contrast to the **access by meaning**.

While the problem itself was posed half a century ago, access by meaning is still in its infancy. The main trends in this area are presented by thesaurus construction [Roget, 1852; Miller, 1985] supposing a development of a "dictionary browser that allows user to explore an on-line dictionary on the basis of semantic, rather than alphabetic, similarities" [Fellbaum, 1998], and reverse dictionary access [Bernstein, 1975; Glanze, 1990, Edmonds, 1999] that in practice resulted in the intelligent definition search [AHDAL; CALD; CCED Lingea; OneLook].

Since then, a great progress has been made. Besides search in definition and lists of synonyms and antonyms, today's electronic dictionaries provide connection to the large corpora and categorize words to domains. However, in many cases related to the access by meaning, available dictionary-access methods provide inappropriate or insufficient output, and there is still a need for more intelligent, structured and differentiated approach to that problem. The necessity to ob-

[2]Over 80% of the access problems belong to following four types: one-character omission, one-character insertion, one-character substitution, or reversal of two letters [Ito and Kuhota, 1987].

Petr Sojka, Key-Sun Choi, Christiane Fellbaum, Piek Vossen (Eds.): GWC 2006, Proceedings, pp. 265–272.

tain empirical data and test evidences was the motivation of the work presented in this paper.

1 Assisting a Dictionary Access

Being unable to recall a word, people may use various methods to initiate the search: the starting point can be a related word, a definition-like description, a typical context or situations etc. We are prone to the opinion that different types of words initiate different strategies of word access and, thus, need different types of access-assisting resources to be applied. In our work, we have focused on the resources of two types – wordnets (WNs) and word association norms (WAN)[3] – and their capability to solve the dictionary access problems.

WordNet as a language resource is regularly used in many NLP applications. In particular, it has been integrated in several systems to facilitate the search in electronic dictionaries [Lingea; OneLook; El-Kahlut and Oflazer, 2004]. On the other hand, WAN – resources representing results of a large-scaled psycholinguistics experiments - are not used so often, and are usually neglected in the NLP applications. However, what concerns structure and content, these language resources – WN and WAN – have much in common. Their detailed comparison is discussed in [Sinopalnikova and Smrz, 2004]. To best of our knowledge, WAN were not used to assist dictionary search [Zock and Bilac, 2004].

In all experiments described in the section below the following WNs and WAN were applied:

- EAT - Edinburgh WAT by Kiss et al [1972]: 8400 stimuli – 54000 words covered - 1000 subjects,
- RAT - Russian WAT by Karaulov et al [1994-1998]: 8000 stimuli - 23000 words covered – 1000 subjects,
- Princeton WordNet 2.0 (115 000 synsets),
- RussNet 0.2 - semantic network for Russian linking lexical semantics to derivational morphology (5500 synsets)

We have designed and implemented an experimental prototype of the electronic dictionary interface based on relations from WNs and WAN with the aim to tackle the TOT problems. The basic idea was to present the information from a WAN in a way compatible with the respective wordnet, and to let a user select what kind of the relation will help in what particular access problems.

A simple merging of the WN and WAN has been performed. We extracted two modes of the associations (S◇R, R◇S) from English and Russian WAN and added them as new types of unidirectional relations to the current links in the respective WNs. The associations of the first type fix the link from a stimulus to all the responses (S◇R). The associations of the second type list all stimuli where a given word appeared among responses (R◇S). The relative frequencies of the associations are assigned to the links; the outputs are sorted according to them.

The results of the interface testing are presented in the next section together with a comparison to the results of corpus-based access and the search in dictionary definitions. Here, we discuss factors that affected the way people approximate the meaning of a word, and thus efficiency of WN- and WAN-based access methods:

