Acta Psychologica 156 (2015) 143–155

Contents lists available at ScienceDirect

Acta Psychologica

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

What's up? Emotion-specific activation of vertical space during language processing

Carolin Dudschig *, Irmgard de la Vega, Barbara Kaup

Universität Tübingen, 72076 Tübingen, Germany

ARTICLE INFO

Available online 30 October 2014

PsycINFO classification:
2300
2330
2340
2700
2720

Keywords:
Language
Emotion
Valence
Vertical space
Metaphorical mapping
Embodiment

ABSTRACT

The relationship between language processing and vertical space has been shown for various groups of words including valence words, implicit location words, and words referring to religious concepts. However, it remains unclear whether these are single phenomena or whether there is an underlying common mechanism. Here, we show that the evaluation of word valence interacts with motor responses in the vertical dimension, with positive (negative) evaluations facilitating upward (downward) responses. When valence evaluation was not required, implicit location words (e.g., *bird*, *shoe*) influenced motor responses whereas valence words (e.g., *kiss*, *hate*) did not. Importantly, a subset of specific emotional valence words that are commonly associated with particular bodily postures (e.g., *proud* → upright; *sad* → slouched) did automatically influence motor responses. Together, this suggests that while the vertical spatial dimension is not directly activated by word valence, it is activated when processing words referring to emotional states with stereotypical bodily-postures. These results provide strong evidence that the activation of spatial associations during language processing is experience-specific in nature and cannot be explained with reference to a general mapping between all valence words and space (i.e., all positive and negative words generally relate to spatial processing). These findings support the experiential view of language comprehension, suggesting that the automatic reactivation of bodily experiences is limited to word groups referring to emotions or entities directly associated with spatial experiences (e.g., posture or location in the world).

1. Introduction

Traditionally, the domain of language processing was regarded as a separate system where experiences are transformed into logical propositions, relying on abstract and amodal computations of meaning (e.g., Pylyshyn, 1973). However, converging evidence suggests that language understanding is grounded in the sensorimotor system (Barsalou, 1999; Glenberg & Kaschak, 2002). Evidence for such an embodied language-processing model is often drawn from compatibility effects between language processing and spatial processing. For example, words referring to entities with a typical location in vertical space (e.g., *airplane*, *worm*), valence words (e.g., *love*, *hate*) and also religious concepts (e.g., *god*, *devil*) have been shown to influence perceptual- and motor-processes related to vertical space (e.g., Chasteen, Burdzy, & Pratt, 2010; Estes, Verges, & Barsalou, 2008; Meier & Robinson, 2004). Although numerous word groups have been empirically related to vertical space, the underlying cause of these associations between language processing and spatial processes remains unclear. In the current study we investigated the question whether these associations between language processing and spatial processing (language-space associations) are rooted in a reactivation of specific experiences during language comprehension (see Zwaan & Madden, 2005) or in contrast, whether these associations are the result of a general correspondence mechanism relating various word groups to vertical space (e.g., Lakens, 2012). In order to investigate this issue, we disentangled in the current study the influence of posture-specific experiential traces activated by specific emotion words (e.g., *proud*, *cheerful* – upright posture vs. *sad*, *depressed* – slouched posture; Darwin, 1872; Tracy & Matsumoto, 2008; Wallbott, 1998) from the influence of word valence (i.e., the valence of words such as *love*, *hate* or *aggression* that are less associated with one specific postural experience). In the following paragraph we will briefly summarize the findings regarding the associations between vertical space and the different word groups mentioned above, as these findings build the starting point of our study.

1.1. Implicit location words

Zwaan and Yaxley (2003) first investigated the importance of vertical space during the processing of words that implicitly convey location information by referring to referents with a typical location in vertical space (e.g., *sky*, *ground*). They showed that participants judge the semantic relatedness of these implicit location words faster when they are presented in a manner that is spatially consistent with their referent

* Corresponding author at: University of Tübingen, Fachbereich Psychologie, Schleichstr. 4, 72076 Tübingen, Germany. Tel.: +49 7071 29 74507; fax: +49 7071 29 3363.
E-mail address: carolin.dudschig@uni-tuebingen.de (C. Dudschig).

http://dx.doi.org/10.1016/j.actpsy.2014.09.015
0001-6918/

arrangement in the world (e.g., *sky* above *ground* is judged faster compared to *ground* above *sky*). Similarly, Setic and Domijan (2007) showed that a category decision (Exp. 1 flying/non-flying; Exp. 2 living/non-living) was faster when the words were presented in a spatially compatible location (e.g., flying animal in the top half of the screen) (cf., Pecher, Van Dantzig, Boot, Zanolie, & Huber, 2010). Estes et al. (2008) first reported that even when word meaning is task-irrelevant, implicit location words (e.g., *hat*, *shoe*) still serve as spatial cues for involuntary attentional orientation. In this study, target discrimination performance in an upper or lower screen location was influenced by centrally presented task-irrelevant words (see also: Dudschig, Lachmair, de la Vega, De Filippis, & Kaup, 2012b; Gozli, Chasteen, & Pratt, 2013). Similar effects have been reported in a sentence-based study (Bergen, Lindsay, Matlock, & Narayanan, 2007) and also when verbs (e.g., *climb*, *drop*) were utilized as spatial cues (Verges & Duffy, 2009). In addition, automatic spatial associations have also been reported in the motor domain. Words such as *roof* or *root* facilitated response movements and eye movements (saccades) towards a location compatible to the typical location of the word's referent (Dudschig, Souman, Lachmair, de la Vega, & Kaup, 2013; Lachmair, Dudschig, De Filippis, de la Vega, & Kaup, 2011; Thornton, Loetscher, Yates, & Nicholls, 2012). These associations between language and motor responses in the vertical space were also found for verbs (Dudschig, Lachmair, de la Vega, De Filippis, & Kaup, 2012a) and even during second-language processing (Dudschig, de la Vega, & Kaup, 2014).

