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Hand Position and Response Assignment Modulate the Activation of the Valence-Space Conceptual Metaphor

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Abstract

Conceptual metaphor is ubiquitous in language and thought, as we usually reason and talk about abstract concepts in terms of more concrete ones via metaphorical mappings that are hypothesized to arise from our embodied experience. One pervasive example is the conceptual projection of valence onto space, which flexibly recruits the vertical and lateral spatial frames to gain structure (e.g., GOOD IS UP-BAD IS DOWN and GOOD IS RIGHT-BAD IS LEFT). In the current study, we used a valence judgment task to explore the role that exogenous bodily cues (namely response hand positions) play in the allocation of spatial attention and the modulation of conceptual congruency effects. Experiment 1 showed that congruency effects along the vertical axis are weakened when task conditions (i.e., the use of vertical visual cues, on the one hand, and the horizontal alignment of responses, on the other) draw attention to both the vertical and lateral axes making them simultaneously salient. Experiment 2 evidenced that the vertical alignment of participants' hands while responding to the task—regardless of the location of their dominant hand—facilitates the judgment of positive and negative-valence words, as long as participants respond in a metaphor–congruent manner (i.e., up responses are good and down responses are bad). Overall, these results support the claim that source domain representations are dynamically activated in response to the context and that bodily states are an integral part of that context.

Keywords: Conceptual metaphor; Embodiment; Valence space

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1. Introduction

The advent of cognitive metaphor theory in the early 1980s shifted the locus of metaphor from language to thought and posited the claim that abstract concepts are metaphorically grounded in our embodied experience (Lakoff & Johnson, 1980). In this view, metaphor is not primarily considered as an ornamental rhetorical device; rather, it is conceived of as a cognitive operation whereby abstract conceptual domains are mapped onto usually more concrete domains, which inferentially lend them structure and scaffold abstract thinking and reasoning (Lakoff, 2014). Thus, for example, the mental representation of notions such as "good" and "bad" is argued to rely on valence-space projections that flexibly recruit both the vertical and lateral spatial dimensions and translate into the GOOD IS UP—BAD IS DOWN (Lakoff & Johnson, 1999) and GOOD IS RIGHT—BAD IS LEFT (Casasanto, 2009) conceptual metaphors, respectively. These metaphors coexist in the usage of speakers as reflected by expressions that, in many languages, connect positive and negative affective valence with the top and bottom of vertical space, on the one hand, and with the horizontal right-left dimension, on the other. In Catalan, for example, those mappings are found in sentences such as (a) *L'empresa ofereix serveis de baixa qualitat* "The company provides low-quality services"; (b) *És una professional d'alt nivell* "She is a top professional"; (c) *Llevar-se amb el peu esquerre* "Get up on the wrong side of the bed"—where *peu esquerre* means left foot; or (d) *Ésser la mà dreta d'algú* "Being someone's right hand," just to mention a few.

Beyond language, the psychological reality of the association between affective valence and vertical space has been corroborated by a large body of research (Marmolejo-Ramos et al., 2014; Meier & Robinson, 2004; Santiago, Ouellet, Román, & Valenzuela, 2012). Conceptual congruency tasks, for example, have shown that vertical space affects valence judgments either by influencing the speed and accuracy of participants' responses or by biasing judgments in a particular direction. Thus, for instance, Meier and Robinson (2004) found that people are faster to judge a word positively or negatively when it is presented in a location that is congruent with the conceptual metaphor GOOD IS UP and BAD IS DOWN, relative to when the word is presented in an incongruent location.

Likewise, the metaphorical mapping of valence onto the horizontal dimension of space has also been verified experimentally. Available evidence indicates that positive valence is associated with the side of space on which subjects act more fluently because of the specificities of their bodies, whereas negative valence is mapped onto the opposite side. This leads to associations that are body-specific and vary between left and right-handers (Casasanto & Chrysikou, 2011; de la Vega, de Filippis, Lachmair, Dudschig, & Kaup, 2012; de la Vega, Dudschig, De Filippis, Lachmair, & Kaup, 2013).

Evidence suggests, therefore, that the conceptual projection of valence onto space is fairly flexible participating in at least two spatial mappings—there also exists empirical support for a third valence-space interaction, POSITIVE IS CLOSE—NEGATIVE IS FAR (Centerbar & Clore, 2006; Chen & Bargh, 1999). This situation is not exceptional; in fact, many other abstract domains (e.g., time, magnitude or power) similarly resort to several source domains or spatial configurations to be structured. In English, for instance, TIME is MOTION and also MONEY, as illustrated by expressions such as *Holydays are coming* or *Long hours have been invested in this project*. In the case of magnitudes, vertical, horizontal, and radial spatial-numerical associations have been reported in magnitude judgments and random number generation tasks (Winter & Matlock, 2017). In language, examples such as *Prices are rising* or *This is a huge sum* also evidence the alignment of quantity and vertical space (MORE IS UP), on the one hand, and quantity and size (MORE IS BIGGER), on the other. Finally, the metaphors CONTROL IS UP and POWER IS BIG, attested in expressions such as *She occupies a high position in the company* and *He is a big fish* as well as in power judgment tasks, also reflect flexibility in the metaphorical conceptualization of power (for a detailed review of the flexible conceptual projection of abstract concepts onto more concrete domains see Borghi et al., 2017; Santiago, Román, & Ouellet, 2011; Winter et al., 2015).