- The most obvious factor affecting the choice of access strategy is the linguistic characteristics of the words searched, in particular, the belonging to a particular **POS.** We have observed that nouns were regularly approximated by a (quasi-) definition description, for instance, a natural genus and specific features, more general or similar concepts etc., e.g. *larder – a room to keep food in*. Thus, the definition search plus assistance by WN or WAN may have a good return in accessing nouns. Words with not so clear signification, such as verbs and adjectives, were rarely described through definitions. For verbs, typical situations and/or collocates were usually given, e.g. while recalling *to sell* subjects produced *to buy, give money, in a shop, shopaholic, goods, clothes, food, seller, merchant.* Naturally, corpus-based assistance may facilitate the access in such cases, also WAN may supply information on domains, situations, and encyclopaedic knowledge. Semantically-related words and typical modified nouns were usually used to described the meaning of adjectives, e.g. *yellow* was approximated by *red, black, orange,* and *lemon, banana, taxi, colour, dress, flower* etc. Thus, corpus-based, and WN and WAN assisting methods may improve the effectiveness of the access for adjectives.
- In addition, the difference between **concrete** and **abstract** entities affects the way people describe the meaning of a word. It was previously reported that TOT states (access problems) also differ in that case. For example, in elderly people TOT states are caused more often by the concrete nouns, than by abstract ones [Rustle and Burke, 1996]. It seems that in the lookup for abstract entities the assistance of WAN is more useful. It is probably related with the way people describe abstract entities – they associate them with typical situations (sometimes corresponding to domain relations, but not always), e.g. *reflex – jerk, knee* (which refer to the typical example of the reflex test, when a

[3] Word Association Norms (**WAN**) represent a collection of empirical data obtained through large-scaled psycholinguistic experiments known as free association tests. The standard technique of the experiments is as follows: words (**stimuli, S**) are presented to subjects, who are asked to respond with the first word that comes into their mind (**responses, R**). The list of stimuli and lists of responses ranged according to their frequency in the answers constitute the body of WAN.

In its most sophisticated form WAN are expanded to associative network for several thousands words. The cycle of data collection is repeated several times: a small set of stimuli is used as a starting point of experiment, responses obtained for them are used as stimuli in the next run, and so on. The complicated procedure of data collection is applied to assure WAN to become a 'thesaurus', i.e. to cover all the vocabulary and map the basic structure of a particular language. So far, large WAN, the so-called **Word Association Thesauri (WAT)** are available for two languages only: English [Kiss et al, 1972] and [Nelson et al, 1992], and Russian [Karaulov et al, 1994-1998]. For other languages only small WAN including 100-200 stimuli are available

tapping below the knee causes the lower leg to suddenly jerk forward)*; fear – shake, scream, shout, sweat* (give us typical examples of the surface characteristics of fear) or *fire, death, decease, ghosts, snakes* (typical fear-causing situations); *rich – millionaire, baron, Getty, Rockefeller* (giving examples of the being rich)*; reflection – water, mirror, glass.* We may say that associations reveal semantics of an (abstract) situation as a list of semantic constituents - separate pieces of information. Semantics of abstract words (verbs, adjectives or nouns denoting complex situation, qualities or emotional states) is rather difficult to approximate. The approximations given by subjects in our experiments corresponded mostly to entries in WAN.