1.2. Words referring to religious concepts

Meier, Hauser, Robinson, Friesen, and Schjeldahl (2007) first showed that divinity-related cognition closely relates to vertical spatial processing. In multiple experiments, they showed that vertical space has a direct impact on encoding god-related concepts, on people's memory regarding the location of god-related items, and even on estimating the probability that strangers believe in god. Interestingly, Chasteen et al. (2010) reported an influence of religious concepts (e.g., *god*, *devil*) on spatial attention. Following centrally presented religious words, participants were faster to detect targets at certain locations. Specifically, target detection was faster at the top and the right hand side of the screen following words such a *god* and *heaven*. In contrast, after words such as *devil*, target detection was faster at the bottom and the left side of the screen.

1.3. Valence words

Meier and Robinson (2004) first showed a relationship between vertical space and valence evaluations of positive and negative words. Participants had to evaluate the valence of a word (e.g., *love*, *hate*) by saying "positive" or "negative" and to subsequently perform a target discrimination task. Positive evaluations facilitated target discrimination in the upper visual field, whereas negative evaluations facilitated target discrimination in the lower visual field. Importantly, participants were actively instructed to evaluate and vocalize word valence. Thus, it remains open whether the actual word-processing (e.g., understanding the word *hate*), the evaluation process (e.g., deciding that hate is negative), or the outcome of the evaluation process (e.g., having activated the abstract concept 'negative') is related to spatial processing. Indeed, a recent study by Santiago, Ouellet, Román, and Valenzuela (2012) suggested that attentional factors do play a crucial role in triggering interactions between valence and space. They showed that focusing on word valence is crucial for finding valence-space associations (cf., Ansorge, Khalid, & König, 2013; Dudschig, de la Vega, & Kaup, 2014). A first study investigating the association between valence words and motor responses in the vertical dimension reported clear limits regarding the automaticity of this association (Brookshire, Ivry, & Casasanto, 2010). Specifically, word repetition and a focus on word meaning modulated the influence of the words on spatially directed motor responses. Similarly, in a study investigating the horizontal association between valence words and hand responses, it has been shown that the valence evaluation process is required to trigger the valence-space interactions during language processing (de la Vega, Dudschig, De Filippis, Lachmair, & Kaup, 2013; de la Vega, de Filippis, Lachmair, Dudschig, & Kaup, 2012).

In the literature, two interrelated mechanisms are discussed that presumably underlie these language-space associations reported in the previous paragraphs: (a) automatic reactivation of experiential traces during language understanding and (b) metaphorical mapping. According to Zwaan and Madden (2005), language understanding is based on the reactivation of experiential traces. For example, a child often hears the word *airplane* in situations where the child's eye gaze is directed upwards toward the sky from the directional cue of a parent's pointing finger. Thus, when later hearing the word *airplane*, these sensory experiential traces are automatically reactivated and build the basis of understanding. As described above, evidence for this experiential trace mechanism is often drawn from studies showing an influence of implicit location words on subsequent perceptual- or motor-processes (e.g., Estes et al., 2008; Dudschig et al., 2014; Lachmair et al., 2011; Thornton et al., 2012). If the hypothesis that language understanding relies on reactivating experiential traces is valid, this leads to a theoretical challenge; specifically, how do we understand abstract concepts that do not refer to something we could have touched, smelt, seen, or otherwise experienced? Here, the second mechanism, the so-called metaphorical mapping as proposed by Lakoff and Johnson (1980, 1999) becomes relevant. It has been suggested that abstract conceptual knowledge, such as knowledge relating to *time*, is directly mapped to sensory-motor experiences with the physical world, whereby space builds a basic dimension of experience to which abstract knowledge is mapped (e.g., Gallese & Lakoff, 2005; Hartmann & Mast, 2012; Kousta, Vigliocco, Vinson, Andrews, & Del Campo, 2011; Santiago, Lupáñez, Pérez, & Funes, 2007; Ulrich & Maienborn, 2010). With reference to this mechanism, Meier and Robinson (2004) suggested that valence has a physical association with space. Specifically, Meier and Robinson suggest that the abstract concepts 'positive' and 'negative' are mapped onto primary concepts that we can experience such as space (Lakoff & Johnson, 1999; but see: Lakens, 2012).

Taken together, the effects of various word groups (e.g., valence words, religious words, implicit location words) on subsequent spatial processing have typically been reported independently for each word group (cf., Gozli et al., 2013). These language-space compatibility effects have been interpreted as evidence for a reactivation of experiential traces stemming from direct experience with the described entities (in the case of implicit location words), or as evidence for metaphorical mapping of abstract concepts onto spatial dimensions (in the case of valence evaluations), or as a mixture of these two mechanisms (in the case of words referring to religious concepts; e.g. seeing drawings of god in an upper position in heaven or speaking about religious concepts with reference to spatial locations). Critically, the increasing number of word groups for which such compatibility effects between language processing and spatial processing have been found demands clarification regarding the basic factors that potentially underlie these compatibility effects. First, confounding factors such as word valence need to be excluded. If it turned out that word valence automatically activates vertical spatial features in tasks that do not demand valence evaluations, several findings that have been reported in the literature need to be reconsidered. For example, items that have a location in the "upperworld" often have a positive bias (e.g., *crown*, *god* vs. *snake*, *devil*). Here, the compatibility effects attributed to a reactivation of an experiential trace, or a metaphorical mapping between a certain concept and space, may be alternatively explained by a general association between word valence and vertical space.

More importantly, with such a variety of different word groups that are presumably related to vertical spatial processing, the question arises how these very general language-space associations can be functional