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Short Communication

Antonym canonicity: Temporal and contextual manipulations

Joost van de Weijer [a,*], Carita Paradis [a], Caroline Willners [a], Magnus Lindgren [b]

[a] Centre for Languages and Literature, Lund University, Box 201, 221 00 Lund, Sweden
[b] Dep. of Psychology, Lund University, Box 213, 221 00 Lund, Sweden

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ABSTRACT

Previous research on antonyms has shown that some pairings form more felicitous couplings than others. Following up on that research, we conducted two semantic categorization experiments using Event Related Potentials to establish whether there are neurophysiological differences related to levels of antonym canonicity. In Experiment 1, the members of canonical antonym pairs (e.g. *black–white*), non-canonical antonym pairs (e.g. *white–dark*) and unrelated word pairs (e.g. *bumpy–small*) were presented in isolation separated either by a short (200 ms) or a long (800 ms) time interval. The canonical antonyms gave rise to significantly lower N400 amplitudes than both non-canonical antonyms and unrelated pairs, but no significant difference in N400 amplitudes for non-canonical and unrelated pairs was found. In Experiment 2, the same pairs were presented in a congruent context. Significant differences in N400 amplitudes across all three conditions were found, also between non-canonical antonyms and unrelated word pairs.

1. Introduction

In recent years, research on lexical semantic relations such as antonymy has experienced a revival of interest among linguists concerned with how meaning in language is expressed, processed and represented. It has then become important to seek answers to fundamental questions such as: What is the nature of antonymy? Are all antonym pairs equally good? If not, why not? How are different pairs represented in the brain? Under what circumstances is the lexical semantic relation of antonymy salient to a language user?

This article reports on two Event Related Potential (ERP) experiments in which two types of adjectival antonym pairs are contrasted, i.e. clearly opposable pairs such as *black–white, hot–cold*, referred to as *canonical antonyms*; and less clearly opposable pairs, such as *white–dark*, *hot–iced*, *dry–fleshy*, referred to as *non-canonical antonyms*. We measured the N400 amplitude for these word pairs and also for unrelated pairs under temporal (SOA) and contextual manipulations in order to determine whether the brain responds differently to word pairs with varying degrees of goodness of opposability.

1.2. Previous work

It has been shown that oppositeness is fundamental to human thinking and that antonymy as a lexical semantic relation plays an important cohesive role in text and discourse (Lyons, 1977; Cruse, 1986; Justeson & Katz, 1991; Fellbaum, 1998; Willners, 2001; Jones, 2002; Murphy, 2003; Jones, Murphy, Paradis, & Willners, 2012; Lobanova, 2012). From the point of view of meaning modelling and the structure of the vocabulary, antonymy is therefore a particularly interesting relation. Previous textual and behavioural investigations of antonyms have shown that not all antonyms are equally felicitous as opposites, but rather that some are better than others (Jones et al., 2012; Paradis, Willners, & Jones, 2009). Canonical antonyms are limited in number but appear to be the clearest exemplars of antonymy both as lexical couplings and with regard to the meanings they express. Examples of such antonyms are *hot–cold*, *dead–alive*, *short–long* and *slow–fast* (Paradis et al., 2009). The members of those pairs express opposite properties on the dimensions of temperature, existence, length and speed, respectively, which are all dimensions that are central to human life and way of living across times and cultures.

An important difference between canonical and non-canonical antonyms is that the meaning of the members of a canonical antonym pair can be used for the modification of a wider range of nominal meanings than non-canonical antonym pairs. For instance, given the dimension wealth, the *poor–rich* opposition applies to a large number of nominal meaning domains where wealth is relevant, while *poor–loaded, poor–prosperous*, or *rich–broke, rich–hard up* are all less salient because one of the members of the pairings is contextually or discursively constrained. Also, a pairing such as *poor–good* is a non-canonical pair along a less general dimension. The members express opposite properties of goodness of nominal

* Corresponding author.
E-mail address: vdweijer@ling.lu.se (J. van de Weijer).

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meanings such as 'examples', 'adherence', 'command' or 'performance'. In other words, canonical antonyms express opposite properties of basic dimensions, such as colour, space, temperature, wealth, whereas the dimensions that non-canonical antonyms relate to more specific nominal meaning domains, such as colour/chocolate, temperature/tea, moistness/fruit.

Words that readily evoke antonymic meanings tend to have a simple semantic structure and they are primarily adjectival meanings (Bianchi, Savardi, & Kubovy, 2011; Paradis & Willners, 2011), which is why we restrict our data set to adjectives. The distinction between canonical and non-canonical antonyms has come forward repeatedly in different studies.

Psycholinguistic studies have shown that canonical antonyms elicit one another in free word association experiments and are assessed to be better opposites than non-canonical pairs (Charles & Miller, 1989; Deese, 1965; Palermo & Jenkins, 1964; Paradis et al., 2009). Speakers can identify canonical pairs faster non-canonical pairs. They are also found to prime each other more strongly (Herrmann, Chaffin, Conti, Peters, & Robbins, 1979; Becker, 1980; Gross, Fischer, & Miller, 1989) also when compared to unrelated pairs with the same frequency of co-occurrence (van de Weijer, Paradis, Willners, & Lindgren, 2012). The results obtained in both textual and behavioural experiments confirm the special status of canonical antonyms in language and cognition and raise the question of why they are felt to be particularly felicitous.

