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Relative Evaluation of Location: How Spatial Frames of Reference Affect What We Value

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Abstract

How we mentally represent spatial relations is known to have effects on cognitive processes such as inferences, co-speech gesture, or memorizing. In addition, spatial positions often serve as metaphors that carry valence. For instance, "moving up the social ladder, "getting it right", or being "in front" feels certainly better than "moving down", "having two left feet", or "lagging behind". Spatial position, however, depends on perspective, more concretely on which frame of reference (FoR) one adopts—and hence on cross-linguistically diverging preferences. What is conceptualized as "in front" in one variant of the relative FoR (e.g., *translation*) is "behind" under another variant (*reflection*), and vice versa. Do such diverging conceptualizations of an object's location also lead to diverging evaluations? We tested this with speakers of German, Chinese, and Japanese using an Implicit Association Test (IAT). Data from two studies suggest that across languages the object "in front of" another object is evaluated more positively than the one "behind", and that both location and evaluation depend on the adopted FoR. In other words: linguistically imparted FoR preferences appear to impact on evaluative processes.

Keywords: spatial cognition, frames of reference, valence, IAT, cross-linguistic comparison

Introduction

Space is of fundamental importance, not only for our very existence and survival—and hence for core cognitive activities devoted to them such as orientation and navigation (e.g., Hutchins, 1983; Golledge, 1999)—but also as a source of metaphors for grasping more abstract or elusive concepts such as number or time (Bender & Beller, 2014; Dehaene, 2003; Núñez & Cooperrider, 2013; Walsh, 2003). For instance, preferences for spatial representations seem to provide structure for how we represent temporal relations (Boroditsky, 2000; Boroditsky & Gaby, 2000).

A number of expressions points to the possibility that spatial representations may also provide metaphorical structure for evaluative judgments, especially along the vertical axis and the lateral axis, with *up* and *right* being predominantly linked to positive valence, and *down* or *left* to negative valence in various cultures (Keating, 1995; Lakoff & Johnson, 1999; Meier & Robinson, 2004). Expressions such as "being at the forefront" versus "lagging behind" do hint at corresponding associations along the sagittal axis as well.

The relationship between space and valence, however, is more complex than these examples suggest, and may be mediated by additional factors. For instance, the more positive evaluation of objects to the right than of those to the left is reversed in left-handers (Casasanto, 2009, 2011), and lateralization in terms of handedness even overrides strong cultural conventions (de la Fuente, Casasanto, Román, & Santiago, 2015). Yet, handedness only affects people's embodied experiences of their own right and left; it does not determine whether they mentally represent an object as being located to the right or left. Evaluations of objects are therefore directly dependent on location in space: If an object changes location, its evaluation changes. But what if it is not location in space that changes, but rather the mental representation of this location? Is the valence of objects also affected if relative positions themselves are conceptualized differently depending on a person's preference for referring to these positions? We addressed this question with a focus on the sagittal axis, for which space-valence associations have not been explored. At the same time, it is the only axis along which the conceptualization of location is affected in distinct ways by linguistic and cultural conventions and hence may vary in important ways (Beller, Singmann, Hüther, & Bender, 2015; Majid, Bowerman, Kita, Haun, & Levinson, 2004).

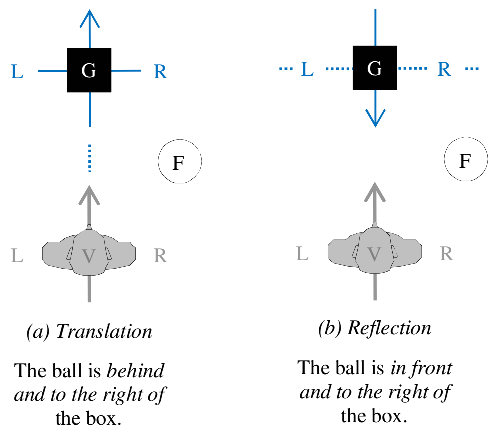

Figure 1:
Two variants of the relative FoR (Levinson, 2003);
F: figure; G: ground; V: viewpoint of the observer;
L/R: left/right

