Effects of Semantic Variables on Picture Naming in a Large Group of People with Aphasia

Leonie Lampe[1,2], Nora Fieder[1,3], Solène Hameau[1], Lyndsey Nickels[1]

[1]ARC Centre of Excellence in Cognition and its Disorders, Department of Cognitive Science, Macquarie University, Sydney, Australia; [2]International Doctorate of Experimental Approaches to Language and Brain (IDEALAB); [3]Berlin School of Mind and Brain, Humboldt-Universität zu Berlin, Germany
Contact: leonie.lampe@students.mq.edu.au

Introduction

When we want to say a word, for example in a picture naming task, we first need to retrieve the word's meaning from the semantic system, before its abstract lexical representation can be activated. It is well established that this process is influenced by various linguistic variables, such as word frequency (e.g., Alario et al., 2002; Nickels, 1997). In addition, semantic variables (e.g., typicality, imageability) have been found to influence naming speed or accuracy of people with (e.g., Laiacona et al., 2001) and without aphasia (e.g., Alario et al., 2004; Rosch & Mervis, 1975).

Semantic feature norms (e.g., McRae et al., 2005) permit the calculation of several new semantic variables which describe aspects of the distribution of semantic features of a target word. So far, few studies have investigated the effects of such variables on word production. In healthy participants, picture naming was found to be facilitated by higher numbers of semantic features (Rabovsky et al., 2016), higher typicality (Dell'acqua et al., 2000; Holmes & Ellis, 2006), and higher distinctiveness (Taylor et al., 2012). Detrimental effects have been found for intercorrelational feature density (Rabovsky et al., 2016) and many near semantic neighbours (Mirman, 2011). In people with aphasia, typicality showed facilitative effects on accuracy (e.g., Rossiter & Best, 2013), higher numbers of near semantic neighbours led to less accurate responses and influenced the error pattern (e.g., Fieder et al., 2016; Mirman, 2011), and a strong first associate was found to reduce naming accuracy (Hameau, 2016). Other semantic variables have not yet been investigated in people with aphasia.

This study presents the first simultaneous examination of the effects of six semantic variables (number of near semantic neighbours, number of semantic features, typicality, distinctiveness, intercorrelational density, strength of the first associate) on picture naming in people with aphasia. We also investigated interactions between these variables and the semantic abilities of the participants with aphasia.

Methods

Participants

The data was taken from the Moss Aphasia Psycholinguistic Project Database (MAPPD) (Mirman et al., 2010), which provides naming responses from people with aphasia on the Philadelphia Naming Test (PNT) (Roach et al., 1996). Here, we analysed naming accuracy and response types of 175 people with aphasia.

Stimuli

89 MAPPD items were selected that also appeared in the McRae et al. (2005) feature norm database and the University of Florida Free Association Norms (Nelson et al., 2004). A number of psycholinguistic properties of the items were used as control variables: length in phonemes, word frequency, age of acquisition, concept familiarity, visual complexity, imageability, and name agreement.

McRae et al.'s (2005) database was used to derive five feature-based semantic predictor variables: number of near semantic neighbours, number of semantic features, typicality (calculated according to Rosch and Mervis' (1975) family resemblance score), distinctiveness, and intercorrelational density. The strength of the first associate was derived from Nelson et al. (2004).

Analyses

Generalised Linear Mixed Models were used to determine the effect of the control and semantic predictor variables on different dependent variables (naming accuracy, semantic errors vs. correct responses, semantic errors vs. omissions, omissions vs. correct responses) and to examine interactions between the participant's score on the Pyramids and Palm Trees test (PPT score; Howard & Patterson, 1992) as a measure of semantic impairment and the six semantic predictor variables. Bayesian statistics were used to determine if potential null-effects were due to there being no effect (evidence for the H_0) or if the data was not sensitive enough to detect possible effects.

Results

Naming accuracy increased for words that were shorter (p<.001), higher frequency (p=.012), acquired earlier in life (p=.005), and more familiar (p=.039). Moreover, participants with intact semantics (high PPT score) performed more accurately (p<.001).

