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Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 31(31)

ISSN

1069-7977

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Publication Date

2009

Peer reviewed

Happiness is... an Abstract Word

The role of affect in abstract knowledge representation

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Abstract

Although the ability to communicate through language about abstract concepts lies at the heart of what it means to be human, our knowledge of how abstract word meanings are represented and processed is extremely limited. In this paper we show that neither of the two dominant accounts (dual coding theory and the context availability model) put forward in order to explain differences between concrete and abstract words fully captures processing (and hence representational) differences between the two types of word meaning. Using lexical decision data, we show that this is, at least partly, because in both accounts abstract words are considered to be unrelated to experiential information. We show instead that there is one type of experiential information, namely affective information, which plays a crucial role in the processing and representation of abstract concepts: affect explains a residual advantage for abstract words, when variables such as imageability and rated context availability are held constant. We discuss our results with respect to embodied theories of cognition and language representation.

Keywords: abstract words; semantics; emotional valence; concreteness; imageability; semantic memory.

Introduction

Concreteness indexes a basic ontological distinction, dividing entities into two basic kinds: concrete entities, which exist in space-time and are independent of human minds/language, and abstract entities, which do not exist in space-time but whose existence depends on human minds/language (Hale, 1988). The ability to communicate through language about abstract concepts, such as *courage*, *dignity*, *revenge*, lies at the heart of what it means to be human. However, up to now, research into semantic and conceptual representation has focused almost exclusively on how concrete word meanings and concepts are represented and processed, to the exclusion of abstract meanings and concepts. No theory of semantic or conceptual representation is complete without an explicit account of how abstract knowledge is acquired, represented, and processed.

In this paper we present and assess a working hypothesis of how the semantic system is organized with respect to the distinction between concrete and abstract concepts, by proposing that concrete and abstract semantic representations differ in terms of the types of information they bind: sensory, motor, affective, and linguistic (how words are

distributed in texts and syntactic information; see Andrews, Vigliocco, & Vinson, in press). The originality of our proposal lies in demonstrating that emotional content, a largely neglected (in the semantic representation/processing literature) type of experiential information, crucially contributes to the representation and processing of abstract concepts.

It has been demonstrated repeatedly, for example, using lexical decision (e.g., James, 1975; Whaley, 1978; Rubin, 1980) and word naming tasks (de Groot, 1989; Schwanenflugel and Stowe, 1989), that concrete words have a cognitive advantage over abstract words—an advantage that has been termed the ‘concreteness effect’.

Among the handful of proposals that have been put forward to explain this effect, two have been particularly influential: dual coding theory (Paivio, 1971; 1986; 2007) and the context availability model (Schwanenflugel and Shoben, 1983; Schwanenflugel, 1991). According to dual coding theory, concrete words are represented in two representationally distinct but functionally related systems: a verbal, linguistic system and a non-verbal, imagistic system. Abstract concepts, on the other hand, are primarily or exclusively represented in the verbal system. The cognitive advantage for words referring to concrete concepts is attributed to the fact that they have access to information from multiple systems. According to the context availability model, both concrete and abstract concepts are represented in a single verbal code and neither the representations nor the processes that operate on these representations differ for the two types of concepts. The argument here is that comprehension relies on verbal context (either supplied by the discourse or by the comprehender’s own semantic memory) in order to be effective. Accessing the meaning of a word involves accessing a network of associated semantic information, and the advantage for concrete words arises because they have stronger and denser associations with contextual knowledge than abstract words. In both of these accounts, concrete word representations are assumed to be richer than abstract word representations (see also Plaut & Shallice, 1993). These two proposals have guided research on concrete/abstract semantics in the last fifteen years or so; results, however, have been inconclusive (for imaging studies, for example, see Sabsevitz, Medler, Seidenberg & Binder, 2005).