Indeed, what is assigned as FRONT or BACK along the sagittal axis depends on the frame of reference (FoR) one adopts. While all FoRs are coordinate systems that help to locate one object (the figure) in reference to another object (the ground), they differ with regard to where they are anchored (Levinson, 2003)[1]. The relative FoR relevant for our study is anchored in an observer. Therefore, to locate the figure in reference to the ground, the observer's coordinate system needs to be transferred to the ground. Crucially, this can be done in different ways—by shifting it to the ground (*translation*) or by mirroring it in the ground (*reflection*)—leading to opposing assignments of FRONT and BACK for the very same arrangement (see Figure 1): Whereas translation implies a further-away object to be conceptualized as "in front of" the ground and a nearer object as "behind", reflection implies the nearer object as "in front" and the further-away object as "behind".

Whether these diverging assignments of FRONT and BACK lead to diverging evaluations is the question we sought to answer. We assumed that, regardless of FoR preference, speakers of widely different languages evaluate objects more positively when conceptualizing them as "in front of" another object than those conceptualized as "behind". Since the object conceptualized as "in front" depends on FoR preference, speakers with a preference for *translation* should evaluate the further-away object more positively, whereas speakers with a preference for *reflection* should evaluate the nearer object more positively.

Study 1

In view of the cross-linguistic distribution of the relative FoRs, as obtained from language elicitation tasks (Beller & Bender, 2017; Beller et al., 2015), we recruited native speakers of German in which reflection is prevalent, and of Chinese and Japanese in which translation is more frequent. Introducing a novel approach into this field of research, we use an *Implicit Association Test* (IAT; Greenwald, McGhee, & Schwartz, 1998) to assess the positive versus negative valence of objects that the participants conceptualized as being "in front of" versus "behind" another object, depending on their preferred FoR.

Method

Participants The sample consisted of 43 native speakers of German (28 female; mean age 23 years, range: 18-35), 40 native speakers of Chinese (27 female; mean age 27 years, range: 22-38), and 40 native speakers of Japanese (22 female; mean age 19 years, range: 18-34). The Chinese participants were born in China to monolingual parents, had been living in Germany for 2.8 years on average (SD = 1.9), and reported excellent proficiency in Chinese (M = 5.0, SD = 0.2) compared to moderate levels of German (M = 3.1, SD = 1.3) and English (M = 3.5, SD = 0.9) on 5-point-rating scales. Data collection took place in Germany (for German- and Chinese-speaking participants) and Japan (for Japanese-speaking participants), and was conducted in the participants' mother tongue by native speakers of German, Chinese, or Japanese, respectively, as experimenters. Participation was voluntary, and was rewarded either with course credit or with 2 Euros or 400 Yen, respectively.

Materials In the IATs, participants discriminated stimuli according to either valence or space. For the standard valence discrimination task, six positive nouns (*health, happiness, smile, joy, peace, friend*) and six negative nouns (*agony, suffering, stench, mishap, illness, war*) had to be categorized as positive or negative. For the spatial discrimination task, twelve schematic drawings of two neutral objects were used. The objects were arranged on the front/back axis and were distinguishable by shape and color (blue/green). Counterbalanced across participants, the objects of one color were singled out as those to be categorized as "in front of" or "behind" the objects of the other color. If, for instance, the target color was green,

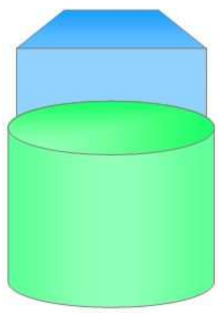

Figure 2:
Example of spatial stimuli used in Study 1

[1] Alternative terminologies are proposed, for instance, by Bohnemeyer and O'Meara (2012) and by Grabowski (1999).

Table 1: Task sequence and example of response key assignment.

