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The word association test in the methodology of thesaurus construction

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Abstract

This paper analyzes the word association test and discusses whether that method should be included in the process of construction of searching thesauri. The first part of the paper describes the searching thesaurus: its definition and function in information retrieval. In the next part the methodology of the word association test is described and discussed in relation to thesaurus construction. The focus of the investigation is on whether the association test is suitable for identification of the specific language use of a limited user group and for identification of synonyms and near-synonyms. The results of three projects, concerning the use of the word association test for thesaurus construction, are reported. It is concluded that the test is a valuable method in the methodology of thesaurus construction. The association test elucidates the use of language of a specific, limited user group and identifies relevant relationships between words. The test, however, does not reveal the context and meaning of the analyzed words. It is thus recommended that the word association test is combined with more qualitative methods.

Background

A thesaurus is a compilation of terms showing synonymous, hierarchical, and other relationships and dependencies. Its function is to provide a standardized, controlled vocabulary to facilitate information storage and retrieval. A typical problem of information retrieval is that one concept might be expressed by many different words (synonyms): Authors, indexers and searchers tend to use a great variety of words to refer to the same thing (Bates, 1986; Blair, 1986). The main purpose of the thesaurus is to guide and provide security in retrieval.

Traditionally, the terminological control in a thesaurus is achieved in various ways. The terms are controlled morphologically, a choice is made between two or more synonyms, and decisions are made on whether to admit proper nouns, and in what form. The meaning of the terms, which in a dictionary might be accompanied by illustrations of different usage, is often restricted to the meaning appropriate for the purposes of a particular thesaurus. The restriction is indicated in a thesaurus by the addition of scope notes and qualifying phrases.

Special types of thesauri exist, and during the eighties several researchers (Bates, 1986, Piternick, 1984, Lancaster, 1986) introduced the concept of a searching thesaurus. This type of thesaurus, also called end-user thesaurus, is regarded as a search only vocabulary rather than an indexing vocabulary. The searching thesaurus is supposed to be a specialized tool in the process of defining and formulating the search request and query.

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The searching thesaurus is designed to link the vocabulary of the searcher with that of the database to be searched. Due to the unique backgrounds, training and experiences of different users, the chance of two people using the same term to describe a concept is quite low and even the same person may use different terms to describe the same concept at different times (due to context, the learning process and the evolution of concepts). Thesaurus can be considered as playing a similar role to that of the intermediary of the system. Bates (1986) calls it the system's "front-end system mind (FSM)" and describes the goals of the FSM as

> to help people get into the system, explore, make their own mental associations, discover the many topics related to their interests and the many terms under which material might be found (Bates 1986, p. 370).

In contrast to conventional thesauri, the searching thesaurus does not seek to control and standardize the term choices but, instead, provide alternatives (synonyms, quasi synonyms, antonyms) to the terms that the searcher has in mind and help the searcher to recall relevant related concepts. By providing the searcher with links and associations between terms that may be surprising thus stimulating further thought, the main goal of the thesaurus is to increase the searcher's perception and cognition and to elaborate and clarify the search formulation. The searching thesaurus is supposed to be a recall-enchancing tool. But, of course, the thesaurus is also a tool to improve precision, suggesting more specific terms.

Rich possibilities for cognition and association are not enough, the thesaurus must also help the searcher to get into the thesaurus and the information system by providing a huge lead-in-vocabulary. The entry vocabulary ought to be exhaustive and of great variety. Bates (1986) stresses the importance of colloquial terms as people access information systems with different requirements, backgrounds, and qualifications.

The purpose of the searching thesaurus can be divided into four main tasks:

- The thesaurus is intended to help searchers to access the contents of the thesaurus. This is done by a large system of lead-in-terms, which guide the searcher into the network of the thesaurus.
- The thesaurus helps searchers understand how the concepts are to be understood by indicating relations between different concepts or by scope notes (definitions and explanations).
- The thesaurus helps searchers to understand their needs for information and to express these in terms of the system.
- The thesaurus is used for query expansion, interactively or automatically.

