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Being *In Front* Is Good—But Where Is *In Front*? Preferences for Spatial Referencing Affect Evaluation

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Abstract

Speakers of English frequently associate location in space with valence, as in moving up and down the "social ladder." If such an association also holds for the sagittal axis, an object "in front of" another object would be evaluated more positively than the one "behind." Yet how people conceptualize relative locations depends on which frame of reference (FoR) they adopt—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? In two studies employing an implicit association test, we demonstrate, first, that speakers of German, Chinese, and Japanese indeed evaluate the object "in front of" another object more positively than the one "behind." Second, and crucially, the reversal of which object is conceptualized as "in front" involves a corresponding reversal of valence, suggesting an impact of linguistically imparted FoR preferences on evaluative processes.

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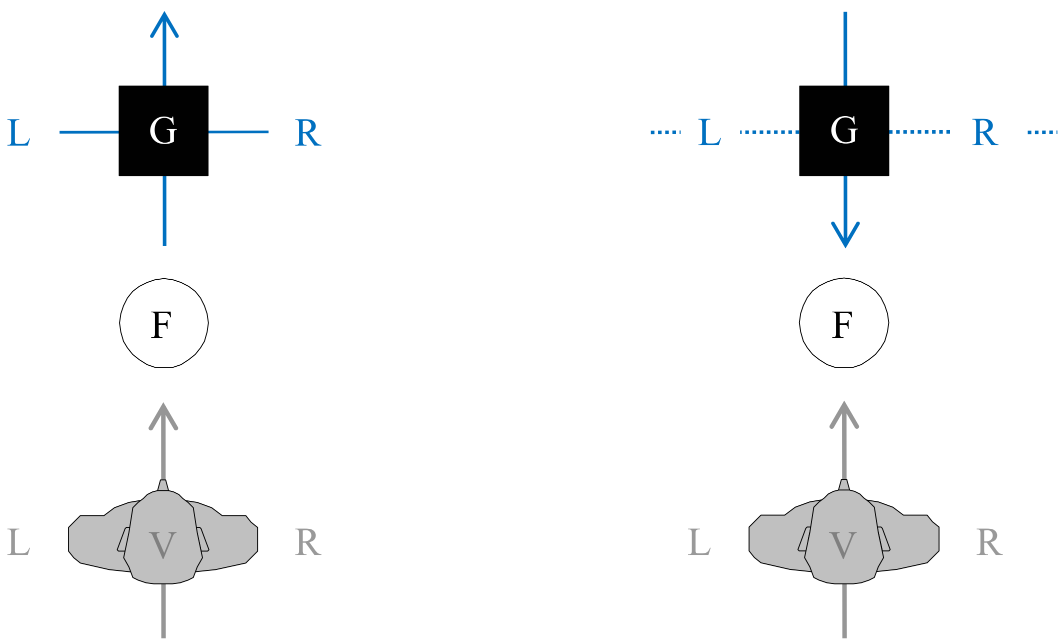
1. Introduction

Spatial representations are of fundamental importance for human cognition. They are crucial for orientation and navigation (e.g., Golledge, 1999; Hutchins, 1983), are considered part of children's "core knowledge" (Spelke & Kinzler, 2007), and affect how we conceptualize abstract domains such as time (Bender & Beller, 2014; Núñez & Cooperrider, 2013) or number (Dehaene, 2003; Walsh, 2003). Beyond these purely cognitive aspects, spatial representations also appear to 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 (Crawford, Margolies, Drake, & Murphy, 2006; Keating, 1995; Lakoff & Johnson, 1999; Meier & Robinson, 2004). Empirically attested associations include the vertical axis (reflected in the "social ladder") and the lateral axis ("getting it right" versus "having two left feet"), but expressions such as "making headway" and "standing in the forefront" versus "lagging behind" and "being backward" 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). Lateralization in terms of handedness even overrides strong cultural conventions (de la Fuente, Casasanto, Román, & Santiago, 2015), and it may serve as point of departure when taking another person's perspective (Kominsky & Casasanto, 2013). 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. In this instance, evaluations of objects are therefore directly dependent on location in space: If an object changes location, its evaluation changes. Now consider an instance, in which 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, which is the only axis along which conceptualization of location is affected in distinct ways by linguistic and cultural conventions (Beller, Singmann, Hüther, & Bender, 2015; Bennardo, 2000; Majid, Bowerman, Kita, Haun, & Levinson, 2004).