There is one commonality in these accounts: only linguistic information contributes to the representation of abstract words whereas experiential information is not part of abstract semantic representations. Here, we propose an alternative account of the representation of concrete and abstract word meanings that draws on work on embodiment. The main assumptions of this hypothesis are the following:

- (1) Two classes of information contribute to the representation of both concrete and abstract concepts: experiential (sensory, motor, and affective) and linguistic (verbal associations arising through co-occurrence patterns and syntactic information).
- (2) Experiential information is critical across domains (concrete and abstract) for the learning (and grounding) of semantic representation.
- (3) Differences between concrete and abstract word meanings as well as within each category (i.e., the category of concrete words and the category of abstract words) arise as a result of the proportion and exact type of experiential and linguistic information they bind.
- (4) The apparent dichotomy between concrete and abstract word meanings arises due to a statistical preponderance of sensorimotor information underlying concrete word meanings and a preponderance of affective and linguistic information underlying abstract word meanings. While sensorimotor information may be foundational for concrete word meanings, affective and linguistic information may be foundational for abstract word meanings, both for their acquisition and their subsequent representation in the adult system. Below, we first put dual-coding theory and the context availability model to test and show that neither fully explains processing differences between concrete and abstract words. We then provide initial evidence in favor of the role of affect in the processing of abstract words.

A Test of Dual-Coding and Context Availability

In the concreteness literature, it is invariably assumed that the psycholinguistic constructs of concreteness and imageability tap into exactly the same underlying theoretical construct, i.e., the ontological distinction between concrete, and abstract, concepts. After all, when nothing else is taken into account, imageability ratings explain 72% of the variance in concreteness ratings. In fact, concreteness and imageability ratings have been used interchangeably in most of the recent literature in the field (e.g. Binder, Westbury, McKiernan, Possing & Medler, 2005; Fliessbach, Weis, Klaver, Elger, & Weber, 2006; Richardson, 2003;). However, concreteness and imageability tap into, at least partially, different aspects of semantic representations. Looking at the ratings for more than 4,000 words in the MRC Psycholinguistic Database, it is clear that whereas the frequency distribution of concreteness ratings is bimodal, with two distinct modes for abstract and concrete words (see also Cartwright & Nickerson, 1979; Nelson & Schreiber, 1992), the distribution of imageability ratings is unimodal. In other words, concreteness ratings capture the categorical

ontological distinction between concrete and abstract words (and their underlying conceptual representations), while imageability ratings index a graded property that is meant to capture the differential association of words with sensory (primarily visual) properties.

Within dual coding theory, imageability ratings by native speakers have been used as an operationalization of the contribution of the non-verbal imagistic system to the representation of concrete word meanings. According to current interpretations of the theory, differences in perceived imageability exhaustively account for processing differences between concrete and abstract words (Reilly and Kean, 2007; Fliessbach, et al., 2006). However, on the basis of the alternative embodied account that we have sketched above, association with sensory attributes may be just one of the dimensions along which concrete and abstract concepts differ.

Context availability also strongly correlates with concreteness ratings, but like imageability, it can be teased apart. In our first experiment and follow-up regression analyses, we controlled our materials for imageability and context availability (in addition to a large number of other sublexical and lexical factors). If either construct can account for the processing differences between concrete and abstract words, here we should not observe any difference between concrete and abstract items.

Lexical Decision for Concrete and Abstract Words

Method

Participants. Fifty-eight native English speakers (32 female; mean age: 28.69 ± 9.96) participated and were paid at a rate of £6 per hour. Three participants were replaced because of a high number of timed-out responses in their data.