Block	*N* of trials	Task	Example of response key assignment	
			D-key	L-key
1	26	Spatial discrimination	behind	in front
2	26	Valence discrimination	negative	positive
3	28	Initial combined task	behind/negative	in front/positive
4	52	Initial combined task	behind/negative	in front/positive
5	26	Reversed spatial discrimination	in front	behind
6	28	Reversed combined task	in front/negative	behind/positive
7	52	Reversed combined task	in front/negative	behind/positive

participants preferring translation (vs. reflection) would categorize the green cylinder in Figure 2 as "behind" (vs. "in front of") the blue cube.

Procedure The IATs were implemented as standard seven-block IATs (for details, see Table 1): Participants first completed two single-task practice blocks (one on spatial and one on valence discrimination). In Blocks 3 and 4, the two tasks were combined by mapping the four categories to two response keys (e.g., *in front*/*positive* on one key and *behind*/*negative* on the other). Block 5 was again a single-task block on spatial discrimination, but with the response key assignment reversed. In Blocks 6 and 7, this task was combined with the valence discrimination task of Block 2, thus mapping *behind*/*positive* on one key and *in front*/*negative* on the other.

The order of combined tasks was counterbalanced across participants (see Nosek, Greenwald, & Banaji, 2007). Stimuli were presented on a vertical computer screen, and responses were given by pressing the D- or L-key on the keyboard[2]. The intertrial interval was 500 ms. All blocks used warm-up trials with additional stimuli (excluded from the analyses), consisting of one trial per category that appeared within each block. Stimuli were presented randomly with the restriction that in the combined-task blocks, spatial and valence stimuli were presented in strictly alternating order.

The IAT effect is defined as the performance difference between the crucial blocks of combined tasks, and is interpreted as revealing the direction and strength of an association (here, between the space and valence categories). Typically, participants respond faster (and more accurately) when two associated categories share a response key than when they do not (Teige-Mocigemba, Klauer, & Sherman, 2010). Accordingly, if *in front* is evaluated more positively than *behind*, then responses should be faster in the *in front*/*positive—behind*/*negative* mapping than in the *in front*/*negative—behind*/*positive* mapping. If, by contrast, *in front* is perceived more negatively than *behind*, the response pattern should be reversed; and if no such link exists, response speed should not differ between mappings.

For all participants, IAT effects were coded such that positive values corresponded to the expected evaluation of *in front* as more positive than *behind*, independently of whether participants adopted translation or reflection to conceptualize where the target object is located. Assuming that all our participants evaluate objects more positively when conceptualizing them as "in front of" (than "behind") another object, we expected positive IAT effects. These effects may differ in size between samples, as there is no reason to assume that the space/valence associations should be of the exact same strength across cultures. What should differ significantly, subject to FoR preferences, is the object that is evaluated more positively: the further-away object under translation, and the nearer object under reflection.

Which of the two variants of the relative FoR a participant preferred was determined by assessing whether the figure presented in the IAT's practice block of the spatial discrimination task was categorized based on translation or reflection in the majority of trials. This assessment was necessary because adoption of a specific FoR is not determined by language, but based on a combination of (sub-)cultural conventions and individual preferences (Beller et al., 2015; Grabowski & Miller, 2000; Hill, 1982), and should therefore be gleaned from each participant's actual spatial discrimination decision.

Results and discussion

Using Tukey's (1977) criterion, we first examined whether any participant was an extreme outlier in terms of mean response latency in the combined tasks (i.e., with values three times the interquartile range below the first or above the third quartile). This led to the exclusion of two German participants, three Chinese participants, and five Japanese participants. Among the remaining participants, reflection was preferred by all 41 German participants (100%), by 28 Chinese participants (76%), and by 34 Japanese participants (97%), whereas translation was preferred by nine Chinese

[2] Keys were placed on the lateral instead of the sagittal axis to prevent confounding the very data we were interested in, namely on how FRONT and BACK are assigned along the sagittal axis.

Table 2: IAT effects in Study 1 and Study 2.