- Naturally, the type of access problem - **monolingual or bilingual** - has an impact on the way people initiate the search of the word. Previous works on TOT-related dictionary access problems [Bilac et al., 2004; El-Kalhut and Oflazer, 2004] focused primarily on **monolingual** dictionaries. When accessing a **bilingual** or **multilingual** source, the user is expected to provide an equivalent in the second (other) language, rather than a description in the same language. Thus, the methods based on domain grouping or lists of semantically related words seem unlikely to be used. However, it is sometime difficult to hit the word with the given (inaccurate, too narrow or too broad etc.) 'translational equivalent'. We have observed that what a user believed to be a perfect translation equivalent regularly turns out to be just an approximation of the meaning, which (while applying the dictionary) evokes a banch of close words that needs further processing and filtering. Moreover, in case of **lexical gaps** it is impossible to produce an equivalent in the mother-tongue, and a user has to apply various ways of meaning approximation quite similar to corpus-, WN- or WAN-based ones using his mother-tongue or a target language. For example, if in Russian there is no term for *to abdicate,* one will have to describe it through definition-like approximation in Russian or in English e.g. "*to formally renounce a throne*", or employ some corpus-based feature using *king, queen, emperor* and *throne* as most probable collocates, etc. And in so doing, the user may face the same problems as during the monolingual dictionary access. That is why our research was not limited to the monolingual case. The interface should reflect the potential difference in knowledge of native vs. non-native language users (see the next item). The first step to implement the idea is to identify this difference. Our preliminary experiments suggest that a comparison of WAN across languages can help in this case.
- The characteristics of a **user** (e.g. age, level of education, cultural background etc.) affect the access process: the frequency and type of access problems, the way people recall and approximate words, and how they access a dictionary. If you are not able to see the point of view, you cannot help a man who gives *university* as a clue for the word *challenge* or associates *charisma* (he cannot recall) with *India*.
- The access process obviously differs in connection with the **media** we use to access electronic dictionary. Most of the current products deal with the written input exclusively. But it was shown [Levelt et al., 1996] that speech form of the input has many advantaged over the written one: it is faster, natural, it facilitates the recalling, and supports more information to be given. A speech dictionary interface could open a range of opportunities, especially concerning the access by form (e.g. facilitating the "sound-as" feature). However, adding a **speech** interface is a challenging task even for the simple entry search as the number of mistakes grows due to incorrect pronunciations, and recognition errors. The option that would enable speech input initiating an advanced search, through the mechanisms 1. a-b) is probably available in no current product. The same holds for **video**. E.g. meaning of the word *shake* is easier to show, demonstrating appropriate movements, than giving its definition.
- When speaking about an electronic dictionary, we usually imagine a program on a desktop PC. However, other **devices** are spread more and more, esp. mobile "computers" – cellular phones, PDAs, electronic translators, etc. As the power of these appliances grows rapidly, we can expect the greater role they will play as mobile providers of dictionary access. The size of the device (mostly, its memory and display) can significantly affect the choice of the access methods – a fulltext search in definitions that would return a lot of candidates, a memory-demanding corpus retrieval can be preferred for standard PCs, but for cellular phones the priorities can be completely different.
- The results presented in the next section compare different dictionary access methods associated with various language resources. The **availability** (and the quality/size) of the resources can play the most important role in the choice of the access methods – if there is no corpus large enough to enable advanced corpus processing, some methods cannot be used, even if they would be preferred, if there is not bilingual dictionaries for the particular pair of languages, multilingual search will be rather substituted by monolingual corpus search etc. Similarly, the availability of WN and WAN is limited.

WN/WAN dictionary interface is not a panacea which helps in all access-problem cases. Evidently, there are pros and cons of the implemented methods. The results presented in the next section demonstrate the pros and contras of the dictionary access based on WNs and WAN for TOT initiated searched. The comparison to the results of corpus-based access methods and the search in dictionary definitions is carried out.

2 Experiments and Results

The previous section deals with the WN/WAN-based interface in general. It has been shown earlier [Sinopalnikova and Smrz, 2004] that the language resources (WN vs. WAN) are in a way complementary and that they can provide information that cannot be easily extracted from other sources such as corpora. The results summarized in this section add a piece to the mosaic showing that WN/WAN interface can be the best choice for the dictionary access in many cases.

It is not easy to devise a procedure for testing various word-access strategies. As mentioned above, we aim at a combination of the TOT-problems in monolingual and bilingual settings and situations when one cannot come up with a (perfect) translation of the searched word (due to lexical gaps, insufficient bilingual dictionary, etc.). When we speak about TOT in the next paragraphs, we mean this broader sense of the access problems.

As it was shown by the previous psychological research [Rustle and Burke, 1996; Levelt et al., 1996] TOT is a rather rare phenomenon. It is reported that for young people the number of TOTs is about 5% of lexical access situations with common words (for proper nouns it is 10%), for old people this number is twice as high. Therefore, to get reliable results, it is crucial to perform a large number of experiments with dictionary access methods.

First, we have tried to combine the evocation of TOT with the user choice of the access method to figure out what is the best strategy and what method leads to the shortest time to find the correct word. However, these experiments did not give us unbiased results as the subjects evidently preferred the language resources and the access methods, which they were most familiar with, and used the others (in the pre-determined order) only if the previous one failed. The previous search influenced the choice of the resource and even the input on the next stage of the experiment.

Therefore, we decided to divide the experiment procedure into two steps. The first one is to induce lexical access problems, to identify the TOT and "Don't Know" cases, to record the way the subject proposes to access the word (i.e. meaning approximations) and to store this information together with the correct word the subject had in mind. The second step is to process the results, simulating an search assistant (intelligent or 'blind') that would select the optimal access method every time. We limited our work to:

- the language-based access only, thus we excluded the cases (parts of the access procedure) when the subjects used non-verbal word approximations, such as mimics, gestures (e.g. drawing a circle in the air, instead of saying "*round*"), sounds (e.g. approximating the word *rattlesnake* with a hiss and waving hands) etc.
- the access by meaning, thus excluding all access-by-form cases from answers, e.g. approximation of *ignorant* through *sounds like arrogant.*

2.1 The experiment design and material

All experiments described below involved subjects between the ages of 25 and 78; including equal number of men and women, with higher education and various professional background (chemistry, computer sciences, humanities, mathematics, mining and public relations). All subjects were native speakers of Russian, all but one knew English at advanced level, and were able to communicate and produce texts in English.

