# Contrast in language, thought and memory
## textual, psycholinguistic and neurolinguistic perspectives

**Specific aims**

CONTRAST IN LANGUAGE, THOUGHT AND MEMORY is an interdisciplinary project between Centre for Languages and Literature, Lund University, the School of Humanities at Växjö University and Psychology, Lund University. The main thesis of the project is that CONTRAST is an extremely powerful construal in human thinking, important to both the organization of coherent discourse and to the mental organization of the vocabulary, and CONTRAST is also part and parcel of evaluative polarity of negative and positive attitude. The human mind is a storehouse of huge amounts of knowledge of different kinds – about the world as well as about language. Studies of how this knowledge is structured have revealed that people tend to group together items that share constitutional or functional features. Characteristic of meanings that are construed on the basis of CONTRAST is that they share important features at the same time as they differ prominently in at least one respect. Meaning is a malleable entity on which structuring construals operate and similarity and difference are important in these processes (Croft & Cruse 2004, Paradis 2005).

CONTRAST comes in different guises in linguistic communication. Our focus of interest is on certain semantic dimensions, e.g. MERIT, WEIGHT and TEMPERATURE and their lexicalized protagonists: *good-bad*, *heavy-light* and *hot-cold* respectively. Such dimensions and linguistically encoded pairings are assumed to play an important rhetorical role in the global organization of text and discourse in terms of thesis and antithesis and at a more local level in constructional frames, e.g. 'help us be slow to judge but quick to forgive', 'Kennedy dead is more interesting than Clinton alive'. Evaluative polarity expressed by the antonyms in their various contexts are important at both levels. There is widespread consensus among linguists that CONTRAST is a robust semantic relation, but in spite of this, relatively little empirical research has been carried out to substantially support the claim. The aim of the project is to make up for this shortcoming. To get a firm grasp of the complexities of CONTRAST, our project builds on textual (corpus-driven as well as corpus-based techniques), psycholinguistic and neurolinguistic foundations.

**Research background**

In spite of the fundamental role of CONTRAST as an organizing and constraining principle in language and thought, little empirical research has been conducted using text-based methodologies, psycholinguistic experiments, neurolinguistic experiments and to the best of our knowledge no research has been conducted using a combination of all three techniques. Theoretical discussions of lexical relations in general, such as antonymy, synonymy and hyponymy in language and thought have to some extent occupied researchers from different schools for a long time. Lexical relations as structuring phenomena have captured the interest of different disciplines such as philosophy, linguistics, anthropology, psychology and computer science. (The various disciplinary interests in lexical relations are described in more detail in Murphy (2003: 62-85)). Practical concerns, on the other hand, have mainly been in focus in the field of

lexicology, lexicography and computational applications, but this knowledge has not been widely spread.

One important aspect that has been a bone of contention concerns how lexical knowledge is represented in memory as well as whether the relations are lexical in nature, conceptual in nature, or both. Previous psycholinguistic studies highlight the tendency of antonyms to elicit one another (and not any other semantic opposites) in psychological tests such as free word associations and the faster speed at which canonical antonyms are identified as opposites (e.g. Becker 1980). However, this research is relatively old and new techniques and new corpus and experiment software have developed which has led to better results and more precise measurements. More recently, empirical studies of antonymy have been carried out by the members of 'The Comparative Lexical Relations Group'[1] that highlight the importance of lexico-semantic pairings for the construal of CONTRAST. Muehleisen (1997) has studied semantic range of antonyms and so has Willners (2001). Jones (2002) adopted a corpus-based discourse perspective of antonym pairs in set constructions. Paradis (1997, 2001) has studied antonymy in the context of degree modifiers. Jones & Murphy (2005) have investigated antonyms in child language. Paradis & Willners (2006a) have carried out experiments on antonymy and negation and antonymy in lexicography (2006b). Finally, Paradis et al. (in preparation) have carried out psycholinguistic experiments measuring degrees of antonym canonicity and Jones et al. (submitted) text-based studies using 'web-as-corpus', but a lot of work remains to be done.