Good examples of searching thesauri providing a concept space of alternative terms for selected concepts are the BRS TERM Database and the Contemporary Thesaurus of Social Science Terms and Synonyms. The BRS Term database is an online merged vocabulary of controlled terms in the Social Sciences, which also provides natural language equivalents of the controlled terms. The Contemporary Thesaurus of Social Science is an interdisciplinary guide independent of any controlled vocabulary, referring

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to synonyms and related terms or phrases for concepts from a variety of different fields within Social Science. The thesaurus consists of groups of synonyms, near-synonyms, and closely related terms. Each group is listed alphabetically under a concept title, scope notes are not used: words are not defined. The thesaurus is designed to help users find meaningful words for natural language searching.

The searching thesaurus can be attached to specific controlled vocabularies, trying to facilitate the understanding and use of these particular vocabulary systems. This is the case of the BRS Term Database which relates descriptors of 5 distinct controlled vocabularies. The searching thesaurus does not need to be restricted to specific vocabulary systems. The thesaurus can try to map the terminology used within a specific subject domain to be used for natural language searching, like the Contemporary Thesaurus of Social Science.

The searching thesaurus is an aid for the sophisticated searcher rather than the typical end-user. Although end-users can learn search techniques, online searching demands knowledge, skills, and experience. Over the years several tests have showed end-users' difficulties with and their lack of use of searching aids (Lancaster, et al.,1991; Wallace, 1993; Siegfried, Bates & Wilde, 1993). The searching thesaurus is a tool which must be actively introduced to its users. The alternative is to integrate it in the systems' user interface to be used automatically.

In spite of these problems the searching thesaurus still has its place, especially in the age of the Internet and WWW. The indexing procedures of the Internet search engines demand much subject knowledge of the searcher, which increases the need for tools like a searching thesaurus. The characteristics of the Internet also demand that this tool is multilingual to facilitate translation of concepts across languages. The metadata concept will probably improve retrieval from the Internet, but still searchers could benefit by searching thesauri linking different controlled vocabularies pointing to natural language terms and phrases. To sum up, the growth of online information retrieval and end user's unassisted searching have increased the need for tools tofacilitate searching.

An important success factor for a searching thesaurus is that it is easily accessed; searchers should be allowed to access the information system using their own vocabularies. It is impossible to predict exactly what specific terms or phrasings searchers will use in formulating their requests; the entry vocabulary ought to be of great variety and complexity to facilitate the match between the user's terms and those of the database.

This paper presents an evaluation of word association as a vehicle for construction of a searching thesaurus. As such, the paper focuses on the elaboration of:

- a varied and complex entry vocabulary
- identification of colloquial, user-oriented terms and relations.

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In the following sections several points will be discussed: thesaurus construction, the methodology of the word association test and the results of three projects using the methodology. The paper will end up with an evaluation and a discussion of the methodology.

Thesaurus Construction

The process of thesaurus construction consists of 3 main steps:

- Acquisition of concepts and terms
- Analysis of concepts and terms
- Presentation of concepts and terms.

The main process is the same no matter what type of thesaurus one intend to develop. However, the intended purpose of the thesaurus will affect the focus and importance of the different processes.

Constructing a searching thesaurus the "term acquisition" process ought to capture as many variant terms for a concept as possible. There are three main written sources of terminology: terms in standardized form found, for example, in dictionaries, thesauri and encyclopedias; non-standardized terminology found in the literature; and terminology in users' recorded questions and profiles. Two unwritten sources are the knowledge and experience of users and experts (Aitchison, 1987).