Materials and design. Forty concrete (e.g., *cousin, oak, stomach*) and 40 abstract (e.g., *horror, beauty, paradise*) monomorphemic words were selected. The items were matched pairwise on 12 lexical and sublexical variables: familiarity, AoA, LogFrequency, number of letters, number of phonemes, number of syllables, mean bigram frequency, orthographic neighborhood, number of synsets and, crucially imageability (for concrete words, average = 5; s.d. = .42; for abstract words, average = 5.05, s.d. = .35) and context availability (for concrete words, average = 5.68, s.d. = .46; for abstract words, average = 5.66, s.d. = .52)¹. The average concreteness rating for the abstract items was 3.45 (s.d. = .40), and for the concrete items it was 5.52 (s.d. = .44). We also selected 40 concrete and 40 abstract words matched with the experimental items in terms of concreteness to serve as the basis for creating the pseudowords for the experiment. We created pseudowords by altering a single letter in one of these words.

¹ Normative data was taken from the MRC database (Coltheart, 1981), CELEX (Baayen et al., 1993); Bristol Age of Acquisition Norms (Stadthagen-Gonzales & Davis, 2006). Context availability ratings were collected in our laboratory on a 1-7 scale using the same instructions as in Schwanenflugel et al., (1989).

Procedure. Participants were tested individually. Each trial began with a fixation cross presented in the middle of the screen for 400 milliseconds, followed by presentation of the string for 2000 milliseconds or until a response was given (whichever was earlier).

Results and Discussion

Reaction Times. We excluded from analysis all responses faster than 200 milliseconds and slower than 2000 milliseconds (0.84% of the data). For two concrete words, accuracy rates did not differ from chance. We excluded these items from further analysis as well as their paired abstract items. We also removed outliers (reaction times 2.5 standard deviations above the mean per condition for each participant (2.04% of the data).

Abstract words were recognized as words faster than concrete words ($M_{\text{abstract}}=568\text{ms}$, $sd=88$; $M_{\text{concrete}}=590\text{ms}$, $sd=99$). This difference was significant both by participants ($F(1, 57)=23.32$, $p<.001$) and by items ($F(2, 37)=5.44$, $p<.05$).

Accuracy. There was a numerical advantage for abstract over concrete words ($M_{\text{abstract}}=96.59\%$; $M_{\text{concrete}}=95.48\%$), but the effect was not statistically reliable ($F(1, 57)=3.166$, $p=.08$; $F(2, 37)=5.44$, $p<.05$).

Thus, when imageability and context availability are held constant, an ‘abstractness effect’ emerges, such that speakers are faster in recognizing abstract rather than concrete words. These results go against both the dual-coding as well as the context availability views as they predict no difference in RTs if imageability and context availability ratings are matched across concrete and abstract words. Next, we confirm these novel findings in a regression analysis of lexical decision RT data for 903 words from the English Lexicon Project (Balota et al., 2007).

Regression Analysis for 903 Words

For the reaction time analyses, we logarithmically transformed the by-item mean reaction times and then fitted an ordinary least squares linear regression model on the transformed data. For the accuracy analysis, we used maximum likelihood estimation models. In this analysis, normative data comes from Clark and Paivio (2004).

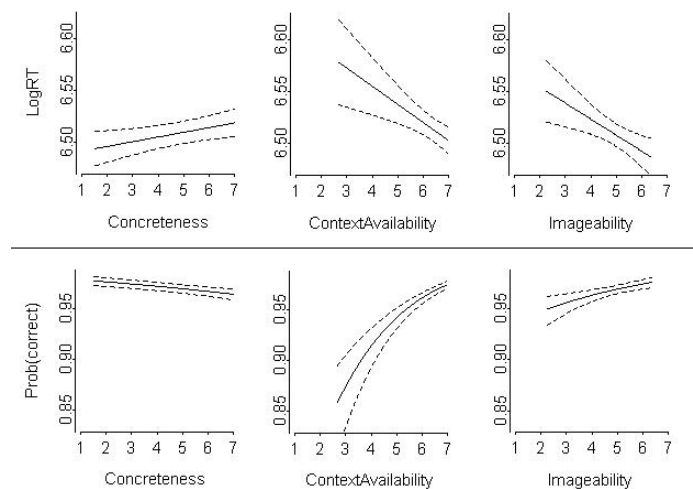
Latencies. In this and all subsequent regression analyses, the procedure is as follows: we first fit a model including all the predictors (lexical and sublexical), using restricted cubic splines (Harrell, 2001) to model nonlinear relationships between individual predictors and the dependent variable, and then take out outliers (following the procedure in Baayen et al., 2006). We then refit the model and use a bootstrap validation procedure (Harrell, 2001) to determine to what extent our model overfits the data. We include a fast backward elimination algorithm in the validation procedure, to eliminate non-explanatory variables. We then refit the model, excluding non-explanatory variables. The results we report are from this final refitted model.