**Theoretical framework**
As stated in the introduction, the purpose of the project is to show that CONTRAST is a powerful construal in language, thought and memory. English and Swedish will be the languages under investigation. The main corpora for retrieval of data will be the *British National Corpus* (BNC) and the *Parole* corpus respectively. In accordance with the Cognitive Semantics framework, we assume that meanings are conceptual in nature and construals of meaning in language are dependent on general cognitive structures and processes such as perception, reasoning and memory. Words take their meanings from the knowledge stored in memory through life experience. Meanings of words are context sensitive, and speakers and addressees readily make use of words in a highly flexible way. We propose that some of this flexibility emerges from strongly routinized linguistic structures such as canonical pairs of antonyms from which new readings are formed through metonymization and metaphorization. Paradoxically, the construal of CONTRAST is a vehicle for dynamicity at the same time as it is a constraint. CONTRAST promotes flexibility in that it may operate on all kinds of different meanings, while in the case of lexicalization of CONTRAST into canonical pairs, both linguistic preservation and dynamicity are at work.

**Method and implementation**
At the time of writing, we have carried out textual and experimental investigations of 'goodness of antonymy' of seven dimensions: SPEED, MERIT, LUMINOSITY, STRENGTH, SIZE, WIDTH and THICKNESS, in English and Swedish (Paradis et.al., in preparation). We were intrigued by what distinguishes so-called canonical antonyms such as *good-bad*,

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[1] The Comparative Lexical Relations Group: http://www.f.waseda.jp/vicky/complexica/index.html

*long-short* and *thin-thick* from other types of contrasts such as *cold-scorching*, *pale-dark* and *speedy-slow*. The results point up a scale of more and less canonical antonyms. In this project, we will examine (at least) twenty-five abstract dimensions and their principal contrasting antonym pairs in English and Swedish, from textual, psycholinguistic and neurolinguistic perspectives. The twenty-five dimensions are AGE, APERTURE, BEAUTY, CORRECTNESS, EMOTION, EXISTENCE, FULLNESS, HARDNESS, HEIGHT, LUMINOSITY, MERIT, SHAPE, SIMILARITY, SIZE, SOUND, SPEED, STRENGTH, TASTE, TEMPERATURE, TEXTURE, THICKNESS, TRUTH, WEALTH, WEIGHT, and WIDTH. The dimensions are selected on the basis of previous research on dimensions of meaning (Dixon 1982, Paradis 2005).

The procedure is as follows: (i) to identify the pattern of canonicity of the twenty-five dimensions using corpus-driven methods, (ii) to measure the force of attraction of canonicity through lexical decision experiments and Event-Related Potential (ERP) measurements, (iii) to chart the polysemy patterns of test items (metonymization and metaphorization) and their propagation of evaluative use in discourse through corpus-based methods, and finally (iv) to test their disposition towards either positive or negative evaluative polarity using judgement experiments, Implicit Association Test (IAT) and ERP measurements.

**(i)     Patterns of canonicity in text**
Previous research has shown that antonyms co-occur in sentences significantly more often than chance would predict (Justeson & Katz 1991) and antonym pairs that we assume are perceived as canonical by native speakers co-occur more often than contextually restricted antonyms (Willners 2001). Willners & Holtsberg (2001) developed a computer program called *Coco* to calculate expected and observed sentential co-occurrences of words in a given set and their levels of probability. *Coco* was also designed to take sentence length variations into account which Justeson & Katz did not do. By using *Coco,* we will identify the most commonly co-occurring pairings in our corpora and, as in our previous studies, we will use the pairs obtained from the corpora for our psycholinguistic and neurolinguistic experiments. In order to cover different levels of strength of canonicity, we will select six of the pairs that co-occur sententially significantly at the level of $10^{-4}$ from each dimension and use them as test items. The method is described in Paradis & Willners (forthcoming).

**(ii)    Canonicity: experimental approaches**
In our previous study of the seven dimensions, we supplemented the textual investigation with elicitation experiments and judgement experiments, using the data retrieved from the corpus as test items. The results of both experiments support our predictions that there is a scale of 'goodness of antonymy' in the sense that some antonyms are strongly routinized as form-meaning pairings, while others are not, at least not when no contextual clues were given. In this project we will perform two different types of experiments on the data set extracted from the corpora. We will perform both psycholinguistic lexical decision experiments in which we also control for time (which we did not do in our previous experiments) and we will perform neurolinguistic experiment to measure brain activity.