In order to grasp the users' spontaneous or "natural" terminology, the users must be consulted. Several methods exist to grasp the users' use of language:

- experts/users may be asked to assist in the scanning of the literature, indexing items with those terms they consider most appropriate
- experts/users may be asked to list terms of importance in their subject fields
- experts/users may be asked to list typical questions which they might put to the system
- experts/users may be shown lists of terms or draft classification schemes, in their own subject fields, and asked to comment, make amendments and add terms
- groups of experts/users may be asked to discuss the terminology and classification in subject areas which appear difficult to delineate and which require careful clarification
- user queries might be collected (Soergel 1985)

In this paper the word associations test will be evaluated as a method to collect the users' vocabulary.

The analysis and structuring of terms for a searching thesaurus will vary compared to traditional thesaurus construction. As the searching thesaurus ought to be more descriptive than prescriptive less attention has to be paid to the morphological control. Regarding semantic control, control focuses on cross referencing to a large space of synonymous and associatively related terms.

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The associative relationship is not easy to define. According to the standard (ISO 2788) the associative related terms are terms

> mentally associated to such an extent that the links between terms should be made explicit in the thesaurus, on the grounds that it would reveal alternative terms which might be used for indexing and retrieval (Aitchison, 1987, p. 44).

The associative relationship is of great importance in retrieval, showing the context of the analyzed concept and giving reference to a variety of aspects connected to the concept. The loose definition implies that there always exists a risk of overloading the thesaurus with valueless relationships. The identification and selection of associative terms are a difficult part of thesaurus construction. The Standard recommends that relationships are founded according to the frames of reference shared by the users of the system. There are various methods to capture user- or domain-oriented associative relationships. They might for example be identified by analyzing user enquiries or documents written by users within the subject domain. Operationally, there is always a risk that the associative relationships, identified by the users, turn out to be strongly subjective and very related to the present situation. The identified relationships might only have a short and very specific relevance which devaluates the value of the relationships.

The control of the meaning of the concept by scope notes and definitions does not have the same significance in a searching thesaurus, but the elucidation of the different understandings and views on a concept will augment the value of a searching thesaurus. In the following section the word association test will be considered as a complementary method for semantic analysis and structuring.

The question of how to present and use the thesaurus is a very important part of the construction process, but will not to be discussed here.

The Word Association Methodology

The word association test is a common method within psychology and has been used for the last one hundred years. Within psychology the method has been used to reveal the private world of an individual. In the simplest form a series of disconnected words (stimulus words) are projected orally or in writing to the subjects who must respond with the first word which comes to mind (response words). Psychologists examine the nature and probabilities of the response words, and sometimes the amount of time it takes to respond. These associations reveal the respondents' verbal memories, thought processes, emotional states and personalities.

Within information science only a few researchers have dealt with word association tests. Kiss (1975) used the method to develop an associative thesaurus of the English language, a kind of Rogets Thesaurus. Pejtersen (1991) used the word association test to structure descriptors from a controlled vocabulary. The descriptors were structured according to their degree of overlap of association response words. If the descriptors

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had many response words in common, they were related in the thesaurus. Ornager (1995) used the association test to improve the search facilities of an image database, containing digitized photographs. In order to deem whether the method is convenient in thesaurus construction, the word association test has been studied in three Danish research projects (Lykke & Skrubbeltrang 1992; Lindholm Kjær, Møller & Sognstrup 1994; Lindholm Kjær, Møller & Kruse 1996). This paper will concentrate on the results of the projects using the association test in the methodology of thesaurus construction.

The association test is a way to identify the associative meaning of a stimulus word or relationship between two stimulus words (Deese, 1962). The response words create a cluster of associative representations of the stimulus word. High similarity of response words between two stimulus words indicate relationship between the analyzed stimulus words.

The clusters of response words can be considered as an indication of the respondent's (un)conscious understanding of the relevance and relationship between the stimulus concept and the concepts revealed by the test. The association test exposes the respondents feeling of "what goes with what;" it is the structure of our situational, working memory which is revealed by the association test (Kiss, 1975).