1. In the **first** series of experiments, eight subjects were asked questions that are correctly answered by a single word, e.g.: *"What is the name of a vehicle that takes people to and from hospital?"*

   ——with the only possible answer *ambulance;*

   "What word means to make an official inspection (of a boundary) on foot?"

   ——with a possible answer *to perambulate.*

If the question induced TOTs (i.e. the subject could not give an answer, but claimed the word was familiar to him/her), the way the subject would use to look for the word was recorded.[4]

The questions were presented in the written form. The answers were given orally, and fixed by an instructor. The tests were carried out using the subjects' mother tongue (Russian), and then repeated with the foreign language (English). The Russian experiment setting included 45 questions, the English one included 40.

2. In the **second** series of experiments, four subjects were asked to log all TOTs they experienced while writing an article (in Russian and English). Their 'diaries' containing information about the starting point of the search – what subjects remembered about the word (meaning, synonyms, context, domain etc.) and the way they found the correct word – were then processed.

In the case of TOT in the foreign language, the subjects could approximate the searched word by other English words but also by words (not always being approximate translations) in their mother-tongue (Russian).

3. The **third** series of experiments included two variants of the first series. Firstly, the subjects were asked to fill the gap in the sentences like "*The colour of the clear sky is blue, but the colour of the deep sea is _____";*

   "*When the sun is shining the sky is blue, but in the stormy weather it is _____"* – the possible answers *ultramarine, indigo, azure, cerulean, navy* etc. all being low frequent words.

   The same eight subjects participated in another variant of the experiment. The sentences were replaced with pictures. The subjects were asked to describe an object or a situation. In the case of TOTs, the potential input to the idealized dictionary interface was recorded. For

[4] Note that the words the subjects used for the look-up were influenced by the search procedure they expected (are familiar with). As a by-product, we recorded the preferred (sequence of) strategies the subjects would apply. Interestingly, the optimal one often differed from that chosen by the subject even if the given words seemed to be specially suited for it.

Table 1: The number of the TOT answers obtained in the first series of experiments.

	mother-tongue	*foreign language*
Number of questions per subject	40	45
Total number of questions asked	320	360
Number of TOT answers	13	31
Relative frequency of TOT answers	4.06 %	8.61 %

example, a picture of a girl with an iron in her hand and a scorched shirt before her induced TOTs related to the words *to scorch*, *stain*, and surprisingly *to burn*, and *iron* (1 subject).

Note that the described simplified experiment setting corresponds to the search with no feedback. Subjects faced the instructor, not the dictionary interface. They got no information whether the access method they chose failed or succeeded. They have no chance to correct their input according to the dictionary output and repeat their search. The experiments we plan for the future involve more realistic conditions where the subjects will initiate the search with a few words, the interface will present the most probable entries for various access methods and the procedure may be repeated until the correct word is found.

The obtained data confirmed the early statement by psychologists that TOT is a rare phenomenon in the mother tongue. The results summarised in Table 1 show that it was induced in about 4.06% cases. Although, we cannot generalise from eight subjects, the numbers seem quite reliable. They are in agreement with those reported in [Rastle and Burke, 1996; Oldfield and Wingfield, 1965; Levelt et al., 1996]. We can also confirm their observations that TOT appears more frequently for longer, low-frequent words or words that a subject not used recently. We did not included proper names as they are rarely looked up in standard dictionaries, so this difference was not taken into consideration in our experiments. Another two TOT inducing factors were observed for the first time – these i)are number of the senses of the searched word and ii) the number of its synonyms. Both these factors are in proportion with the frequency of access problems.

The frequency of the inability to recall a word in a foreign language depends on the subject's age, education and professional background, the choice of the queried words and many other factors. The percentage could be affected easily (reduced or increased) by choosing simpler words, familiar to subjects or complex, technical, rare words. This should be taken into account when one interprets the figures in the third row of Table 1. We tried to set the experiment material so that it corresponded to was higher than the subject's level of the language knowledge.