3.10% of the data were removed as outliers. Model optimism was very low (0.29%). Although imageability and

context availability had a significant facilitatory effect on latencies ($F(1,863) = 8.72$, $p < .01$; $F(1, 863) = 10.30$, $p < .01$, respectively), concreteness had a significant inhibitory effect ($F(1,863) = 5.51$, $p < .05$)—final model $R^2 = 71.70\%$. Plots of the partial effects of these predictors appear in Figure 1.²

Accuracy rates. All three variables of interest predicted probability of a correct response in the same direction as before (imageability $\chi^2 = 12.82$, $df=1$, $p < .001$; context availability: $\chi^2 = 105.13$ $df=1$, $p < .001$; concreteness: $\chi^2 = 21.08$, $df=1$, $p < .001$;—see Figure 1 for the partial effects.

Figure 1. Plots of the partial effects of Concreteness, Context Availability, and Imageability. Dashed lines indicate 95% confidence intervals. The effects are adjusted to the median of all other continuous predictors and to class ambiguous words.



Thus, this regression analysis provides converging evidence to our experiment showing that when imageability and context availability are partialled out, abstract words are processed faster than concrete words.

The Role of Affect

In the introduction, we presented a working hypothesis according to which experiential information is central to the representation of both concrete and abstract words, the difference being that concrete and abstract words' meanings are statistically associated to a greater extent with different types of experiential information: while sensorimotor information is foundational for concrete word meanings,

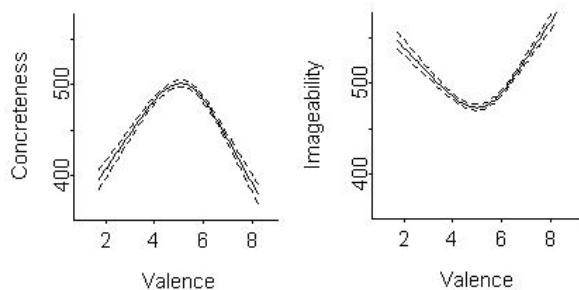
² The zero-order correlation between concreteness and latency is negative, while in the analyses above we find a positive slope for concreteness. Cases in which the coefficient reverse in sign have been associated with the phenomenon of enhancement (e.g., Friedman & Wall, 2005). Here, we assume that the positive coefficient for concreteness in this model represents the direct effect of concreteness when the indirect effect (mediated by imageability) is held constant (further details available upon request).

affective information may be foundational for abstract word meanings. To provide support for this hypothesis, in this section, we first provide evidence that indeed abstract words are more affectively loaded than concrete words and that the more affectively loaded a word is, the more imageable it will be (regardless of its concreteness). Then, we carry out another large-scale regression analysis, in which we show that the faster latencies for abstract words are due to their higher association with affective information.