Our reason for introducing the word association test within the methodology of thesaurus construction is the wish to catch the intuitive, colloquial thinking of the users of information systems. Research has shown that users do not use the information systems professionally and consciously. For that reason, the individual, spontaneous relations, identified by the association test, could be of use in information retrieval. The associated terms could function as lead-in terms and help the users to access the information system. Another function of the associative terms could be to help the users to clarify their information needs. For users with unclear information needs it could be useful to browse a set of associative related terms showing distinct facets of the subject of interest.

Various methods need to be considered when planning a word association test. The respondents may be allowed to associate freely (free association test) or responses may be limited to semantic categories, to particular synonyms, to terms within a certain context or to choice among alternatives (controlled association test).

Priming is a way of manipulating the responses through verbal instruction and through the setting of the physical equipment of the imagined (work) context. Explicit information about the purpose of the test and context of the stimulus words as well as visual impressions communicated by the physical surroundings is expected to prime the respondents' mental models of the work domain and thus influence their associative responses. Priming is normally used in controlled tests.

The presentation of stimulus words varies a lot, depending on the methodology. In a discrete test a stimulus word is presented one time and the respondent must associate one response. In a continued test the same stimulus word is displayed a number of

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times and the respondents must continue to give responses to the original stimulus word. In a continuous test the stimulus word is used as a starting point for a chain of responses. It is displayed only one time to the respondents. By using a continuous test method there is a risk that the respondents will associate their response to the last given response word, which provides a chain or set of associations.

However, that might be particularly helpful in constructing a search thesaurus. Comparisons of the possible effect on responses of the various test methods do not provide the consistent results needed to elucidate what methodology to use for specific purposes (Pejtersen, 1991).

In order to develop a searching thesaurus within a specific subject domain, it seems relevant to use a controlled test. Searchers working within a certain framework do not associate freely when searching information. They make their considerations and associations in relation to the subject domain of interest.

To capture as many relations as possible to a concept the continued test seems most suitable. The discrete test method will probably provide a smaller number of relations. Using the continued method compared to the continuous method it is more likely that the respondents keep on track and continue to give responses to the original stimulus word.

Priming could be valuable to keep the respondents on track and to generate terms related to a particular context.

The Word Association Test in Practice

The project of Lykke and Skrubbeltrang (1992) was done in the research center of APV Pasilac Denmark, an international company dealing with technical equipment for the food industry. Concerning the association test the main purpose of the project was analyzing whether the association test is useful as a methodology of construction of searching thesauri.

The intention was to test whether the association test is suitable for identification of :

- the language use of a specific user group: their terminology (choice of words, form, use of abbreviations and compound terms etc.) and their way of relating concepts
- synonyms and near-synonyms to selected concepts in order to generate a large system of lead-in-terms

The association test was carried out as a controlled, primed test involving nine users of the information system. The stimulus word were presented to the respondents in written as well as in oral form, and the respondents had 1 ½ min to associate, preferable with three responses. The continuous test method was chosen because the pilot project showed that the test persons found it easier and more comfortable to associate three

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relations at a time. They had no problem keeping on track and continuing to associate the original stimulus word.

The respondents were instructed to associate in relation to their work domain and work functions avoiding general, broad concepts within the domain, e.g. *milk* and *cheese*. Every respondent wrote down his personal responses in a little booklet.

The associations were made in English because English is the official language of the company and the information system. However, the pilot project showed that some of the respondents had problems associating in English. In order not to miss valuable associations because of language problems, associations in Danish were allowed. Concepts within the subject domain is well defined. Subsequently, the response words given in Danish could be translated into English without any problems.

In the test the respondents made associations to 24 stimulus words, taken from the system's controlled vocabulary.

Results

The test was successful; the respondents could easily make the associations. Before further analysis the form of the response words was standardized, e.g. *feta* and *feta cheese* were normalized to one form. A word database was created. The stimulus words (descriptors from the system's controlled vocabulary) were recorded as the title of the record, the response words were registered in the subject field, and the respondents in the author field. This database was used in the statistical analysis, calculating the frequency and overlap between the different types of words as well as for the qualitative analysis.

