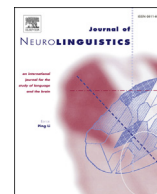


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Journal of Neurolinguistics

journal homepage: www.elsevier.com/locate/jneuroling

Divergent and convergent hemispheric processes in idiom comprehension: The role of idioms predictability



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ARTICLE INFO

Article history:

Received 16 February 2016

Received in revised form 3 April 2017

Accepted 12 May 2017

Available online 23 May 2017

Keywords:

Idioms

Figurative language processing

Right-hemisphere

ABSTRACT

Idioms are a form of figurative language expressions in which their intended meaning is not derived from the meaning of constituent words. Previous studies examining hemispheric asymmetries in idiom comprehension argue about the relative contributions of the hemispheres to the figurative and literal processing. However, it is not clear what psycholinguistic factors may direct hemispheric asymmetries and the way in which figurative vs. literal interpretations are processed. In the current study we report a behavioral study that examined whether idiom-irrelevant meanings are suppressed or retained as a function of visual field and the degree of predictability of the idioms. Native Hebrew speakers were presented with idioms in a semantic judgment task, where we manipulated visual field and predictability. The results seem to support the notion that a bi-hemispheric network is involved in idiom comprehension with prevalence for the left hemisphere. Overall, the results confirm the role of idioms predictability as the main factor that directs idiom comprehension and modulates hemispheric asymmetry in semantic processing.

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1. Introduction

Consider the English idiom *crying over spilled milk*. How does a listener understand the phrase? In particular, how does a listener come to the relevant figurative semantic associations, such as *irreversible loss* and *inappropriate regret*, without being distracted by irrelevant literal associations, like *cow products* and *liquid dynamics in gravitational field*? In general, a traditional perspective in figurative language literature supports the view that 'Natural language' functions (e.g., conversations and text) are based on frontal and temporo-parietal regions of the left hemisphere (LH) regions, that are crucial for basic language processes (Jung-Beeman, 2005). Nevertheless, from a growing number of studies it is known that the right hemisphere (RH) also plays a crucial role in figurative language processes such as novel metaphors (Anaki, Faust, & Kravetz, 1998; Faust & Mashal, 2007; Mashal & Faust, 2008; Mashal, Faust, Hendler, & Jung-Beeman, 2009; Pobric, Mashal, Faust, & Lavidor, 2008; but see also Rapp, Leube, Erb, Grodd & Kircher, 2004, 2007) and irony (Eviatar & Just, 2006).

One popular model to explain RH prominence in figurative tasks was suggested by Beeman (Beeman, 1998; Jung-Beeman, 2005). According to the *fine versus coarse semantic coding theory* (FCT), the RH activates 'broad semantic fields', whereas the LH activates 'narrow semantic fields'. Consequently, the LH is more suitable for selecting a single interpretation and inhibiting irrelevant interpretations, whereas the RH activates large but diffuse semantic fields that include peripheral, subordinate

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information. These procedures differ in terms of processing time: whereas the formation of a fine semantic field in the LH is considered rather fast, the formation of a coarse semantic field is more demanding and requires more time to allow a “spread of activation”. In support of this hypothesis, the RH appears to be more adept in retrieving and maintaining semantic activations requiring atypical interpretations (Beeman & Bowden, 2000; Bowden & Jung-Beeman, 2003). Neuroimaging and EEG data also agree with the notion of the relative importance of the RH for coarse processing (Jung-Beeman et al., 2004). For example, neuroimaging studies on lexical semantic ambiguity comprehension suggest that ambiguity processing per se can also lead to RH involvement (Stowe, Haverkort, & Zwarts, 2005; Zempleni, Renken, Hoeks, Hoogduin, & Stowe, 2007). Others also suggested that the RH is involved in the comprehension of ambiguous words (Burgess & Simpson, 1988; Faust & Chiarello, 1998; Harpaz, Levkovitz, & Lavidor, 2009).

Alternatively, according to Giora's *Graded Salience Hypothesis* (GSH) (1997, 1999, 2003), the more salient a candidate meaning, the more easily and earlier it is accessed. That is, regardless of contextual bias (literality or non-literality for example) salient meanings (coded meanings) are easier to access than less salient ones (non-coded meanings - novel meanings) that require more complex and inferential processes. Salience here is a complex feature, combining conventionality, frequency, familiarity, prototypically, and perhaps additional factors. Performing the search for appropriate meanings are two mechanisms running in parallel, one bottom-up and sensitive only to the linguistic stimuli, the other top-down, sensitive to linguistic and extra-linguistic inputs, and tasked with predicting and integrating information (Giora, 2008).