Concreteness, Imageability, and Valence

We first wanted to establish that abstract words are indeed more emotionally valenced than concrete words. The ANEW database (Bradley & Lang, 1999) contains valence ratings for 1,040 words. Although this is a large database, for only a small subset of the normed words are there concreteness and imageability ratings ($N=354$). As described in Kousta et al. (submitted), we collected valence norms for 1,200 words for which other psycholinguistic norms are available following exactly the same procedure as ANEW. Fifty of the words were also items in ANEW—we obtained ratings for these words from each of our participants. Because the correlation between our ratings and the ANEW ratings for these words was very high ($r=.95$), with similar means and standard deviations, we merged the two databases. For a group of 1,757 words for which valence, concreteness, and imageability norms were available from the MRC Psycholinguistic Database, we carried out a regression analysis in which we used imageability and valence as predictors of concreteness ratings. We found that, even after the effect of imageability is held constant, valence is a significant predictor of concreteness ratings ($F(2, 1753) = 231.23, p < .001$; nonlinear $F(1, 1753) = 460.36, p < .001$ —see Figure 2): the more valenced a word is the more abstract it tends to be (positive words being more abstract than negative words); conversely, the more neutral a word is the more concrete it tends to be. We have therefore confirmed the intuition that there is a greater association between abstractness and valence.

Figure 2. Plots of the partial effect of valence (1=negative; 9=positive; 5=neutral) as a predictor of concreteness (left) and imageability (right) ratings. Dashed lines indicate 95% confidence intervals.



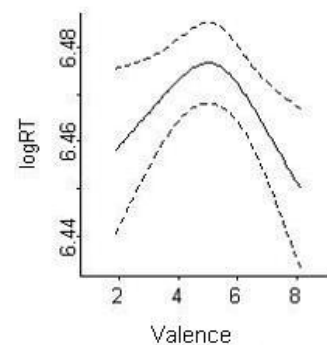
This finding is important in demonstrating that abstract words do indeed have a ‘privileged’ link with at least one type of experiential information.

We also wanted to determine the extent to which imageability ratings might be predicted by valence, conducting a similar analysis with valence and concreteness as predictors of imageability and found that the more emotionally valenced a word is, the higher its imageability rating—neutral words are less imageable ($F(2, 1753) = 192.58, p < .001$; nonlinear $F(1,1753) = 361.42, p < .001$ —see Figure 2).

Does emotion explain the ‘abstractness effect’?

In order to determine whether valence is implicated in the abstractness effect, we carried out another set of regression analyses on lexical decision data for 1,458 words from the English Lexicon Project, for which concreteness, imageability, familiarity, and age of acquisition norms were available. This was the same set of words we used in Kousta et al. (submitted), where we investigated the effects of valence (as well as arousal) on lexical decision latencies and accuracy rates. We carried out two sets of analyses: one in which all the lexical and sublexical variables above were included but not valence, and one in which valence was added as a predictor. For reaction times, when valence was not included in the model, both concreteness and imageability were significant predictors of lexical decision reaction times (concreteness: $F(1, 1406) = 6.28, p < .05$; imageability: $F(1, 1406) = 4.15, p < .05$). In the model with valence added, we found that valence was a significant predictor of latencies ($F(2, 1404) = 4.20, p < .05$; Nonlinear: $F(1,1404) = 7.95, p < .01$; Figure 3 shows the partial effect of this variable), predicting inhibition for neutral words and facilitation for emotional words, the facilitation being greater for positive than negative words.

Figure 3. Plot of the partial effect of valence on lexical decision latencies. Dashed lines indicate 95% confidence intervals.



Neither concreteness nor imageability were significant predictors of latencies in this model, however (concreteness: $F(1, 1404) = 1.26, n.s.$; imageability $F(1, 1404) = 0.85, n.s.$). We have therefore found that emotion mediates both the concreteness and the imageability latency effects. However, the effects of both concreteness and imageability

survive in the accuracy analyses (concreteness: $\chi^2 = 15.91$, $p < .001$; imageability: $\chi^2 = 9.36$, $p < .001$), even when valence is entered as a predictor ($\chi^2 = 6.23$, $p < .05$; nonlinear $\chi^2 = 5.54$, $p < .05$). This means that, although emotion is obviously playing an important role in semantic representation, experiential information (affective, sensorial or motoric) does not exhaust the dimensions along which concrete and abstract words differ. We return to this point in the general discussion.