The clusters of response words were compared with clusters of indexing terms. The cluster of indexing terms was extracted by a ZOOM-like algorithm from the following record fields: controlled terms, assigned uncontrolled terms, titles, and abstracts). The comparison was made to see whether the terminology of the authors and indexers were similar to that of the users/respondents. There was a surprisingly low degree of overlap; in average 31%. Within the key subjects of the company the overlap was better, in average 49%. Stimulus words belonging to actual research areas of the company also resulted in a better overlap compared to words belonging to research of a later date.

The overlap between the test persons was also low, in average 22%. Even though the users belonged to the same work domain and more or less had the same professional backgrounds, the test revealed an extremely varied use of language. The test did not reveal a different use of synonyms, but did find that there was a different understanding of relationships for the concepts used as stimulus words. Furthermore, the qualitative analysis showed that more specific stimulus word within the work domain, for example *analytical techniques*, provided a more well-defined set of highly related response words, whereas more general stimulus word like *milk* provided a set of less interrelated words.

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By the qualitative analysis is was also revealed that two of the respondents, recently coming from a similar, competing company, used another vocabulary. Some concepts within the work domain have a sort of nickname, *UHT pilot plant* is for example called *palatest.* The new employees did not use the local nickname for *UHT pilot plant* which all the "old ones" did.

Some relationships, identified by the association test, are shown in Fig. 1.

A qualitative analysis of the response words showed that the response words, generally, were of high relevance to the stimulus words and to the subject domain. As shown in Figure 1 and Figure 2 the test revealed that compared to a controlled vocabulary within the subject field, The FSTA Thesaurus, the method identified a greater amount of associative terms to the stimulus words, terms of a more specific level and terms from other hierarchies.

In relation to the stimulus word *UHT* the association test identified, for example, the terms *bacterial spores, protein denaturation* and *holding time* - concepts which are of a more specific level, belong to different hierarchies and all highly related to *UHT.*

Further, the responses elicited how the concepts are related in that particular work domain. It is normal within dairy production to relate *brine* with *cheese making* and *cheese salting*, but the relations between *brine* and *chilled water, feta, microfiltration,* and *salt slurry* are indications of the company's specific profile and research. The same can be said about the relations to *whey* and *UHT.* Normal relations to *UHT* are *sterilization, sterile products, heat treatment, milk products, bacterial spores*, but relations as *aseptic packaging, cooked flavour, chocolate milk, cream, desserts, infusion, juice, protein denaturation, recombined products, shelf life* indicate the company's special concern and research. Normally connected to *whey* are *b-lactoglobulin, cheese, lactose, traditional cheese, whey protein,* and *WPC.* Relations like *desalination, filtration, hyperfiltration, permeate, reparation of protein, skim whey, UF cheese,* and *ultrafiltration* show the company's special profile and focus.

Moreover, the test revealed that the respondents' way of relating concepts also depends on their personal focus and work tasks.

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Stimulus word:	*Brine*	*UHT*	*Whey*
Response word:	*cheese making*	*aseptic packaging*	*b-lactoglobulin*
	cheese salting	*bacterial spores*	*cheese*
	chilled water	*chocolate milk*	*desalination*
	feta	*cooked flavour*	*filtration*
	microfiltration	*cream*	*hyperfiltration*
	salt	*desserts*	*lactose*
	salt slurry	*heat treatment*	*permeate*
	taste	*holding time*	*reparation of protein*
		infusion	*skim whey*
		juice	*traditional cheese*
		milk products	*UF cheese*
		protein denaturation	*ultrafiltration*
		recombined products	*whey protein*
		sterile products	*WPC*
		sterilization	
		whole milk	

Fig. 1: Examples of associations to three selected stimulus words

The purpose of the two other projects led by the author of this research paper was to get more empirical results. The association test was carried out at Aalborg Business School, in the Department of Marketing and the Department of Computer Systems ;and at Novo Nordisk, an international Danish company within the medical industry.