The main body of the data was obtained in the first series of experiments. Other experiments produced a significant supplement to it. After processing the diaries, and excluding the TOT problems that were form-based, we obtained another 12 word-access procedures for Russian and 26 for English. Together with 13 and 31 from the fill-in/picture-description experiments, we end up with 25 word approximations for Russian and 57 for English.

The complete data set was then processed using the five strategies of the word access. The simplest setting of the results evaluation (called **blind approach** later) was to take the logged approximations of the words as sequences of words with no structure or special relations. These undifferentiated word approximations were than used as the input for each of the access-assisting resource. That means that even if a subject claimed that a word X represent a typical context of the searched word Y, X was not excluded from the input to WN or WAN. On the other hand, the small size of the experiment data allowed us to perform a detailed (semantic) analysis of the access procedures as well. In the second case, the words approximations were classified manually, assigned to the appropriate access method(s), and processed in the way optimal for the given method (**intelligent approach**).

Different word-access methods were evaluated against both sets of word approximations - the blind and intelligent ones. We entered the word approximations as the input to all the access-assisting resources we studied, and analysed their outputs. Regularly, the correct word was obtained with more than one access method. Then, we computed the position of the searched word in the output. The reported 'winner' is the method that returned the correct word at the upper position.

2.2 Evaluating definition-based access method

The standard dictionary access methods suppose a search in the entries. In the blind settings, we searched for all the approximation words. The intelligent approach simulated a parsed input – the definition part is searched in the definitions, the usage part in examples etc. Longman Dictionary of Contemporary English [LDOCE] was used for the English part, and the Explanatory Dictionary by Shvedova and Ozhegov [EDR] for Russian. The bilingual search was performed with Multitran dictionaries [MAD]. The language of the words in the bilingual approximations mixing English and Russian was identified manually. The translation equivalents provided by the bilingual dictionary were combined with the results of the search in LDOCE. The score of the words returned by both sources was increased.

2.3 Evaluating corpus-based access methods

Two corpus-based methods were evaluated for English word approximations:

- The first employs standard KWIC search over BNC and retrieves the most frequent collocates of all the approximation words (the blind setting) or the relevant part of them (the intelligent setting).
- The second corpus-based method takes advantage of advanced techniques of the corpus processing, namely WordSketches for English [Kilgarriff et al., 2004].

The blind setting selects the related words for approximation set as a whole, not analysing the type of relations. The "understanding" of the relation provided by the deep (manual) analysis (perfect input) is crucial for the intelligent approach – for each approximation word the specified set of the wordsketch relations is retrieved only. The retrieved words are ordered according to the computed score provided by the sketch engine in both cases. The same procedure as for English was applied over Bokrjonok 3.0 – a balanced corpus of the modern Russian [Smrz and Sinopalnikova, 2004].

2.4 Evaluating access methods based on wordnets and word association norms

The contributions of WN and WAN integrated into the implemented interface were evaluated separately. The blind approach presents all the approximation words without any distinctions of the kind of relations. The intelligent approach concerns the relevant part of the approximation words only and looks up the related words according to the relevant relation. Edinburgh WAT [Kiss et al., 1972] and Russian WAT [Karaulov et al., 1994-1996] were used for the second set of experiments. Again, the blind approach makes no difference among words, the intelligent one tries to guess the optimal combination of associations that are looked up.

The results of all the experiments are summarized in Table 2.

The N/A results mean that the given method of the dictionary access could not guarantee an effective look-up for obtained word approximations. This can be partly explained by the insufficient size (or absence) of the respective language resources - the size of the RussNet is limited to 5500 synsets, the wordsketches for Russian are not available at the moment.

The smaller numbers in the column of the intelligent approach in comparison with the blind approach for corpus-based and WAN-based interfaces should not be interpreted wrongly. They do not evidence that the blind approach outperforms the intelligent one in these cases. Rather the results suggest that the detailed analysis of user's input was helpful to the other access strategies too, and in more effective way.

3 Conclusions and Future Directions

Our experiments were focused on the access by meaning, not by form. We tried to explore what language resources can facilitate the lexical access and in what way, what strategies of access are preferential and in what cases. In our experiments, we simulated monolingual look-up (Russian) as well as bilingual one (Russian-English).

