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Spatial attention is driven by mental simulations

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A commentary on

High skies and oceans deep: Polarity benefits or mental simulation
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Many studies have shown that task performance is affected by the relation between the spatial location and the meaning of a target word. These effects have been obtained for object names that have typical positions in the physical world (Zwaan and Yaxley, 2003; Bergen et al., 2007; Šetič and Domijan, 2007; Estes et al., 2008) and for concepts that are metaphorically related to spatial position (Richardson et al., 2003; Meier and Robinson, 2004; Schnall and Clore, 2004; Schubert, 2005; Giessner and Schubert, 2007; Casasanto, 2009; Van Dantzig, 2009). Although these findings are consistent with a mental simulation account, at least some of the interactions between meaning and spatial location might be explained by polarity alignment. In our study (Pecher et al., 2010) we tested whether spatial congruency effects are best explained by mental simulations or by polarity alignment.

According to the polarity alignment principle, stimulus dimensions and response alternatives with binary values are coded as having a + (*plus*) polarity or – (*minus*) polarity. An UP location is coded as + and a DOWN location is coded as –. Furthermore, a "yes" response is coded as + while a "no" response is coded as –. Responses are faster when stimulus and response polarities are aligned (++ or ––) than when they are misaligned (+– or –+). In our study, we presented stimulus words ("helicopter," "submarine") at an UP or DOWN location of the display. Participants performed either a sky decision task or an ocean decision task. We found that participants were faster to respond to UP than to DOWN stimuli in the sky decision task, but that they were faster to respond to DOWN than to UP stimuli in the ocean decision task. Our findings show that spatial congruency effects in semantic decision tasks are best explained by meaning driven spatial attention rather than polarity alignment. In a commentary on our study, Lakens (2011) argues that our conclusions are premature. His argument consists of two criticisms.

Criticism 1: The results still show polarity alignment effects, we just changed the reference frame. Lakens argues that the polarity alignment explanation predicts our results. According to Lakens (2011), the polarity principle states that responses are coded relative to multiple frames of reference. As an example, he refers to a study by Banks et al. (1975) in which participants decided which of two "balloons" or "yo-yos" was higher or lower. The stimuli were two small dots at the end of vertical lines that extended from the top or bottom of the display. When the stimuli were labeled balloons the lines started at the bottom edge of the display and the dots were placed at the top ends of the lines, resembling helium-filled balloons on strings. When the stimuli were labeled yo-yos the lines started at the top edge of the display and the dots were placed at the bottom ends of the lines, resembling hanging yo-yos. Participants were faster to pick the higher balloon compared to the lower one, but were faster to pick the lower yo-yo than the higher one. The most obvious explanation for this effect is that the higher balloon and the lower yo-yo were easier to spot because they were visually sticking out. This is in line with the finding that when participants were simply instructed to judge the length of the string (without any reference to "balloons" or "yo-yos") responses to the longer strings were faster than to the shorter strings. Thus, participants were faster to select the perceptually more salient stimulus than the less salient stimulus. Therefore, these results do not necessarily show that spatial position is coded in a relative way. Moreover, Proctor and Cho's (2006) extensive discussion of the *above*/ABOVE advantage centers on the argument that the UP location and "yes" response are coded +, whereas the DOWN location and "no" response are coded –. They discuss studies in which a dot is located above or below a square containing the word *above* or *below*. When participants decide whether the location of the dot matches the word, they are faster to respond "yes" to an *above*/ABOVE stimulus than to a *below*/BELOW stimulus. The stimulus and response are aligned when the dot is located above the square (++) but not when the dot is located below the square (–+). Lakens (2011) proposes that in our ocean decision task DOWN was coded +, because DOWN was the default endpoint for *ocean*. However, this explanation is inconsistent with Proctor and Cho's (2006) argument. If the coding of UP and DOWN is reversed by changing the default endpoint, this should also be the case when the *above* decision is changed to a *below* decision. If DOWN is the default endpoint for *ocean*, it should also be the default endpoint for *below*.

Criticism 2: We should investigate the relative contribution of semantic and linguistic processing rather than try to reject linguistic processing. In our paper we did not investigate conceptual versus linguistic processing, nor did we reject linguistic processing as an explanation for meaning representation. Rather, we argue that polarity alignment does not explain our data. Contrary to what Lakens seems to suggest, however, the polarity alignment principle is not a theory of how meaning is extracted from linguistic information. Instead, the polarity alignment principle explains spatial congruency effects as occurring during response selection in a binary task. Proctor and Cho (2006) argue that some stimulus–response mappings are easier because they are aligned, resulting in faster responses than the opposite mapping. Thus, polarity alignment occurs as a consequence of using a task where both the stimulus and the response have binary values. The principle therefore has no bearing on how meaning is represented.

Now that Lakens had brought up the subject, however, we will address the question of meaning representation by linguistic or sensory–motor processing. Lakens (2011) suggests that meaning is extracted from linguistic information. There is, however, no evidence that meaning is *extracted* from linguistic information. Rather, models such as HAL and LSA *capture* meaning. A crucial aspect of such models is that their input consists of utterances by people. Whatever the nature of people's representations (symbolic or grounded in sensory–motor processing), their utterances will reflect at least some aspects of their mental representations. Thus, that co-occurrence models capture perceptual aspects of the environment merely indicates that people represent and talk about such knowledge, and leaves open the question whether those representations are symbolic or grounded. A related question, addressed by Barsalou and colleagues (Solomon and Barsalou, 2004; Barsalou et al., 2008; Simmons et al., 2008), is whether task performance is the result of linguistic processing or meaningful simulations. These researchers do not assume that meaning is extracted from linguistic information, but argue that in some circumstances linguistic information such as word association is enough to perform a task. On this account, meaning is still represented by simulations, however, the task might not require activation of meaning.

In sum, Lakens' claim that our conclusions are premature is based on two inaccurate arguments. First, Lakens argues that coding of spatial position as + or − is relative. However, this is inconsistent with prior explanations of polarity effects. Second, Lakens (2011) suggests that by dismissing polarity alignment as an explanation of our data, we reject linguistic theories of meaning. We never made such claim. Instead, we agree with Lakens that it is important to investigate how linguistic processing and mental simulation contribute to language comprehension. This issue, however, was not the topic of our paper.

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