Indeed, what is assigned as FRONT or BACK along the sagittal axis depends on the frame of reference (FoR) one adopts. Spatial FoRs are cognitive tools used to construct an oriented space within which spatial relations among objects are identified, that is, they help to locate one object (the figure F) in reference to another object (the ground object G), as in "The ball is behind the box." All types of FoR have in common that they are coordinate systems consisting of intersecting axes (e.g., a vertical, sagittal, and lateral axis), but they differ with regard to where they are anchored and how they are oriented. Such FoRs have been extensively studied, and distinct theoretical traditions have created a plethora of labels for the different types of FoRs. The approach adopted here follows the terminology and categorizations described in Levinson (2003), which for cross-linguistic studies is the one most widely applied (e.g., Bennardo, 2002; Levinson, 2003; Majid et al., 2004; Pederson et al., 1998; Senft, 1997; alternative terminologies and categorizations are discussed in Levinson, 2003, p. 26; see also Bohnemeyer & O'Meara, 2012; Danziger, 2010; Grabowski, 1999; O'Meara & Pérez Báez, 2011; Talmy, 2000).

The relative FoR relevant for our study is anchored in an observer different from the ground object. Therefore, to locate the figure in reference to the ground, the observer's coordinate system originally anchored in the observer needs to be transferred to the ground (Fig. 1). Crucially, this can be done in different ways—inter alia 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: Whereas translation implies a further-away object to be conceptualized as "in front of" the ground and a



(A) Translation

The ball is *behind* the box.

(B) Reflection

The ball is *in front of* the box.

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

nearer object as "behind," reflection implies the nearer object as "in front" and the further-away object as "behind."

Crucially, both translation and reflection are equally valid perspectives on spatial constellations,[1] and it is basically a matter of convention, which variant (if any) is to be preferred for mutual understanding. A survey across seven languages revealed widely diverging preferences for adopting relative FoR variants (Beller & Bender, 2017; Beller et al., 2015). Reflection was adopted by most participants speaking German (*reflection*: 88.4%; *translation*: 5.8%) and by a majority of those speaking Norwegian (71.9% vs. 21.9%), US-English (71.2% vs. 22.7%), and Farsi (40.9 vs. 28.8%); translation was adopted by a majority of the participants speaking Chinese (*reflection*: 16.7%; *translation*: 38.9%), Japanese (36.7% vs. 48.6%), and Tongan (7.7% vs. 57.7%).[2] As can be seen from these data, there is some within-group variability, and apart from language, a few additional factors have been identified that appear to affect which variant gets chosen. For instance, while the likelihood of translation increases when motion is involved (Grabowski & Miller, 2000; Hill, 1978, 1982), the likelihood of reflection increases when the figure is occluded by the ground object (Bennardo, 2000; Hill, 1978), presumably based on more general anthropomorphological principles guiding people's referencing strategies (Grabowski, 1999).

According to these principles, the positive pole along the sagittal axis would be in the direction of sight; that is, locations conceived of as being "in front of" people would be evaluated as more positive than those "behind" them. As we have seen, with a relative FoR, FRONT/BACK relations are transferred into the ground object (Fig. 1), and this implies the possibility that (the location of) a figure F conceived of as being "in front of" the ground G would also be evaluated more positively than those "behind" the ground. In contrast to the former case (i.e., objects being "in front of" or "behind" the observer), which involves an *actual difference in location*, the latter case (the figure being "in front of" or "behind" the ground depending on the FoR variant) only involves a *difference in how this location is conceptualized*.

Whether these diverging assignments of FRONT and BACK lead to diverging evaluations is the question we sought to answer. As suggested by the metaphor approach, 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." Crucially, 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.

2. Study 1

To investigate the effect of FoR preferences on evaluation, we needed samples of participants that differed in their preference for either reflection or translation. In view of the cross-linguistic distribution of the relative FoRs as obtained from surveys using language elicitation tasks (Beller & Bender, 2017; Beller et al., 2015), we therefore recruited native speakers of German in which reflection is prevalent, and of Chinese and Japanese in which translation is more frequent. Using an *implicit association test* (IAT; Greenwald, McGhee, & Schwartz, 1998), we introduced a novel approach into this field of research to indirectly 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.