Corpus studies have shown that antonyms tend to occur close to one another in text and discourse. Canonical antonyms tend to co-occur at higher than chance rates within sentences. They co-occur significantly more often than other antonym pairs and words expressing other semantic relations (Justeson & Katz, 1991; Willners and Holtsberg, 2001). It is natural to think that relational strength is simply a frequency effect, but it has been shown, that co-occurrence frequency *per se* does not fully explain the priming effect that has been seen within antonym pairs (van de Weijer et al., 2012).

Neurolinguistic research, finally, has shown that the N400 is effective in indexing lexical facilitation (although not exclusively, see Kutas & Federmeier, 2011). The amplitude of the N400 decreases when the targets are facilitated by primes or contexts (Kutas & Hillyard, 1980; Lau, Phillips, & Poeppel, 2008; Laszlo & Federmeier, 2008; Lau, Almeida, Hines, & Poeppel, 2009). Antonyms are effective primes with clear consequences for the N400 amplitude (Bentin, 1987; Kutas & Federmeier, 2000; Kutas & Iragui, 1998; Roehm, Bornkessel-Schlesewsky, Rösler, & Schlesewsky, 2007). Using pairs of word–antonym or word–nonword, Bentin (1987) investigated the effect of expectancy factors of ERPs in a word recognition task. Bentin showed that expected antonyms were recognized significantly faster than any other words or non-words. However, Bentin did not make a distinction between canonical and non-canonical antonyms. Rather, his antonym set included canonical antonyms only. Kretzschmar, Bornkessel-Schlesewsky, and Schlesewsky (2009) studied the effects of semantic relatedness and target predictability comparing congruous and incongruous sentence endings in antonym constructions such as 'the opposite of black is white/yellow/nice'. The predicted sentence endings ('white') were compared with related and unrelated unpredicted sentence endings, 'yellow' and 'nice' respectively, where a predictability-based N400 was evident at the critical word.

In contrast to previous ERP studies, our focus is on whether there is a difference between canonical antonyms, non-canonical antonyms and unrelated word pairs with respect to brain activity. The non-canonical antonyms are thus of special interest. We build on previous work on antonyms for the selection of test items and use principled corpus techniques to secure a balanced test set of both the antonyms, the unrelated word pairs and the contextual primes.

1.3. Purpose and predictions

The purpose is to examine the electrophysiological correlates of canonical antonyms, non-canonical antonyms and unrelated word pairs using ERPs. The task given to the participants was to judge whether pairs of adjectives were opposites or not. We varied two dimensions that could potentially influence the results of the experiments. In Experiment 1, we presented the two members of each pair separated either by a 200 ms interval or by a 800 ms interval because we wanted to be able to determine whether the longer time interval would lead to a reduced N400 amplitude for the non-canonical antonyms compared to the unrelated adjectives. Based on the previous findings described above, we expected to find lower N400 amplitudes for the canonical antonyms in both SOA conditions. For the non-canonical antonyms, we were most interested in whether the N400 would depend on the SOA manipulation, with a larger possibility for a reduced N400 amplitude in the long than in the short SOA condition. Experiment 2 differed from Experiment 1 in that all the adjective pairs were preceded by nouns. Each and every noun was selected in such a way that it combined in a natural way with both members of the adjective pair. The purpose of this experiment was to see whether any differences between non-canonical antonyms and unrelated word pairs would arise if the participants were given a suitable context. The experiments were carried out in an experimental studio in the Humanities Lab at the Centre of Languages and Literature at Lund University. All the materials were in Swedish, and the participants all reported Swedish to be their first language.

2. Experiments

2.1. Experiment 1: Manipulation of SOA

Experiment 1 was a semantic categorization task in which the participants were presented with three types of adjective pairs: canonical antonyms, non-canonical antonyms and unrelated word pairs. They were asked to decide whether the adjectives were opposites or not. In order to probe the answer to this question in more detail, we manipulated the time difference (SOA) between the presentation of the first and the second member of each pair using either a short (200 ms) SOA or a long (800 ms) SOA. The reason for the manipulation of the SOAs is that long SOAs may allow for controlled retrieval of words (Lau et al., 2008). For automatic processes, it may be the case that N400 effects are absent at the shorter SOAs but present at long SOAs, which may have an effect on the brain response. We expected significant N400 effects for canonical antonyms irrespective of SOA and that long SOAs, allowing controlled retrieval, would lead to clear N400 effects for the non-canonical pairs. The order of presentation within each pair was not varied in this experiment, that is, the adjectives that were displayed first and second were the same for all participants.

2.1.1. Results

In general, N400 amplitudes were higher in the 200 ms SOA condition than in the 800 ms SOA condition ($F(1,37) = 11.0$, $p = 0.002$). Prime type significantly affected N400 amplitudes, $F(2,74) = 11.2$, $p < 0.001$, but there was no interaction with SOA, $F(2,74) < 1$, *n.s.* While non-canonical antonyms were not different from unrelated probes ($p > 0.9$), canonical antonym probes had lower N400-interval amplitude than the other two categories ($p < 0.002$). Fig. 1a and b show these results.

2.2. Experiment 2: Context manipulation

As mentioned in the introduction, context may play a more important role for non-canonical antonyms than for canonical ant-