Canonicity will be tested using the lexical-decision paradigm. In this paradigm, the task of the subjects is to make decisions about antonymy by pressing a button. The

contrasting words will be presented in pairs, a prime word and a target word. The instruction to the subjects is to press the Yes-button if the second word is an antonym of the first word, and the No-button if it is not. Canonical antonyms will alternate with non-canonical antonyms in the experiment. The prediction is that responses to canonical antonyms will be more accurate and faster than those to the less canonical ones. Both response times and error rates will be logged and analyzed.

Secondly, in order to further refine our analysis of CONTRAST and confirm our previous results, we will include electrophysiological responses to relevant stimuli. We will carry out a neurolinguistic ERP experiment, again on the same test set. Canonicity is assumed to have a brain and memory correlate in that strength of pairings of antonyms are likely to yield strong ERP effects. The N400 is an ERP component that is responsive to linguistic stimuli and has been shown to vary systematically with semantic relatedness. N400 has often been used to measure semantic integration and semantic expectation of words in a sentence context. Neural activity as expressed by ERPs makes it possible for us to compare the effect between expected and unexpected words, i.e. good vs. bad antonyms as well as unrelated pairings with and without context. Differences are shown as a negative deflection of the ERP around 400ms (300-500ms) after the expected stimulus. The amplitude of the N400 effect increases when stimuli are more difficult to integrate. For instance, in a context where an exotic plant is expected, 'pines' will induce a greater N400 effect than 'palms', but smaller than for 'tulips' (Kutas & Federmeier 2000), see Figure 1. Using Kutas' & Federmeier's figure as a template, we provide a graphic representation of the expected results from word pairs of varying canonicity, see Figure 2. The scaling is not intended to represent actual amplitude differences.
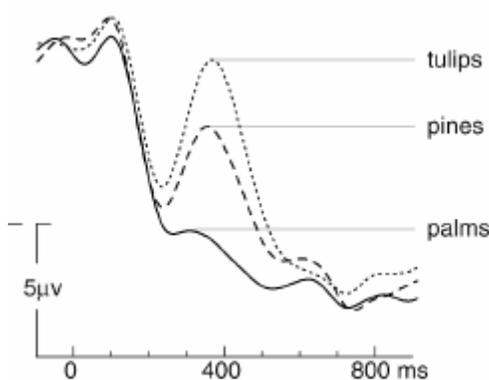


**Figure 1.** The influence of plausibility and memory organization on the N400 response to words in sentences, e.g. "They wanted to make the hotel look more like a tropical resort. So along the drive way they planted rows of…" Kutas and Fedemeier (2000: 466).
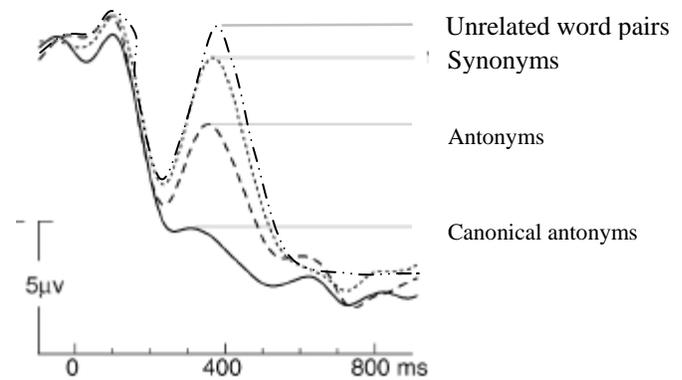


**Figure 2.** Sketched expected pattern of the ERP study, based on a figure from Kutas and Fedemeier (2000: 466). The curve for the unrelated word pairs has been added.

If antonymy is a continuum, we expect the N400 amplitude to covary with the degree of antonymy. In a first step, we will use a basic ERP-design with bins of stimulus pairs of strong, medium, and weak antonymy with at least 25 stimulus pairs in each bin. Subjects will be presented by a text prime that will be followed by a probe that varies in antonymy, and we expect a negative relationship between antonymy and N400 amplitude. Antonyms have previously been used as stimuli in ERP studies (Bentin 1987),

but we question his method of data collection and his claim that there are as many as 80 strongly canonical antonym pairs. Our previous textual and psycholinguistic studies rather point in the direction that there is a continuum of antonym strength in language. We have therefore developed more rigorous principles of data collection before experiments can be reliably performed from a linguistic point of view.