The described experiment setting corresponds to the initial search only. Our future research will focus on advanced techniques of the access evaluation. We will provide the user with a more realistic application interface, which will be able to present search results from more than one information source simultaneously and allow the user to add new data to its current input and see the updated results. We will also pay attention to the design of the search form. The current prototype is rather complex. We cannot expect that an average user will be able to classify his/her word approximations correctly, to define the kind of relation between given word and the searched one or to identify optimal access strategy.

The subjects participated in the evaluation experiments know English at advanced or professional levels. However, the research on the optimal dictionary access methods is relevant also for beginner language learners. When the standard way of the search in a bilingual dictionary fails, it is very difficult to find the word for them as their vocabulary is rather limited. Thus, the WAN part of the interface seems to be of crucial importance then. Either a very good bilingual dictionary (ideally combined with a parallel corpus) or much more advanced combination methods are needed for such search.

Dictionary search is not the only area where the word-access problems appear. Our current cooperation with the Support Centre for Students with Special Needs aims at an application of the user interfaces discussed in the paper for visually and hearing impaired people. Especially, the latter group may take advantage of the WN/WAN-based interfaces that seem to match their needs when dealing with complex computer applications. We will also experiment with the use of WN and WAN to improve language modelling in applications for the handicapped students.

4 Acknowledgements

This work was partly supported by the Ministry of Education of the Czech Republic Grant MSM 6383917201 and European Social Fund MSMT CZ04.1.03/3.2.15.1/0146.

Dictionaries

AHDAL - *The American Heritage Dictionary of the English Language*: Fourth Edition. 2000. `http://www.bartleby.com/61/`

Bernstein T. (1975) *Bernstein's Reverse Dictionary*. NY:Times Books.

CALD - *Cambridge Dictionaries Online – Cambridge Advanced Learner's Dictionary* `http://dictionary.cambridge.org/`

CCED - *Collins COBUILD Advanced Learner's English Dictionary*. 4th edition. Harper Collins Publishers, 2003.

COED - *The Compact Oxford English Dictionary* - `http://www.askoxford.com/`

Edmonds D. (1999) *The Oxford reverse dictionary.* NY: Oxford University Press.

EDR - Shvedova N. V., Ozhegov S. Ju. (1992) *Explanatory Dictionary of Russian.* www.lib.ru/ozhegow

Glanze W.D. (1990*) Illustrated Reverse Dictionary: Find the Words on the Tip of your Tongue.* Pleasantville, NY.

LDOCE - *Longman Dictionary of Contemporary English (Online)* `http://www.ldoceonline.com/`

Lingea: `http://www.lingea.cz`

MAD - *Multitran automatic dictionaries (Online).* www.multitran.ru

MW - *Merriam-Webster Online Dictionary* `http://www.m-w.com/`

Table 2: Evaluation results for five access methods.

Dictionary-search method	Number of "winners"			
	for the blind approach		for the intelligent approach	
	Russian	English	Russian	English
Fulltext search in entries	10	12	11	15
Corpus-based collocates	8	5	7	2
Word sketches	N/A	14	N/A	17
WN-based interface	N/A	15	N/A	17
WAN -based interface	9	9	9	6

NWED - *The New Webster Encyclopaedic Dictionary of the English Language.* (1997). New York.

OneLook: `http://www.onelook.com/`

References

Benedict project: `http://mot.kielikone.fi/benedict`

Bentivogli L., Forner P., Magnini B., Pianta E. (2004) *Revising WordNet Domains Hierarchy: Semantics, Coverage, and Balancing*. In: Proceedings of COLING 2004, Workshop on "Multilingual Linguistic Resources", Geneva, Switzerland, August 28, 2004, pp. 101-108.

Bilac S., Baldwin T., Tanaka H. (2003) *Improving dictionary accessibility by maximizing use of available knowledge.* In: "Traitement automatique des langues", 44 (2).

Bilac S., Watanabe W., Hashimoto T., Tokunaga T. and Tanaka H. (2004) *Dictionary search based on the target word description.* In: Proceedings of the 10th Annual Meeting of the Association for Natural Language Processing. pp.556-559.

Brown D.M., McNeill D. (1966) *The tip of the tongue phenomenon.* Journal of Verbal Learning and Verbal Behavior, 5. pp. 325–337.

