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Thematic and taxonomic relations of novel words learned from action and perceptual features

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ABSTRACT

The current study explored whether novel words can be related to pre-existing words in semantic memory via thematic or taxonomic relations. The meaning of the novel words was learned from descriptive actions or perceptual features. In a lexical decision task, the novel words served as primes for their corresponding concepts, taxonomically and thematically related targets. ERP results showed that the taxonomically but not the thematically related words elicited reduced N400s relative to the unrelated words. A control experiment revealed a priming effect between the corresponding concepts and the thematically related words, ruling out the possibility of the inappropriate selection of targets. These results suggest that while adult learners rapidly integrate the learned novel words into semantic network, the taxonomic information is more available than the thematic information for novel words learned from semantic features.

1. Introduction

People acquire concepts from interactions with environment during the life span and therefore they continually develop an enlarged semantic network. Conceptual learning is an important linguistic component for ones' language competence and performance. Investigating the novel word acquisition contributes to understanding the representation and organization of concepts in the semantic network. It is known that acquiring the meaning of a novel word requires establishing conceptual relations between the novel word and words in pre-existing semantic network. The current study aimed to explore the influence of learning contexts on the semantic representation of novel words, specifically whether different semantic relations of novel words could be learned during the initial stage of word acquisition.

1.1. Learning conditions

Previous studies have shown that acquired word meaning is largely determined by learning conditions. The conditions manipulated in previous studies differed in certain ways. One is selective attention, that is, what aspects of semantic representations of a word (e.g., perceptual features or action features) participants were asked to attend to (Bermeitinger,

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Wentura, & Frings, 2011). When participants were instructed to focus on perceptual features of a word by a secondary task (e.g., to pay attention to the color), semantic priming effects emerged between natural concepts but not between artifactual concepts. However, the priming effects reversed when action features were focused on (e.g., to pay attention to the moving direction). Another is the way of learning, that is, by direct mapping or through inference from context (Batterink & Neville, 2011; Chen, Wang, & Yang, 2014; Mestres-Missé, Rodriguez-Fornells, & Münte, 2007; Perfetti, Wlotko, & Hart, 2005). Comparing with direct mapping, learning novel words through inference from contexts can construct more connections between the novel words and known concepts (Chen et al., 2014).

Among various kinds of semantic relations between concepts, taxonomic and thematic relations are highly relevant for conceptual organization (Borghi & Caramelli, 2003; Estes, Golonka, & Jones, 2011; Yee, Chrysikou, & Thompson-Schill, 2013). Taxonomic relation defines the relation between concepts of the same category. Concepts belonging to the same taxonomic category usually share common features (Rogers & McClelland, 2004). Thematic relation organizes concepts by their participation in the same scenario or event (Lin & Murphy, 2001). Thematic relations are broad and could encompass temporal, spatial, causal, or functional relations between concepts (Estes et al., 2011). Concepts with thematic relations usually co-occur and perform complementary roles in the same episodes or events.

There are many studies in literature investigating the taxonomic relation of concepts. Kellenbach, Wijers, and Mulder (2000) reported that targets elicited a smaller N400 when they were primed by concepts sharing common features. Borovsky, Elman, and Kutas (2012) found that the novel words learned in highly constraining contexts could prime semantically related words in a lexical decision task, which was evidenced by reduced N400 amplitude for the semantically related compared to the unrelated words. Tamminen and Gaskell (2013) examined the integration of novel words, which were learned from direct definitions and through inference from language contexts, into existing semantic network. In a lexical decision task, the learned novel words served as primes. Words that were semantically related or unrelated with the novel words served as targets. Both the target words never co-occurred with the novel words during training. They found that the reaction time for the semantically related words was shorter than for the unrelated words. These results suggest that, after a brief training, newly learned words have been integrated into the semantic networks.

Some studies also investigated the thematic relation of concepts in the semantic networks. Pluciennicka, Wamain, Coello, and Kalenine (2015) asked participants to identify target pictures among distractors, which was primed by point-light display (PLD) of either object-related actions or meaningless moving dots. The actions displayed in PLD were used to activate the thematic relations between the targets (e.g., saw) and the distractors (e.g., wood). In the action priming condition, the identification time of the targets that paired with the thematically related distractors was shorter comparing with those in the meaningless moving dots priming condition.

It can be observed from above-mentioned studies that the shared perceptual features were usually used to indicate the taxonomic relation between novel words and known concepts, and the actions for the thematic relation. That is, perceptual features and actions could help the construction of semantic relations, but they may have determined what kinds of relations to be constructed between words and concepts (Breitenstein et al., 2007; Coutanche & Thompson-Schill, 2014; Tamminen & Gaskell, 2013).

Neuroimaging data have also provided evidence for the distinct roles of the perceptual feature and action in the construction of semantic relations. Kalénine et al. (2009) asked participants to identify taxonomic and thematic relations for non-manipulable-natural, non-manipulable-artifact, manipulable-natural, and manipulable-artifact targets in a picture matching task. The result indicates that the processing of taxonomic relations selectively relied on perceptual similarity processing as reflected by the specific activation in visual region, whereas the processing of thematic relations relied on action and space processing as reflected by the specific activation in temporo-parietal network. Therefore, it is reasonable to speculate that learning from perceptual features and actions may influence which aspects of word meaning to be acquired, and what kind of relations to be established between learned and pre-existing words. So far most studies have mainly concerned with taxonomic relations between novel words and known concepts inferred through perceptual features. It remains to be investigated whether thematic relations could be built during short-term learning.

1.2. Learning stages

Learning novel words is a complicated cognitive process. It has been proposed that the learned novel words undergo an initial rapid familiarization, and then a slow lexical consolidation to become an integrated part of the semantic networks (Davis & Gaskell, 2009). Previous studies have shown that the initial word acquisition relies on medial temporal lobe and hippocampal activations, and the consolidation is supported by neocortical activities (e.g., Davis, Betta, Macdonald, & Gaskell, 2009).

However, other studies suggested a rapid integration of learned novel words during short-term learning. Tamminen and Gaskell (2013) found that the learned novel words could prime semantically related words in a lexical decision task both immediately and one week after training, which suggests that the novel words became a part of the mental lexicon immediately after learning. It is speculated that our brain may effectively form new cortical circuits to learn new words rapidly (Shtyrov, 2012). Atir-Sharon, Gilboa, Hazan, Koilis, and Manevitz (2015) used multi-voxel pattern analysis (MVPA) to investigate the neocortical plasticity during word learning through fast mapping (FM). FM involves incidental inferring learning supported by old information in the context. They found that this rapid word acquisition was hippocampal-independent and supported by the anterior temporal lobe (ATL), inferior-posterior lateral temporal, occipital neocortex