**(iii)     Patterns of evaluative polarity in text**
We will investigate the polysemy patterns of the lexical items retrieved from the corpora, both individually and as pairings. We will examine their patterns of metonymization and metaphorization – as well as to what extent these patterns are symmetrical in the antonym pairings. For instance, the older use of *black coffee* has given rise to *white coffee*. In order to create a robust foundation for cross-linguistic comparison of lexico-semantic structure, the model of analysis that will be used is ontological in nature (Paradis 2005).

Furthermore, we will investigate the underlying evaluative polarity of the members of the antonym pairs in context. The question we are asking is to what extent one of the members of the various parings promotes negativity in most contexts, while the other member promotes positive polarity. It is well-known that some lexicalized pairs are inherently evaluative such as *good-bad* and *happy-sad,* while others such as *quick-slow*, *true-false*, *open-close* and *light-heavy* are more loosely associated with positive and negative readings, e.g. *slow to realize*, *slow to respond*, *slow to adapt vs. quick to spot*, *quick to prepare*, *quick to use*. The tendency and the governing principle seem to be that *slow* is negative and *quick* is positive.[2] Our hypothesis is that evaluative polarity is most clearly propagated through the 'figurative' meaning. For instance, *light-heavy* constitute a strongly canonical pair of antonyms along the dimension of WEIGHT as evidenced through sentential co-occurrence in the BNC (Paradis & Willners forthcoming). The concrete reading of *heavy bag* as opposed to *light bag* may out of context be understood as a matter-of-fact expression about WEIGHT, but within context both of them may very well be either neutral, positive or negative. However, for some relatively common combinations evaluative polarity is part of the combination itself, e.g. *heavy smoker* has a negative ring and *light food* a positive one. We thus propose that *heavy* is more often used in combinations where negativity is involved, while the reverse is true of *light*, and this is particularly clear in 'figurative' uses of expressions such as *heavy smoker* 'unhealthy degree of smoking', *light food* 'lightness is elegant', *heavy book* 'hard to read', *light work* 'is pleasurable'. There are of course also certain contexts where a lot of WEIGHT is positive. For instance, in the context of power as in *a heavy politician, heavy* is positive. Positive attitude is invoked in certain contexts and we will investigate what those contexts are. Like conventionalized metonymization and metaphorization, attitudinal overtones are ubiquitous at the same time as people are largely unaware of them, unless they are explicitly brought to a head.

**(iv) Evaluative polarity: experimental approaches**
In the pshycholinguistic experiment, evaluative polarity will be investigated by means of test sentences in which an adjective is used in either a concrete context, e.g. *a heavy bag*, or a metaphorical context, e.g. *a heavy sorrow*. Subjects will be asked to rate the

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[2] Cultural and social aspects will of course play an important role in the research on evaluative polarity, both in the corpus part and in the experimental part.

adjectives in the sentences on a seven-point scale ranging from negative to positive. The results will show how much the judgements of the subjects agree on an adjective, and how context influences evaluative polarity.

We will then adopt the Implicit Association Test (IAT), in which subjects learn to associate two buttons with different adjectives, two for each button, e.g. one button with *good* and *light* and the other button with *bad* and *heavy*. Subjects will then be asked to classify other word, using either of the four adjectives. We predict that 'polarity synonyms', e.g. *good* and *light*, are easily associated with one another and the task is performed faster than adjectives that are not 'polarity synonyms', e.g. *good* and *heavy*. The IAT is described in detail in Nosek, Greenwald & Banaji (2005).

In the neurolinguistic part, we will set up a three-factor experiment in order to test the effect of metaphorical evaluative associations on the N400 amplitude. The factors are polarity, 'literal-figurative', and congruency. Stimuli will be presented as text. Stimulus examples 1-4 below are all metaphorical. Examples 2 and 3 are congruent in the sense that the metaphorical use of the TEMPERATURE dimension agrees with our everyday understanding of the concepts MURDERER and MOTHER. Examples 1 and 4 are incongruent. Congruent and incongruent stimuli will be used for both poles of an evaluative dimension, e.g. *warm-cold*, to allow analysis of any possible asymmetrical effects, i.e. that one pole has a stronger effect than the other. Our predictions are that incongruent combinations such as 1, 4, and 6 will generate higher amplitudes in the N400 window than congruent combinations. We do not predict any asymmetrical effects. Sentences using concrete examples of the dimensions, such as 5-8, below, will be presented as control conditions. This will give us a baseline for estimation of incongruency effects related to the evaluative dimension. In this case, we expect larger N400s to 5 and 7, as compared to 6 and 8.