General Discussion

In this paper we have shown that neither dual coding theory nor the context availability hypothesis can fully explain processing, and hence representational, differences between concrete and abstract words, and that once constructs derived from these two accounts (i.e., imageability and context availability) are held constant, there is a residual advantage for abstract words—an abstractness effect.

It is important to point out here that the abstractness effect we reported should be evaluated within the context of the concreteness effect: zero-order correlations between concreteness and behavioural measures reveal an advantage for concrete words. However, what may have created confusion in previous work is the attempt to specify a single process or type of information as responsible for differences between the two types of word meanings. Here instead we adopted a working hypothesis according to which concrete and abstract words differ along a number of dimensions, including differential recruitment of sensory, motoric, affective, and linguistic information. According to such an approach, the dimensions along which concrete and abstract words differ may not always point to an advantage for concrete words.

Traditionally, abstract word meanings and the conceptual features they bind have been assumed to be acquired and represented exclusively by way of properties of the linguistic system. Although the contribution of language to learning semantic representations is undeniable, its exclusive role in learning and representing abstract meanings has been questioned by embodied theories of meaning, especially through work in cognitive linguistics (e.g., Lakoff & Johnson, 1999; Gibbs, 2006) and more recently perceptual symbol systems theory (Barsalou, 1999). In a proposal akin to ours, Barsalou and Wiemer-Hastings (2005) suggest that abstract concepts and word meanings are grounded in introspective states (mental and affective). In an exploratory study, Barsalou and Wiemer-Hastings asked speakers to generate features for words varying in concreteness (3 highly abstract words: truth; freedom; and invention; 3 highly concrete words: bird, car, and sofa; 3 intermediate words: cooking, farming, and carpeting). They found that abstract meanings focus on introspective content (as well as social and event content, and less centrally content about physical settings). However, beyond this feature generation task, there is no evidence in support of the proposal that such states underlie the representation of

abstract concepts. Here we provide for the first time crucial evidence in support of the proposal that one type of experiential information, emotion, plays a crucial role in semantic representation and processing with respect to the abstract/concrete distinction. We have shown that this type of experiential information is more associated with abstract rather than concrete word meanings and predicts an advantage for abstract over concrete words. Moreover, we provide some evidence in support of the proposal that emotion may play a crucial role in the acquisition of abstract word meanings: words denoting emotional states are acquired early in linguistic development and provide one perhaps critical example of how a word may refer to the inner rather than the outer world.

Although we have shown that emotion plays an important role in the processing of especially abstract words, it does not seem to be the end of the story. Even when the effect of valence was removed, there was still an advantage for abstract over concrete words in accuracy rates. Despite the fact that in all accounts of the representation of abstract words it is proposed that linguistic information plays the most important role in their acquisition and subsequent representation, there is very little work that explicitly addresses the role of language in the acquisition and representation of abstract word meanings specifically, as compared to concrete word meanings. We believe that a full characterization of the properties of abstract and concrete word meanings is not possible without clarifying exactly what role linguistic information plays in their acquisition and representation.

In summary, the results we report cast doubt on what we thought we knew about concrete and abstract lexical concepts: several different types of information are involved in explaining what makes a word concrete or abstract—not all of these types of information predict an advantage for concrete words, however. Abstract words have up to now been viewed in terms of what they lack rather than what they actually are, and as a result, our knowledge of their content and organization is severely limited. The work we have presented here makes an important step towards identifying what abstract meanings might consist in and bolster the hypothesis that experiential information is crucially involved in their representation, just as it is involved in the representation of concrete concepts.

Acknowledgments

This research was supported by a EU (FP6-2004-NEST-PATH) grant (#028714) to Gabriella Vigliocco and by an ESRC grant (RES620286001) to the Deafness, Cognition, and Language Research Centre (DCAL).

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