2.1. Methods

2.1.1. Participants

The samples consisted of 43 native speakers of German (28 females; M_{age} 23 years, range: 18–35), 40 native speakers of Chinese (27 females; M_{age} 27 years, range: 22–38), and 40 native speakers of Japanese (22 females; M_{age} 19 years, range: 18–34). Most participants were university students of various disciplines, ranging from bachelor to PhD level, and were recruited in their native languages via internet postings, flyers, and personal approach at university courses, international clubs, or other academic activities. Data collection took place in Germany (for German- and Chinese-speaking participants) and Japan (for Japanese-speaking participants), and it was conducted in the participants' mother tongue by native speakers of German, Chinese, or Japanese, respectively, as experimenters. Although Chinese participants were recruited in Germany, all participants were born in China, with both of their parents being native speakers of Chinese. On average, Chinese participants had been living in Germany for 2.82 years (SD = 1.88) and reported fluent proficiency in Chinese (M = 4.98, SD = 0.16) compared to rather moderate proficiency in German (M = 3.07, SD = 1.29) and English (M = 3.45, SD = 0.90) on 5-point rating scales ranging from 1 (*not at all*) to 5 (*fluent*). For all samples, participation was voluntary, and it was rewarded with course credit or with 2 Euros or 400 Yen, respectively.

2.1.2. Overall procedure

Upon arrival, participants were welcomed by a native speaker as experimenter and provided informed consent in their respective mother tongue. In individual sessions lasting for about 10 min, participants first completed the IAT before providing demographic data on age, gender, handedness, their major subject or profession, and, for Chinese participants, information on language skills as well as for how long they had been living in Germany.

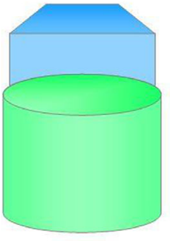
2.1.3. The implicit association test

To be able to assess participants' spontaneous preferences and to prevent a potential biasing, we chose the IAT as an implicit mean of assessment. The IAT presented participants with positive and negative nouns in a valence discrimination task and with pictures displaying a figure and a ground object in a spatial discrimination task. Nouns were to be categorized as being *positive* or *negative*, whereas pictures were to be categorized according to whether the figure object was *in front of* or *behind* the ground object. By leaving the latter decision to the participant, we were able to identify each participant's FoR (as explained below).

The crucial IAT blocks combined the spatial and the valence discrimination tasks by mapping the four categories (*positive/negative* and *in front of/behind*) to two response keys in one of two ways: by mapping *in front of* and *positive* on one key and *behind* and *negative* on the other, or by mapping *behind* and *positive* on one key and *in front of* and *negative* on the other. Research on the IAT consistently shows that participants respond faster and more accurately when the two categories that share a response key are overlapping than when they are not (Teige-Mocigemba, Klauer, & Sherman, 2010). Accordingly, if *in front* is evaluated more positively than *behind*, then responses should be faster and more accurate in the *in front of–positive/behind–negative* mapping than in the *in front of–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 between space and valence, response speed and accuracy should not differ between mappings.

The performance difference between the crucial IAT blocks is reflected in the so-called IAT effect, which is interpreted as revealing direction and size of the association strength between, in the present case, the space and valence categories. In the current study, 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 in all three languages. These effects may differ in size between the samples of different languages, as there is no reason to assume that the space/valence associations should be of the exact same strength across cultures. IAT effects should not differ in size, however, between participants adopting translation and participants adopting reflection (independent of the language) because positive IAT effects reflect the very preference for *in front of* as compared to *behind* that we expected for all participants. Note that such a finding would imply that, with different FoR preferences, different objects are evaluated more positively: the further-away object by participants adopting translation, and the nearer object by participants adopting reflection.

2.1.3.1. Materials: For the valence discrimination task, six positive nouns (health, happiness, smile, joy, peace, and friend) and six negative nouns (agony, suffering, stench, mishap, illness, and war) had to be categorized as positive or negative by pressing one of two response keys. For the spatial discrimination task, 12 schematic drawings of two neutral objects were used. The objects were arranged on the front/back axis and were distinguishable by shape (cylinder, reversed pyramid, cube, and ball) and color (blue/green). Counterbalanced across participants, the objects of one color were singled out as target objects that had to be categorized via pressing a key as "in front of" or "behind" the objects of the respective other color. If, for instance, the target color was green,



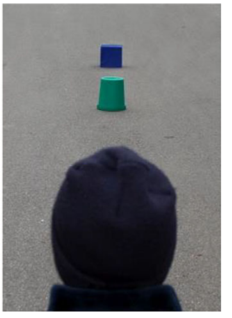


Fig. 2. Examples of spatial stimuli used in (a) Study 1 (left) and (b) Study 2 (right).

participants preferring translation (vs. reflection) would categorize the green cylinder in Fig. 2a as “behind” (vs. “in front of”) the blue cube.