Burke, D.M., MacKay, D.G., Worthley, J.S., Wade, E. (1991) *On the tip of the tongue: What causes word finding failures in young and older adults*. Journal of Memory and Language, 30. pp. 542–579.

Cronbach L. J. (1942) *An analysis of techniques for systematic vocabulary testing.* Journal of Educational. Research, 36. pp. 206–17.

El-Kahlout I. D. and K. Oflazer. (2004) *Use of Wordnet for retrieving words from their meanings.* In: Proceedings of the Global Wordnet Conference (GWC2004). pp. 118–123.

Fellbaum C. (ed.) (1998) *WordNet: an electronic lexical database.* MIT Press.

Ito T., Kuhota M. (1987) *A Retrieval System for On-line English-Japanese Dictionaries*.

James W. (1890) *The principles of psychology.* Vol. 1. New York: Henry Holt & Co.

Karaulov, Ju.N., Cherkasova, G. A., Ufimtseva, N.V., Sorokin, Ju. A., Tarasov, E.F. (1994, 1996, 1998) *Russian Associative Thesaurus*. Moscow.

Kilgarriff A. (2002) *Web as Corpus.* Poster session at the Tenth EURALEX International Congress, EURALEX 2002, Copenhagen, Denmark.

Kilgarriff, A., Rychly, P. Smrz, P. and Tugwell, D. (2004) *The Sketch Engine*. In: Proceedings of the 11th European Association for Lexicography) International Congress (EURALEX2004), Lorient, France, 6–10 July 2004. Université de Bretagne Sud. Volume I. pp. 105–116.

Kiss, G.R., Armstrong, C., Milroy, R., and Piper, J. (1973) *An associative thesaurus of English and its computer analysis*. In: Aitken, A.J., Bailey, R.W. and Hamilton-Smith, N. (eds.), "The Computer and Literary Studies". Edinburgh: University Press.

Levelt W., Roelofs A., Meyer A.S. (1999) *A Theory of the Lexical Access in Speech Production*. Behavioral and Brain Sciences, 22. pp. 1–75.

Lin, Dekang. (1998) *Automatic retrieval; and clustering of similar words*. In: Proceedings of COLING-ACL Montreal 1998. pp. 768–774.

Löfberg L, Juntunen J-P, Nykanen A, Varantola K, Rayson P, Archer D. (2004) *Using a semantic tagger as dictionary search tool.* In Williams G. and Vessier S. (eds.) Proceedings of the 11th EURALEX (European Association for Lexicography) International Congress (Euralex 2004), Lorient, France, 6–10 July 2004. Université de Bretagne Sud. Volume I, pp. 127–134.

Maylor, E.A. (1990) *Age, blocking and the tip of the tongue state.* British Journal of Psychology, 81. pp. 123–134.

Miller G. A. (1985) *Wordnet: A dictionary browser*. In: Proceedings of the First Conference of the UW Centre for the New Oxford English Dictionary, INFORMATION IN DATA. Waterloo, Canada, pp. 25–28.

Rastle K. G, Burke D..M (1996) *Priming the tip of the tongue: Effects of prior processing on word retrieval. in young and older adults*. Journal of Memory and Language, 35. pp. 586–605.

Roget P. M. (1952) *Everyman's thesaurus of English words and phrases.* London, New York, Dutton.

Rychlý P. and Smrž P. (2004) *Manatee, Bonito and Word Sketches for Czech.* In: Proceedings of the Corpora-2004. Saint-Petersburg, Russia. pp. 34–41.

Sinopalnikova A., Smrž P. (2004) *Word Association Norms as a Unique Supplement of Traditional Language Resources.* In: Proceedings of LREC 2004. Lisbon, Portugal.

Smrž P., Sinopalnikova A. (2004) *Corpus Analysis for Lexical Database Construction: A Case of Russian and Czech Wordnets.* In: Proceeding of the 33th International Conference on Linguisitcs. St.Petersburg State University, Russia. pp. 23–31.

Zock M. (2002) *Sorry, what was your name again, or how to overcome the tip-of-the tongue problem with the help of computer?* In: Proceedings of the SemaNet workshop, COLING 2002.

Zock M., Bilac S. (2004) *Word lookup on the basis of associations: from an idea to a roadmap*. In: Proceedings of the Workshop on Enhancing and using electronic dictionaries, COLING 2004. pp. 29–35.

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