Study	Sample (*N*)	*M* (*SD*)	95% CI	*t*	*p*	Cohen's d_{D6}
Study 1	German (41)	231 (230)	[158, 303]	7.73	<.001	1.21
	Chinese (37)	146 (284)	[51, 241]	3.07	.004	0.50
	Japanese (35)	167 (207)	[105, 236]	5.48	<.001	0.93
Study 2	German (43)	292 (228)	[222, 362]	11.59	<.001	1.77
	Chinese (48)	153 (309)	[64, 243]	2.54	.015	0.37

participants (24%) and one Japanese participant (3%). Consistency in FoR adoption across the stimuli of the spatial discrimination task was high for all three samples and across FoR preferences, with $M > 94\%$ in each sub-group.

As recommended by Greenwald, Nosek, and Banaji (2003), IAT effects were calculated using the D6 scoring algorithm (used for inferential statistics only; for ease of interpretation, descriptive statistics are based on raw latencies). As expected, IAT effects were significant in all three samples of Study 1, $M \geq 146$ ms, $t \geq 3.07$, $p \leq .004$, indicating considerably faster responses to the *in front*/*positive*—*behind*/*negative* mapping than to the reversed mapping (Table 2).

Importantly, participants' evaluation of *in front* as more positive than *behind* was independent of their preferred variant of the relative FoR. Recall that nine of the 37 Chinese participants adopted translation. IAT effects for these participants were of the same size as those for participants preferring reflection, $t(35) = 1.06$, $p = .298$.

Participants thus evaluated *in front* more positively than *behind*—irrespective of their native language or cultural background. For the quarter of the Chinese participants preferring translation over reflection, the reversal of which object is conceptualized as "in front of" the other involved a corresponding reversal of evaluation of one and the same object: Further-away objects were more positive than nearer objects for participants preferring translation, but more negative for participants preferring reflection.

While the results of Study 1 are basically straightforward, the proportion of translational references among the Chinese- and Japanese-speaking participants was lower than anticipated. One reason could be that the nearer object partly occluded the further-away object, which may have highlighted the former at the cost of the latter (hence privileging reflection; cp. Bennardo, 2000; Grabowski, 1999; Hill, 1982). In addition, partially occluded objects may be devalued *a priori*. Since it was always the further-away object that was partially occluded, devaluation may have contributed to the more negative evaluation of this object by the majority of participants who preferred reflection and hence categorized the partially occluded further-away object as *behind*.

Study 2

To exclude partial occlusion as an alternative account, we repeated Study 1 with new spatial stimuli.

Method

Participants The new samples consisted of 50 native speakers each of German (35 female; mean age 22 years, *range*: 18-34) and Chinese (37 female; mean age 25 years, *range*: 18-33). Chinese participants were born in China to monolingual parents, had been living in Germany for 1.6 years on average ($SD = 1.4$), and reported excellent proficiency in Chinese ($M = 5.0$, $SD = 0.2$) compared to moderate levels of German ($M = 2.5$, $SD = 1.0$) and relatively good command of English ($M = 3.8$, $SD = 0.9$) on 5-point-rating scales. Data collection took place in Germany and was conducted in the participants' mother tongue.

Materials and Procedure For the spatial discrimination task, we now used photographs of real objects that were similar to the objects used in Study 1 both in shape and color, but differed in that no object was occluded (see Figure 3). In addition, an observer with the same looking

Figure 3:
Example of spatial stimuli used in Study 2

direction as that of the participant was inserted to emphasize perspective-taking. Apart from this, material and procedure were the same as in Study 1.

Results and discussion

The same exclusion criteria as in Study 1 led to the exclusion of seven German participants and two Chinese participants. Among the remaining participants, reflection was preferred by all 43 German participants (100%) and by 33 Chinese participants (69%), whereas translation was preferred by 15 Chinese participants (31%). Consistency in FoR adoption across stimuli was again high, with $M > 91\%$ in each sub-group.