In the project at the Business School the controlled test method was compared with the free association method to test the presumption that the controlled test method provides response words of stronger relevance to the stimulus words. The stimulus words were selected from a local, controlled list of descriptors. The comparison showed that the controlled test revealed a higher degree of relevant response words than the free test method. The relevance of the response words were tested by a qualitative analysis which divided the response words into four groups: response words of strong relevance, response words of weaker relevance, response words of remote relevance and response words of no relevance (noise). Of the response words provided by the controlled method, 45% were of high relevance, whereas 24% of the response words provided by the free test method were of high relevance.

Another purpose of the test was to see whether two distinct user groups made different associations to the same stimulus words. A group of marketing students were tested and compared to a group of students of computer technology. The comparison showed a different use of language according to word form as well as relationships. The response words associated by the computer students were of a more precise, specific level compared to the response words of the marketing students. Generally, the response words were also of higher relevance to the stimulus words. An explanation could be that the computer studies are more well-defined than the marketing studies. Another reason could be that the computer students had studied one year longer than

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the marketing students participating in the test. These results confirm the results from project of Lykke and Skrubbeltrang that the association test will provide a better result concerning relevance and overlap the more knowledge the respondents possess about the subject domain. The relevance of the stimulus words for the respondents will also affect the relevance of the response words. Both tests showed that stimulus words of high topicality and interest provided response words of high relevance. On the other hand the tests revealed the importance of lead-in-terms and browsing tools for users with less subject knowledge.

The main purpose of the Novo Nordisk project was to use the association test to identify differences in the language use. Two different user groups were tested to investigate whether it is possible to use the association test to identify the language use of a specific user group. The tests were carried out as a qualitative analysis and comparison of the relationships identified in the literature within the work domain with the relationships identified by an association test. The analysis showed that for a user group of engineers/researchers working with Hormone Replacement Therapy, there was a great overlap between the language use of the literature and the user associations. The association test revealed relevant associative relations.

The overlap between the language use of the literature and the user associations was much lower for a user group working within marketing. The user group was non-homogeneous in respect of professional background and work tasks which clearly was identified by the analysis. The conclusions of the project recommend the use of association test to identify the language use of the respondents.

BRINING
BT CURLING
BT PICKLING

RT SALT

UF brines
salting

STERILIZATION
BT THERMAL PROCESSES

RT CANNING
RT FILTRATION
RT HEATING
RT PASTEURIZATION
RT STERILIZED MILK

NT IRRADIATION

UHT treatment
see STERILIZATION

WHEY
BT DAIRY PRODUCTS

UF karabesch

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UF retorting
UF UHT treatment
UF uperization

Fig. 2: Record examples of the Food Science and Technology Abstracts Thesaurus (FSTA Thesaurus 1981)

In Figure 3. the main results of the three projects are summed up.

Results concerning the use of language	Results concerning the methodology
• the test reveals the terminology of the respondents, e.g. the specificity and form (the use of abbreviations, spelling, plural/singular and compound terms) • the test reveals useful, related terms • the test reveals mostly associative relationships, indicating te specific focus of the respondents • the test reveals some synonyms; the more respondents, the more distinct synonyms • the test reveals some hierarchical relationships • the test reveals sublanguages within an organization • the response words have a low overlap with words extracted from the titles and abstracts of documents within the work domain	• controlled, primed test methods give more relevant, specific responses than a free test • respondents, working in a specific limited work domain, associate easily with three responses • the association test provide user- and domain-oriented relations • broad stimulus words result in a lower overlap than more specific stimulus words. The set of response words is not so well-defined as for more specific stimulus words • stimulus words, concerning the main subject of the domain, result in a higher overlap and higher relevance of response words • stimulus words in relation to new research result in higher overlap and higher relevance of response words • stimulus words from more peripheral research result in lower overlap