2.1.3.2. IAT procedure: The IATs were implemented as standard seven-block IATs (for details, see Table 1 and Fig. 3): 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 of/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, the task of Block 5 was combined with the valence discrimination task of Block 2, thus mapping *behind/positive* on one key and *in front of/negative* on the other.

The order of combined tasks was counterbalanced across participants (see Nosek, Greenwald, & Banaji, 2007). Stimuli were presented in the center of a vertical computer screen against a white background with an inter-trial interval of 500 ms. In each block, response labels were presented for the two tasks at the top left and top right corner of the screen. Responses were given by pressing the D- or L-key on the keyboard with the left or right index finger. Ideally, the response keys at least for the spatial discrimination task would be along the same axis as the relative locations under scrutiny (Bender & Beller,

Table 1
Task sequence and example of response key assignment

Block	No. of Trials	Task	Example of Response Key Assignment	
			D-key	L-key
1	26	Spatial discrimination	behind	in front of
2	26	Valence discrimination	negative	positive
3	28	Initial combined task	behind/negative	in front of/positive
4	52	Initial combined task	behind/negative	in front of/positive
5	26	Reversed spatial discrimination	in front of	behind
6	28	Reversed combined task	in front of/negative	behind/positive
7	52	Reversed combined task	in front of/negative	behind/positive