Surprisingly, none of the semantic variables predicted naming accuracy, there was only a marginal effect of the number of semantic features (p=.094), with increased accuracy for items with many features. Bayesian correlations between the semantic variables and naming accuracy corroborated the null effects for the number of near semantic neighbours, typicality, distinctiveness, and intercorrelational density (BF_{01}>3). For the strength of the first associate (BF_{01}=1.370) and the number of semantic features (BF_{01}=0.357) we were unable to adjudicate between the H_1 that there was an effect of the variable on naming accuracy and the H_0 that there was no such effect.

In the error analyses we found that high typicality increased the probability of a semantic error over a correct response and an omission. Moreover, there were interactions between the PPT score and typicality: The probability of semantic errors over correct responses and omissions decreased for high typicality items in lower PPT score participants, while higher PPT score participants were unaffected by typicality when comparing semantic errors and correct responses and showed the opposite pattern of lower PPT score participants when contrasting semantic errors and omissions (Figure 1). No other semantic variables reached significance.

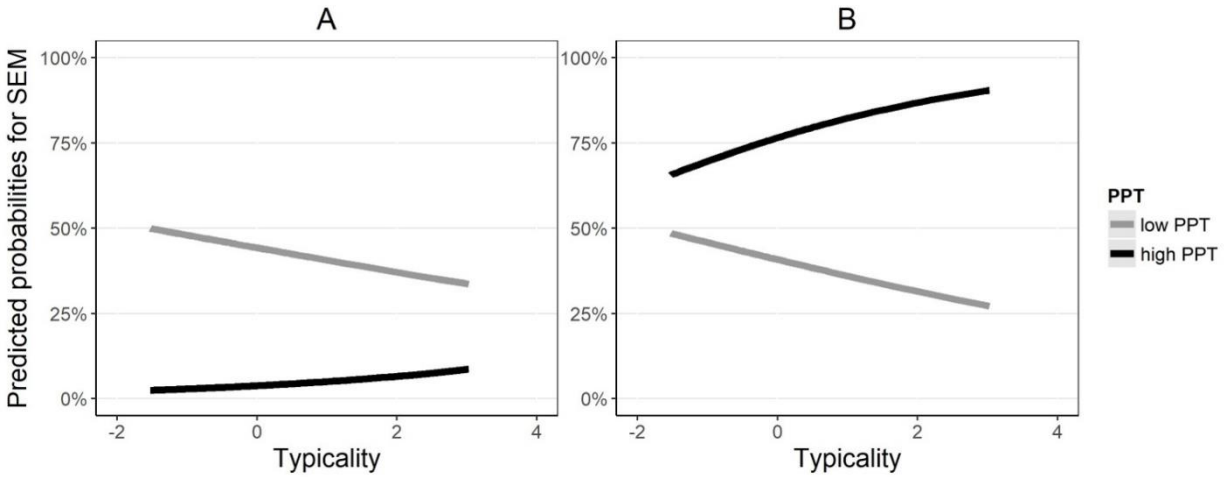

Figure 1. Interaction between performance on the Pyramids and Palm Trees test and typicality on probability of a semantic error over a correct response (Panel A) and of a semantic error over an omission (Panel B).
Note. Abbreviations: SEM – semantic error; PPT – Pyramids and Palm Trees test score.

Effects of the semantic variables will also be reported for a subgroup with a central semantic impairment.

Discussion

This was the first research to examine effects of six semantic predictor variables (number of near semantic neighbours, number of semantic features, typicality, distinctiveness, intercorrelational density, strength of the first associate) on the naming performance of a large group of people with aphasia. In contrast to previous research, we found no reliable main effects of these variables. Importantly, previous publications used smaller samples of participants, and not all studies analysed the data taking individual patient variation and a large number of control variables into account, which might have distorted their results.

The results for the clinical population examined here suggest that conceptualisation and lexical selection processes for word production were unaffected by the tested variables. However, the interactions of the PPT score and typicality in the error analyses suggest that patients with a semantic impairment could be more prone to such influences. These findings have implications for the architecture of the semantic system and the processing dynamics of lexical selection as well as for assessments of aphasia and its rehabilitation.

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