Mashal and Faust (2008) proposed a hybrid model (which we will here call, FCT-GSH) integrating the LH/RH structure of FCT with the functional criterion of GSH. According to this framework, highly salient, closely-related meanings are processed mainly by the LH, while less salient meanings are processed mainly by the RH. Mashal, Faust, Hendler, and Jung-Beeman (2008) tested this idea by examining the hemispheric distinction in processing familiar and ambiguous idioms in a lexical decision task. Reaction time to target words which were related to the idioms in a literal and hence less-salient manner was faster when the targets were presented to the left visual field/right hemisphere (LVF/RH) than when presented to right visual field/left hemisphere (RVF/LH); reaction times, however, did not differ between LH and RH when target words were related to the idiomatic, figurative meanings of the expressions. These results suggest that the RH is better able to process less-salient interpretations, and they give initial support to the FCT-GSH hybrid model.

The FCT-GSH hybrid model may be considered as a “dual core” theory of language comprehension. Dual core conceptualization supports the notion that the RH understands language *differently* than the LH, and in some aspects of language comprehension, the RH is dominant in comparison to the LH (e.g., novel metaphors, ambiguous words). With respect to idioms, the classical neuropsychological view (Kempler, Van Lancker, Marchman, & Bates, 1999; Vanlancker & Kempler, 1987) suggests that only RH damage has major consequences on the processing of figurative language and specifically of idiom. Kempler et al. (1999) stated that the RH is preferentially involved in processing this particular type of language in normal adults, based on a double dissociation found in RBD and LBD patients, which suggests that literal and idiomatic language, are mediated by different cerebral structures in adults, with a RH dominance for understanding idiomatic expressions.

In contrast to these ‘dual-core’ models with their functional redundancy and parallel-processing, Papagno and colleagues have argued that the LH, not the RH, plays the dominant role in idiom comprehension (Cacciari et al., 2006; Papagno & Caporali, 2007; Papagno & Genoni, 2004; Papagno, 2001; Papagno, Curti, Rizzo, Crippa, & Colombo, 2006; Papagno, Lucchelli, Muggia, & Rizzo, 2003; Papagno, Tabossi, Colombo, & Zampetti, 2004; Rassiga, Lucchelli, Crippa, & Papagno, 2008). For example, it has been shown by Papagno et al. (2006) that right brain-damaged patients, though impaired in idiom comprehension, performed significantly better than left brain-damaged patients in an idiom comprehension task. Papagno and Cacciari (2010) confirmed that integrity of the left temporal lobe is required to process unambiguous idioms, however the RH can process ambiguous idioms with a dominant figurative interpretation.

Importantly, Papagno and colleagues argue in support of a specific role of executive functions as the main function that is responsible to monitor and inhibit different meanings (see also Titone, Holzman, & Levy, 2002). For example, in a series of studies, which employed different paradigms, it has been shown that aphasic patients had a marked bias toward literal interpretation, as if the literal meanings were not inhibited or suppressed (e.g., Cacciari et al., 2006; Papagno & Caporali, 2007; Papagno & Genoni, 2004; Rassiga et al., 2008).

With these findings comes the Configuration Hypothesis (CH) (Cacciari & Tabossi, 1988; Papagno & Cacciari, 2010). According to this theory, idioms are processed word-by-word, like any other piece of language, until enough information has accumulated to render the sequence of words identifiable as – or highly expected to be – an idiom. At this point, the idiomatic meaning is retrieved. Cacciari and Tabossi (1988) reported that the idiomatic meaning of highly predictable expressions was accessed sooner than that of less predictable expressions. In contrast, the literal meaning of less predictable phrases was activated sooner than that of highly predictable phrases.

According to the theory, with the recognition of the idiomatic key, the literal meaning no longer continues to accumulate activation, although it is not completely suppressed. This hypothesis may suggest that damage to the LH ought to impair, along with other linguistic skills, the comprehension of idioms (Papagno & Cacciari, 2010). However, this hypothesis is at odds with the view of the FCT-GSH that posits that in different conditions, the RH should play a major role in idiom processing. Another example for the discrepancy between these two frameworks is related to the hemispheric dominance of non-salient meanings of conventional idioms. The FCT-GSH predicts such inputs would be highly prominent in the RH (Mashal et al., 2008). However, different brain stimulation studies showed that after LH disruption with rTMS (Fogliata et al., 2007; Oliveri, Romero, & Papagno, 2004; Rizzo, Sandrini, & Papagno, 2007), literal meanings of highly familiar idioms were highly available, implying that literal related meanings were not completely suppressed or maintained in the RH.

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