1. The murderer is a warm person
2. The murderer is a cold person
3. The mother is a warm person
4. The mother is a cold person

5. Coffee is a warm drink
6. Coffee is a cold drink
7. Ice tea is a cold drink
8. Ice tea is a warm drink

**PhD projects**
Two doctoral students form part of the project and will both be jointly supervised by Paradis and Willners. Their topics concern antonymic adverbials along the same dimensions of meaning as the adjectives, e.g. *slowly-quickly*. These adverbial studies will make use of the same methodological principles as the ones outlined for the adjectives. While the study of antonymic adjectives will increase our knowledge of nominal semantics, the adverbial counterpart will increase our knowledge of verb semantics and make comparisons between these two main types of meaning construals possible with respect to this particular field of research. **PhD project 1:** Roy Liddle, Växjö University (2009-2010). Liddle is currently financed for two years, 2007-2008, by the Wallenberg foundation and working on Dimensional adverbials with –*ly* and zero suffixes. **PhD project 2:** Simone Löhndorf, Lund University (2008-2011). Dimensional adverbials in text and discourse.

**Significance**
This research is important for any theory of mental models. It is also of great importance to language technological applications such as further development of semantic webs (e.g. Gärdenfors 2004), lexicology (e.g. Cruse et al. 2002, 2005), applied linguistics (e.g. Tomasello 2003) and cross-linguistic lexical typology (e.g. Koptjevskaja-Tamm forthcoming). Last but not least, we want to emphasize the importance of this kind of interdisciplinary research from a methodological point of view. Research on language and cognition calls for evidence from different sources and cross-fertilization of scientific techniques.

**International collaboration**
Paradis and Willners have studied antonymy from various perspectives using a variety of methods for more than a decade and both are at the international forefront of antonymy research and members of 'The Comparative Lexical Relations Group' (http://www.f.waseda.jp/vicky/complexica/index.html).

**Equipment**
The Centre for Languages and Literature at Lund provides us with the state-of-the-art equipment and expertise for carrying out experiments and corpus investigations (http://www.sol.lu.se/humlab). No ethical considerations are necessary for our experiments since they do not involve information about the participants.

**Project management and ethical considerations**
The project members, including the doctoral students, will work closely together as a research group. Caroline Willners and Carita Paradis will work together on all parts of the project on a pro rata basis. Joost van de Weijer will mainly be responsible for the statistical analysis of the experiments and corpus investigations and for the design of the psycholinguistic experiments. Magnus Lindgren will be responsible for the neurolinguistic experiments.

|  | Textual study | Neurolinguistic study | Psycholinguistic study |
|---|---|---|---|
| 2008 | Reading. Corpus data collection: concordances from BNC and Parole. Database design and categorization for semantic tagset. Tagging of data. Double-checking the tagging. | Reading. Preparing test material based on the textual data. | Preparing test material based on the textual data. |
| Dissemination: Writing papers on semantic categorization and tagging. Conferences | | | |
| 2009 | Semantic and statistical analysis of the textual data. | Design of experiments and implementation. Data collection. | Reading. Design of experiments and implementation. Data collection. |
| Dissemination: Writing papers on the results of the textual analysis. Conferences. | | | |
| 2010 |  | Data analysis. | Data analysis. |
| Dissemination: Writing papers on the results of the neurolinguistic analysis as well as the psycholinguistic analysis. Conferences. | | | |
| 2011 | Comparing the textual studies with the psycholinguistic and neurolinguistic studies. | | |

Dissemination: Writing papers on the results of the project results. Conferences.
Organizing a conference on CONTRAST IN LANGUAGE, THOUGHT AND MEMORY.
Writing project report.

A research assistant will be employed for double-checking the tagging of the corpus material and the data collection for the psycholinguistic experiments and a technician for the neurolinguistic experiments which is a very time consuming task.

The results will be submitted to various different ISI-recognized journals and disseminated at suitable conferences.

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