Fig. 3: Test results

Discussion and Conclusion

Analyzing the test results of the three research projects, the conclusion is that the association test is a valuable method to identify the use of language of a specific, limited user group. The association test elucidates the terminology of the users regarding word form, use of abbreviations and compound terms, and identifies the users' intuitive, subjective way of relating terms. The relationships, identified by the test, are generally of high relevance. Compared to indexer thesauri they are more specific, given across

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hierarchies, and express the special focus of the work domain. Some equivalent relationships are revealed, but there are surprisingly few. In order to identify synonyms the test would need to be carried out in another way by asking directly for synonyms.

The test results show that the association test is a fruitful method to identify associative related terms to the stimulus word. The response words are generally of high relevance and elucidate the specific focus and relationships of the group of respondents.

The main function of integrating the word association test in the methodology of thesaurus construction is to ensure user-orientation by:

- controlling the selected terminology according to the user group's use of language
- identifying user-oriented associative relationships
- identifying colloquial terms
- identifying clusters of synonyms and near-synonyms

The outcome of the test depends on the amount and choice of stimulus words. Depending on the scope of the thesaurus, a variety of stimulus concepts are needed to cover the subject field of interest. Furthermore, the stimulus words ought to be of a certain specificity in order to get relevant responses. Specific stimulus words produce the most useful associations.

The method should not be used alone. The need for stimulus words is an important reason why the method cannot stand alone. The stimulus words are necessary to carry out the test. It is recommended to find the stimulus words using traditional word acquisition methods or using terms from a existing vocabulary. The association test may reveal other concepts of relevance for the thesaurus under construction, but there is no guarantee that all relevant concepts for the thesaurus will be identified by the method.

An important problem with the association test is that the method is based on linguistic units out of context. The test does not directly reveal the meaning and the respondent's understanding of the stimulus words or the response words. The association test is based on individuals' intuitive and subjective associations. The identified relationships are not well considered (spur of the moment) nor based on an explicit understanding of the subject domain.

This fact both solidifies the method and devaluates it. It solidifies the method because it refreshes the thesaurus methodology by making it possible to catch and integrate the more spontaneous, colloquial and subjective terms and relations in the thesaurus structure. It devalues the method because of the possible diversity of understanding that causes unreliability in the test result.

The results, so far, do not provide evidence of incorrect interpretation of the stimulus concepts, but incorrect interpretation may occur. Therefore, the methodology has to be developed in order to elucidate the subject's understanding of the stimulus word and of the response words. Several possible solutions exist:

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- presenting the stimulus words in context
- asking for definition and description of the different types of words
- discussing the test result with the respondents

Subsequently, the explanations and definitions could be analyzed using discourse analysis. Recently research has provided interesting results in identifying relevant aspects and categories of concepts through discourse analysis of written definitions (López-Huertas, 1997). López-Huertas' paper shows how authors' writings can be used to identify their models and perceptions of the subject domain.

The three projects described have been limited to smaller groups of users and to well-defined subject domains. To use the association test in a wider context of a less well-defined user group and subject domain it might be difficult to define and find a suitable group of respondents being representative of the future user group with regard to knowledge and focus. In each of the described projects less than 100 stimulus words have been used. The qualitative analysis may cause problems when the amount of stimulus words and response words increase.

End-user searching and the importance of linking the end-user to the vocabulary of the information systems is still a critical problem for information retrieval. For that reason a new research project has been started to develop the methodology of the association test. The project has several goals. One is to find out whether it is possible to identify more synonyms and near-synonyms by the association test. Another important goal is by combination of methods and by developing the methodology of the association test to ensure that the result of the association test is less subjective and based both on the understanding of the subject domain and on the subjective understanding of the individual user.

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