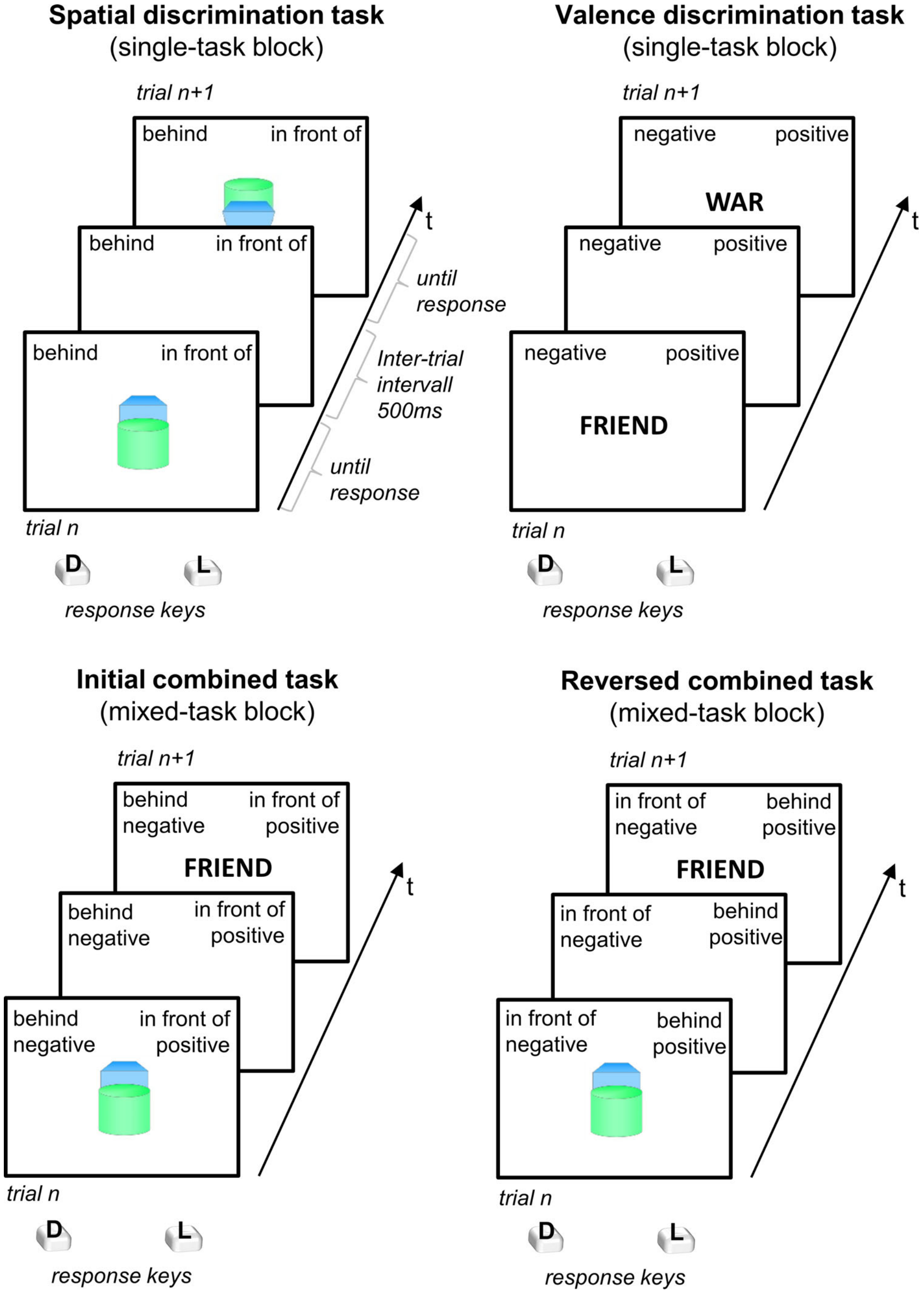


Fig. 3. Examples of trial sequences for the two discrimination tasks in single-task blocks and for the initial and the reversed combined tasks.

2014; Fuhrman et al., 2011). However, predefining a *further away* and a *nearer* key along the sagittal axis as “in front of” and “behind,” respectively, would compromise the very data we aim to collect, namely on how exactly participants assign FRONT and BACK along this axis. For this reason, we chose keys along the lateral axis, for which participants can be expected to be most familiar. Mapping of FRONT and BACK to the left and right key, respectively, switched between Blocks 1, 3, and 4 versus Blocks 5, 6, and 7.

All blocks used one trial per response category that appeared within each block as warm-up trials. Single-task blocks were thus preceded by two additional warm-up trials, and combined-task blocks were preceded by four additional warm-up trials. Warm-up trials used additional stimuli and were excluded from the analyses. Stimuli were presented randomly with the restriction that in the combined-task blocks (i.e., Blocks 3, 4, 6, and 7), spatial and valence stimuli were presented in strictly alternating order. Instructions were provided in the participant’s native language (i.e., German, Chinese, or Japanese).

2.1.4. Assessment of FoR preference

The data obtained from the spatial discrimination block (i.e., Block 1) in the IAT were used to determine a participant’s preference for one of the variants of the relative FoR. Specifically, if the participant responded “in front of” in more than 50% of the trials in which the target object was the *nearer* one, a preference for reflection was inferred. Conversely, if the participant responded “in front of” in more than 50% of the trials with the target object being the one *further away*, a preference for translation was inferred. The inferred preferences were then transferred to the analyses of the crucial combined task blocks (see below). Note that such an 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 it must therefore be gleaned from each participant’s actual spatial discrimination decision. Although individual preferences can change over time and depending on task and context, previous studies (Beller et al., 2015; Rothe-Wulf, Beller, & Bender, 2015) suggest that set effects are strong enough to keep FoR preferences stable throughout the continuous course of this experiment (an assumption bearing out, as reported below). As one consequence, participants did not receive error feedback during IAT trials for incorrect responses as is otherwise often done in IATs.

2.2. Results

Using Tukey’s (1977) criterion, we first examined whether any participant was an extreme outlier in terms of mean response latency or error rates[3] 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 with error rates above 24% (M = 6.57%, SD = 7.52), three Chinese participants with error rates above 34% (M = 7.76%, SD = 11.20), and five Japanese participants, four with error rates above 50% (M = 10.49%, SD = 15.02) and one with particularly slow response latencies of 1,281 ms (M = 726 ms, SD = 145). 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 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 subgroup.

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). To test whether speakers of each of the three languages evaluate objects *in front* more positively compared to *behind*, IAT effects were tested against zero in separate *t* tests for each language. As expected (and detailed in Table 2), 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 and more accurate responses to the *in front of/positive—behind/negative* mapping than to the reversed mapping.

Importantly, participants' better performance in the *in front of/positive—behind/negative* mapping as compared to the *behind/positive—in front of/negative* mapping 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, $t(35) = 1.06$, $p = .298$.

2.3. Discussion

Across the three languages, participants 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; cf. Bennardo, 2000; Grabowski, 1999). 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

Table 2
Implicit association test effects in the different samples of 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

by the majority of participants who preferred reflection and hence categorized the partially occluded further-away object as *behind*.

3. Study 2

To exclude partial occlusion as an alternative account, we repeated Study 1 with the same experimental setup and procedural details as in Study 1, yet with new spatial stimuli.