IAT effects were computed as in Study 1 and were again significant in the two samples, $M \geq 153$ ms, $t \geq 2.54$, $p \leq .015$, indicating faster responses to the *in front*/*positive*—*behind*/*negative* mapping than to the reversed mapping (for details, see Table 2). Again, participants' evaluation of *in front* as more positive than *behind* was independent of their preferred FoR, as indicated by the non-significant difference between IAT effects for Chinese participants adopting translation versus reflection, $t(46) = 0.29$, $p = .773$.

As in Study 1, participants evaluated *in front* more positively than *behind*—irrespective of their native language or cultural background. And again, the reversal of which object is conceptualized as "in front of" the other involved a corresponding reversal of evaluation. Due to the modified stimuli used in this study, partial occlusion of the further-away object can be excluded as an explanation of its devaluation.

General Discussion

Does the way in which we evaluate objects depend also on how we *conceptualize* their location in space, rather than simply on where they *are* located? The work reported here suggests that this is indeed the case. Findings from two studies across three languages and cultural settings (with native speakers of German in Germany, of Chinese in Germany, and of Japanese in Japan) indicate that participants evaluate objects more positively when they conceptualize them as "in front of" another object than when they conceptualize them as "behind". Importantly, this positive evaluation holds for the further-away object when *translation* is adopted, yet for the nearer object when *reflection* is adopted.

The evidence is in line with the metaphor approach, according to which spatial concepts provide structure not only for more abstract domains, but also for evaluative judgments. While associations between space and valence have been described for the vertical axis (Keating, 1995; Meier & Robinson, 2004) and the lateral axis (Casasanto, 2009, 2011; de la Fuente et al., 2015), the present studies show these associations also for the sagittal axis. More concretely, they reveal that phrases such as "being at the forefront" versus "lagging behind" are not mere metaphorical expressions, but reflect a genuinely more positive evaluation of entities located "in front of" other entities. While the strength of this association differs somewhat across samples, with more pronounced effects for German participants than for the two East Asian groups (likely due to different strength of the association across cultures), its direction is the same in all three groups. This evidence is even more compelling in view of the fact that it was obtained with an *implicit* task specifically designed to tap into more automatic, rather than deliberate, processes.

Crucially, however, our findings also indicate that the association between location and valence is subject to linguistic and cultural conventions that affect how location is conceptualized—namely as *in front* or *behind*. Contingent on the adopted FoR, one and the same object in one and the same location may be evaluated as more positive or more negative: Under translation, the further-away object is regarded as the object *in front* and hence evaluated more positively, whereas under reflection, it is regarded as *behind* and hence evaluated more negatively.

In the current study, the proportion of translational references among the Chinese- (and Japanese-) speaking participants was lower than in previous surveys. While this lower proportion is disadvantageous for statistical power, it is not problematic per se, as such preferences are known to be subject to some variation depending on context (cf., Wilke, Bender, & Beller, 2019). A potentially more critical concern could be raised regarding the IAT itself. As this method assesses the link between relative location and valence by mapping category labels onto response keys, it might be suspected that participants could have used the category labels associated with the keys and their correspondence in polarity as a convenient short-cut (De Houwer, 2001; Proctor & Cho, 2006). However, the cognitive processing of stimuli required for the spatial task involved the computation of ternary relations between figure and ground from one's own viewpoint, which renders it unlikely that the observed effects were brought about by effects of labels or polarity only.

In conclusion, while previous work demonstrated that spatial representations have effects on cognitive processing (e.g., Bender & Beller, 2014; Haun, Rapold, Janzen, & Levinson, 2011; Levinson, Kita, Haun, & Rasch, 2002; Majid et al., 2004), here, we show that how we conceptualize the location of entities may even reverse the evaluation of these very entities. As conceptualizations of location are informed by diverging preferences for spatial FoRs across speech communities, their association with non-spatial conceptualizations and evaluations provides a promising new approach to explore effects of language and culture on cognition, which is a topic of key interest across several sub-disciplines of cognitive science. Opening up new avenues for investigation, implicit approaches like the one presented here could make it to the forefront in this contested field.

Acknowledgments

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