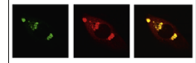


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Research Report

Concreteness effects in single-meaning, multi-meaning and newly acquired words



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ABSTRACT

This study examined the extent to which concreteness influences the acquisition and subsequent processing of novel (low frequency) concepts. Participants were trained on 70 rare English words (35 concrete, 35 abstract) paired with definitions. ERPs were then recorded while participants performed a semantic categorisation (concrete vs. abstract) and a lexical decision task on single-meaning, multi-meaning and the newly acquired words. During training there was a significant effect of concreteness, in that participants were more successful at acquiring concrete concepts. In both the semantic categorisation and the lexical decision task, concreteness effects were evident in the behavioural and in the ERP data for all word types, with concrete words eliciting more negative waveforms than abstract words in the N400 time window. Behaviourally, participants experienced greater difficulty in judging the concreteness of multi-meaning words, yet concreteness effects in the N400 were equally strong for all three word types across both tasks. These findings indicate that concreteness represents a fundamental distinction in the way that items are represented in memory, which is independent of the participant's perceived judgement. They further demonstrate that novel concepts can be acquired rapidly after minimal training, and that the neurophysiological correlates associated with processing novel words are modulated by the specific nature of the conceptual characteristics assigned to the word.

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1. Introduction

Language acquisition has traditionally been studied in children. This is not surprising given the rapid expansion of vocabulary from infancy to early childhood. Language development however is not restricted to childhood, but continues well into adulthood. It has been estimated that the average

five year old begins school with a vocabulary size of around 4000–5000 word families and then acquires around a thousand families per year, with the average graduate leaving university with a vocabulary size of approximately 20,000 word families (Nation and Waring, 1997). While some of these will be synonyms for existing words, in many cases, new conceptual information must be acquired together with the

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new word. Novel concepts are particularly likely to be encountered by those progressing through education, but are not exclusive to this group. Advancing technology together with social and cultural change mean that language is continually shifting, with new words entering the lexicon while others fall into disuse. Despite this, there is currently very little research exploring the acquisition of novel concepts during adulthood. The aim of this study was to examine how concreteness impacts the acquisition and subsequent processing of novel concepts.

Concreteness is one factor known to affect the conceptual processing of words. It is usually defined as the extent to which an item can be experienced by the senses (Richardson, 1975). It is distinct from, but highly correlated with its sub-variable, imageability, which refers to the extent to which an item evokes a mental image. Although the two variables are very similar, concreteness is a broader definition of imageability which refers to all five senses rather than simply visualisation. Due to the overlap in definition, under most circumstances highly imageable words are analogous to concrete words, and low imageability words are processed like abstract words. For sake of simplicity therefore, within this paper the two variables will be considered interchangeable.

Numerous behavioural studies have shown that concrete words are processed more quickly and accurately than abstract words during tasks such as sentence comprehension (Schwanenflugel and Stowe, 1989) lexical decision (Kroll and Merves, 1986; Schwanenflugel et al., 1988), semantic decision (Bleasdale, 1987; Kroll and Merves, 1986) and bilingual translation (e.g. De Groot, 1992; De Groot et al., 1994; De Groot and Poot, 1997; van Hell and De Groot, 1998). In memory experiments, concreteness also influences how easily items are recalled (Hiroshi et al., 2002; Paivio et al., 1969²) and recognised (Fliessbach et al., 2006).

In addition to influencing behavioural responses, concreteness effects can be observed at the neurophysiological level in event-related potentials (ERPs). ERPs represent the changes in electrical brain activity associated with a specific stimulus or 'event'. Research on word concreteness has focused primarily on the N400, a large negative-going waveform which occurs 300–500 ms after the presentation of a meaningful event. Kutas and Hillyard (1980) were the first to demonstrate the semantic sensitivity of the N400 by showing that its amplitude is increased in response to a word which is semantically incongruous with its preceding sentence context (relative to a congruous word). Words presented in isolation also elicit an N400 response, the amplitude of which is sensitive to the semantic characteristics of the word. For example, Kounios and Holcomb (1992) have shown that words which are semantically more specific (e.g. Dog) elicit a larger N400 response than less specific category words (e.g. Animal). In relation to concreteness, concrete (and high imageability) words elicit a larger N400 than abstract (and low imageability) words (e.g. Hiroshi et al., 2002; Holcomb et al., 1999; Kounios and Holcomb, 1994; Tolentino and Tokowicz, 2009; Tsi et al., 2009; West and Holcomb, 2000; Zhang et al., 2006), thought to reflect activation of more

extensive semantic information from memory for concrete words (Kounios and Holcomb, 1994). In some studies, N400 concreteness effects are found to be larger over the right hemisphere (e.g. Kounios and Holcomb, 1994), and they tend to have a more anterior distribution than the classical N400 congruency effect (Holcomb et al., 1999; Kounios and Holcomb, 1994; West and Holcomb, 2000) which is usually maximal at parietal electrode sites. Although the primary focus of the present work is on the N400, it should be noted that concreteness effects in the ERP usually extend beyond the typical N400 timeframe, often lasting up to around 800–1000 ms (Hiroshi et al., 2002; Holcomb et al., 1999; Kounios and Holcomb, 1994, West and Holcomb, 2000).

Within the language learning literature, a number of studies have demonstrated that novel concrete words are easier to learn than novel abstract words (De Groot, 2006; De Groot and Keijzer, 2000; Mestres-Misse et al., 2009; van Hell and Candia-Mahn, 1997). In the most recent of these (Mestres-Misse et al., 2009), adult participants were required to learn the meanings of novel concrete and abstract words from the contextually constrained sentences in which they were presented. They then performed a behavioural two alternative forced choice task in which they were shown one of the novel words together with a correct and an incorrect translation. In this latter task concrete words elicited shorter response latencies and were associated with fewer omissions than abstract words. fMRI BOLD responses were also measured during the learning phase to identify brain regions associated with the learning of each type of word. The fMRI data revealed that the ventral anterior fusiform gyrus, an area associated with high level visual processing, was involved only in the learning of new concrete words. Virtually no activation was observed in this area during the acquisition of new abstract words leading the authors to conclude that there may be qualitative differences in the way in which concrete and abstract words are learnt.

In all of the word learning studies cited above, participants learnt new words associated with concepts that already existed in their semantic memory. These studies suggest that it may be easier to map novel words to concrete concepts, but they do not say anything about the ease with which the concepts themselves are learnt. Although this issue has not been examined in the adult language learning literature, there is evidence from the developmental literature that highly imageable, concrete concepts might be easier to learn, at least for children. Recently, several studies have shown that imageability correlates negatively with the age of acquisition (AoA) of both nouns and verbs (Ma et al., 2009; McDonough et al., 2011). Importantly, imageability predicts AoA independently of form class (McDonough et al., 2011) and is of a larger predictive importance than input frequency (Ma et al., 2009). Thus, imageability may explain why nouns are more prevalent than verbs in the early vocabulary of English-speaking children. Compatible with the proposal that imageability plays a key role in the acquisition of concepts is the observation that in Chinese, where nouns and verbs are rated more closely in imageability (by native speakers) than in English, Chinese-speaking children learn more verbs than English-speaking children in the early years (Ma et al., 2009). McDonough et al. (2011) suggest that highly imageable

²In these studies imageability rather than concreteness was manipulated.

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