3.1. Methods

3.1.1. Participants

The new samples consisted of 50 native speakers each of German (35 females; M_{age} 22 years, range: 18–34) and Chinese (37 females; M_{age} 25 years, range: 18–33). All participants were university students of various disciplines, ranging from bachelor to PhD level; recruitment was identical as in Study 1. Data collection took place in Germany and was conducted in the participants' mother tongue by native speakers of German or Chinese, respectively, as experimenters. As in Study 1, all Chinese participants were born in China, with both of their parents being native speakers of Chinese. On average, they had been living in Germany for 1.63 years (SD = 1.42) and reported fluent proficiency in Chinese (M = 4.96, SD = 0.20) compared to rather moderate proficiency in German (M = 2.53, SD = 0.97) and good command of English (M = 3.76, SD = 0.86).

3.1.2. 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 Fig. 2b). In addition, an observer with the same looking direction as that of the participant was inserted to emphasize perspective-taking (cf. Beller, Bohlen, Hüther, & Bender, 2016; Beller et al., 2015). Apart from this, material and (overall) procedure were the same as in Study 1.

3.2. Results

The same criteria as in Study 1 led to the exclusion of seven German participants with error rates above 21% (M = 9.67%, SD = 13.30) and two Chinese participants with error rates above 33% (M = 7.58%, SD = 10.25). 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 subgroup.

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 and more accurate responses to the *in front of/positive—behind/negative* mapping than to the reversed mapping (for details, see Table 2).

Again, participants' better performance in the *in front of/positive—behind/negative* mapping as compared to the *behind/positive—in front of/negative* mapping was independent of their preferred FoR, as indicated by the non-significant difference between IAT effects for Chinese participants adopting translation versus reflection, $t(46) = 0.29$, $p = .773$.

3.3. Discussion

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.

4. 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 farther-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 demonstrated for the vertical axis (Keating, 1995; Lakoff & Johnson, 1999; Meier & Robinson, 2004; Schubert, 2005) and the lateral axis (Casasanto, 2009, 2011; de la Fuente et al., 2015), the present studies demonstrate these associations also for the sagittal axis. More concretely, they reveal that phrases such as "making headway" and "standing in the forefront" versus "lagging behind" and "being backward" are not mere metaphorical expressions, but reflect a genuinely more positive evaluation of entities located "in front of" other entities. These associations are likely grounded in real-world experiences (e.g., being in front confers clear advantages when queuing for limited goods, for obtaining an undisturbed view, or in sports). The strength of this association differs somewhat across samples, with more pronounced effects for German participants than for the two East Asian groups, perhaps due to differences in how much emphasis is placed on competition and excellence. Its direction, however, 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 remainder of this section, we discuss possible limitations of the current study and we address a conceptual question that has remained open.

4.1. *Possible limitations of the current study*

The extent to which the findings from the current study can be generalized may be limited by characteristics of the samples investigated and by methodological decisions.

4.1.1. *Sample characteristics: Distribution of FoR variants*

With regard to samples, the distribution of relative FoR variants may be an issue. Specifically, the proportion of translational references among the Chinese- (and Japanese-) speaking participants was lower here (24% in Study 1 and 31% in Study 2 for Chinese) than in the surveys on which our sampling was based (39%).

This lower proportion may have been disadvantageous for the statistical power in our analyses as it rendered a substantially smaller number of participants ending up in one condition compared to the other. However, such variation in proportions across studies and procedures can be expected as people's FoR selections also depend on demand characteristics of task and situation (see also Wilke, Bender, & Beller, 2019) and are not assumed to be entirely stable across samples of one population. One question to be tackled in future studies is therefore whether the characteristics of a setting (such as assessing a spatial constellation on an upright computer screen) or details of the participants' background (such as dialect or move to a foreign country) affect their preferences for a specific FoR. At least for the Chinese-speaking participants in the current study, it is possible that their preferences were affected by the German-speaking environment in which they currently live and in which they were tested.

To reduce potential influences of linguistic environment, the experiment was set up in the participant's mother tongue (including the instructions), and it was conducted by experimenters who were native speakers of the participant's mother tongue (cf. Fuhrman et al., 2011; Lai & Boroditsky, 2013). Even more importantly, though, the lower proportion of translation in the Chinese sample does not impair the theoretical inferences that the current study aimed to test: Translation and reflection are still linked to diverging conceptualizations of relative location (of the further-away vs. nearer object as being "in front"), with positive evaluations of whatever is construed as being "in front."

4.1.2. *Methodological decisions*

As explained earlier, we had to choose an axis for recording participants' responses that was different from the axis under scrutiny (i.e., participants used keys along the lateral axis to indicate relative position along the sagittal axis).

Previous work especially on the spatialization of time has emphasized that using congruent axes may be decisive for data interpretation (overview in Bender & Beller, 2014). For instance, to investigate whether temporal representations unfold along the sagittal, lateral, or vertical axis, it is crucial to provide participants with a sagittal, lateral, and vertical axis (Fuhrman et al., 2011) or, even better, use an entirely open design (Fuhrman & Boroditsky, 2010). Yet, while such designs are mandatory for exploring the dimensions onto which time is mapped, they are less important when the dimension is fixed and the task boils down to determining its direction (by assigning FRONT and BACK, respectively). Not only do participants tend to be flexible in the dimensions they recruit (Torralbo, Santiago, & Lupiáñez, 2006), but they are also able to reorient relatively quickly when invited or demanded by a task (e.g., Casasanto & Bottini, 2010). Against this background, we are convinced that the practice blocks in the current study were sufficient to establish the required association of the response keys with the assessment of relative positions.

A related concern may be addressed at the fact that the response keys along the lateral axis may be aligned with writing direction for some, but not all participants. Specifically, Mandarin and Japanese speakers could be assumed to be more exposed to writing directions from top to bottom. This traditional writing direction, however, is increasingly giving way to a "western-style," left-to-right direction in both Japanese and Chinese (Taylor & Taylor, 2014), and it can be assumed that especially the younger generation from which our student samples were drawn would be highly familiar with such a left-to-right writing direction. More importantly, while writing direction seems to inform to a significant extent the direction in which time is conceptualized to flow (Bergen & Chan Lau, 2012; Tversky, Kugelmass, & Winter, 1991), it is not obvious whether and how writing direction would impact on evaluation.

Matters are more serious when it comes to handedness. As mentioned in the introduction, people tend to evaluate objects on their dominant side as more positive than objects on their non-dominant side (Casasanto, 2009, 2011). However, this association of handedness with evaluation can be adjusted in perspective-taking (Kominsky & Casasanto, 2013) and even reversed by training (Casasanto & Chrysikou, 2011). As the vast majority of our participants was right-handed (93% in Study 1 and 91% in Study 2), we mapped POSITIVE to the right and NEGATIVE to the left key to accommodate participants' natural preferences, thereby forcing the 8% of left-handers in our study to conceptually re-map positive valence with the non-dominant side (due to the logic of the IAT, this mapping cannot be counterbalanced). If the enforced re-mapping in left-handers affected their performance, it would have reduced the effect size, hence contributing to a more conservative outcome. Possibly confounding effects of the mismatch in axes can therefore be neglected.

Finally, potentially critical concerns could also be raised regarding the IAT itself. As this method employs binary classification tasks to assess 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 or their correspondence in polarity as a convenient short-cut (De Houwer, 2001; Proctor & Cho, 2006). Yet several arguments speak against such an interpretation. First, 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. Second, for an effect of polarity correspondence to occur, response options for each of the involved dimensions would have to be aligned purely on the grounds of representing the unmarked versus marked endpoints of their respective dimension (Proctor & Cho, 2006). This, however, presupposes that the label for one endpoint (the unmarked pole) is broader than the other in that it encompasses the entire dimension, while the other (the marked pole) only refers to its end of the dimension. For instance, "high" (or "happy") as the unmarked pole can refer to any point along the "height" (or "happiness") dimension, whereas "low" (or "sad") refers only to its negative end. The dimension unfolding along the sagittal axis, however, is not verbalized (to the best of our knowledge, there is no such word as "frontness") and hence lacks the marked and unmarked poles that would be a prerequisite for any structural mapping to occur (see also Santiago & Lakens, 2015, for evidence against polarity correspondence effects on the lateral axis in the domains of number and time). Most importantly, however, the topic of our study is the reversal of the association depending on a preference for reflection versus translation, rather than the nature of the association itself.

4.2. Open questions

Previous work demonstrated that how we conceptualize the location of an entity has effects on cognitive representations, inferences, co-speech gesture, memory, and even more basic cognitive processes (Bender & Beller, 2014; Haun, Rapold, Janzen, & Levinson, 2011; Levinson, Kita, Haun, & Rasch, 2002; Majid et al., 2004). For instance, judgments of location are typically faster for an object that is nearer to a participant than for a further-away object. This pattern switches when the participant takes the opposite perspective, causing a remapping of spatial relations that leads to faster responses to the object that is further away for the participant, but nearer for the other person (Cavallo, Ansuini, Capozzi, Tversky, & Becchio, 2017). While this study suggests that the conceptualization of *far* and *near* may shift due to perspective-taking, with consequences for the speed of processing, our study suggests that—even if *far* and *near* remain the same—conceptualizing them as *in front* or *behind* in distinct ways affects evaluation. Whether these differences in conceptualization entail differences also with regard to other cognitive processes is an important question for future research.

Throughout this article, we have argued that relative position in space is linked with valence, and we have interpreted respective findings as a more positive evaluation of the object depending on whether it is conceptualized as being located "in front of" or "behind" the ground object. As one of the reviewers for this paper noted, it remains unclear, though, whether it is really the object itself or its location that is evaluated as more positive or negative. This question is difficult to answer, as the two aspects cannot be disentangled easily. In fact, for the purpose of the task at hand, object and location define each other to some extent. Responses to a task like "Is the green object in front of/behind the blue object" determine a specific location for a specific object. Moreover, neither the objects nor their relative positions differ for participants; what differs is the *conceptualization* of the same location of the same object depending on the adopted FoR, that is, on perspective. For this very reason, we maintain, it is not decisive whether location or object attracts a greater share of the evaluation. In either case, evaluation would hinge on the adopted FoR, which establishes an impact of linguistic conventions on representation and evaluation.

Finally, our findings also have broader theoretical implications. If, as our data suggest, space–valence associations are indeed not exclusively determined by embodied experiences, but also—and prominently so—by how spatial relations are represented, then the diversity in those representations across cultural and linguistic groups opens up for greater variability. FRONT, BACK, LEFT, and RIGHT are locative concepts implicated in the intrinsic and relative FoRs, but absent from the gamut of absolute FoRs (Levinson, 2003). Given that some languages exclusively make use of one of the latter (Majid et al., 2004), would their speakers still form associations between spatial position and valence, and if so, which ones would they prioritize? Would they still judge things at their dominant side as more positive than those on their non-dominant side, and a position at the forefront, however conceptualized, as more positive than one at the back? We know that absolute locations can have particular value (e.g., Bennardo, 2002; Núñez, Cooperrider, Doan, & Wassmann, 2012; Núñez & Cornejo, 2012), so perhaps people with a preference for an absolute FoR form similar associations, but in structurally distinct ways. It would be interesting to examine whether these associations would still be strong enough to bear on processing fluency and speed.

4.3. Conclusion

While previous work demonstrated that spatial representations have effects on cognitive processing, here we show that how we conceptualize the location of entities may even reverse the evaluation of these very entities (and/or their location). As diverging 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, thereby opening up new avenues for investigation in this contested field. Given how fundamental spatial representations are for human cognition, making headway in this regard would be a valuable step.

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Authors' contributions

AB and SB developed the study concept; ARW and STM contributed to its final design. All authors discussed the development of the material; STM implemented the IAT. ARW and STM organized data collection in Germany, and MS collected the Japanese data. STM conducted the data analyses. AB prepared a first draft of the manuscript; the other authors amended parts and provided critical revisions, and all authors approved the final version.

Notes

1. A different way of putting this would be to treat the ground object as if it were a second person. In the reflection variant, also referred to as "canonical encounter," "vis-à-vis," or "mirror image" in other research traditions, this fictive person is facing the observer, while in the translation variant it is looking in the same direction as the observer, hence also being labeled "aligned" or "in-tandem" (e.g., Clark, 1973; Grabowski, 1999; Hill, 1978, 1982). But note that this perspective fully accounts only for translation, not for reflection. Canonical encounter, like reflection, leads to FRONT assignment to the space between the observer and the ground; it cannot, however, account for the fact that LEFT and RIGHT remain unchanged.
2. The values represent the percentages of participants who preferred the respective FoR variant, that is, who adopted this variant in at least four out of a set of six non-oriented, frontal items. The values for German, English, Chinese, and Tongan are taken from Beller et al. (2015, table 5, p. 12), those for Norwegian, Farsi, and Japanese from Beller and Bender (2017, table 3, p. 120); values for German in Beller and Bender (2017) are comparable (*reflection*: 88.6%). The values do not necessarily add up to 100% as a few participants preferred a third variant, and the remaining participants exhibited no clear preference for any of the FoR variants.
3. Responses categorized as incorrect included assigning positive [negative] stimuli in the valence discrimination task to the negative [positive] key and assigning the nearer [further-away] target in the spatial discrimination task at odds with the participant's inferred preference for translation or reflection.

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