The source of such metaphorical diversity has been attributed to the multifaceted origin of metaphors, which can be traced back to our bodily, cultural, and linguistic experience (Casasanto, 2014, 2017; Kövecses, 2005). The conceptualization of time as motion along the front-back axis, for example, appears to be partially grounded in our embodied experience of motion (Lakoff & Johnson, 1980), a space-time correlation that is simultaneously strengthened by the use of corresponding linguistic expressions (see the examples above). The spatialization of time along the lateral axis (past-left/future-right vs. future-left/past-right), however, is more consistent with culture-specific time-space mappings derived from reading and writing conventions, among other cultural artifacts such as calendars (Casasanto & Bottini, 2014; Duffy, 2014; Fuhrman & Boroditsky, 2010; Ouellet et al., 2010). Finally, the TIME IS MONEY metaphor seems to respond to our cultural experience of a wage-based economy (Ritchie, 2006).

In the case of the valence-space metaphors, the conceptual projection of valence onto vertical space appears to reflect the influence of bodily experience (e.g., the experiential correlation between an upright or slumped posture and positive and negative emotional states, respectively); language (*I'm feeling up*); and cultural conventions like the prototypical arrangement of rank orders or the use of thumbs-up/thumbs-down gestures to express a positive or negative response to a stimulus, among others (Casasanto, 2014; Lakoff & Johnson, 1999; Winter & Matlock, 2017). On the other hand, valence preference for one side in space (left or right) is attributed to our manual motor fluency. Idioms (see examples above) and culturally based customs like raising our right hand when taking an oath also help to maintain and reinforce the GOOD IS RIGHT and BAD IS LEFT mappings, not only among those whose dominant side is their right side but also among left-handers (Casasanto, 2017; Casasanto & Bottini, 2014).

This situation evidences that multiple ways of conceptualizing the very same notion coexist in our conceptual system, which in turn begets the question what determines the preference for a particular metaphorical conceptualization over the others when several competing metaphors are available. Recent research has suggested that both metaphor selection and congruency effects are mediated by attentional dynamics and the overall coherence of the contents integrated in the working memory representation set up to perform a task (Santiago et al., 2011, 2012). Thus, from this point of view, conceptual mappings and congruity effects rely dynamically on context and can be modulated by manipulating the activation of the conceptual dimensions that interact in a task, which can be achieved by orienting attention endogenously and exogenously (see e.g., Brookshire, Ivry, & Casasanto, 2010; Lebois, Wilson-Mendenhall, & Barsalou, 2014; Santiago et al., 2012; Torralbo, Santiago, & Lupiáñez, 2006). In this respect, previous research has shown that bodily manipulation is an effective modulator of spatial attention, able to guide attention allocation in higher-order spatial representations like the mental number line (Hartmann, Grabherr, & Mast, 2012). In domains such as time, power, politics, and valence, a number of studies have also proved that the adoption of specific body postures (Dijkstra, Eerland, Zijlmans, & Post, 2012; Eerland, Guadalupe, Franken, & Zwaan, 2012; Oppenheimer & Trail, 2010; Riskind, 1983), or the execution of metaphorically congruent motor actions (Casasanto & Dijkstra, 2010; Dehaene, Bossini, & Giraux, 1993), facilitates the activation of specific orientational metaphors and affects task performance. In the particular case of valence, the retrieval of positive and negative biographical memories has been shown to be modulated by the direction of participants' arm movements (Casasanto & Dijkstra, 2010) as well as by the manipulation of their facial expressions or body posture—upright versus slumped position—(Riskind, 1983; Wilson & Peper, 2004).

Likewise, there is also evidence that the spatial frame of reference that subjects adopt to perform a task is also partially shaped by cultural conventions relative to the customary way we interact with objects—for example, the prototypical way a computer monitor is viewed—(Crawford, 2009). Our knowledge and representation of objects include not only visual and functional information but also information about the conventional way we use them (Casasanto, 2017). This aspect of objects' representation is thought to be activated, at a minimum, when it is task-relevant contributing to set the spatial frame of reference that defines spatial locations. Together, these studies support the claim that incidental physical aspects like participants' spatial location, bodily states, and actions are an integral part of the local context in which people construct meaning (Casasanto & Lupyan, 2015) and can act as attention grabbers.

Recent research has shown that language processing relies on both perceptual simulation and language statistical processes variably depending on the cognitive task that is being performed, the type of stimulus being used, and the time course of processing, among other factors (Louwerse, Hutchinson, Tillman, & Recchia, 2015). It has been proposed that the processing advantage seen in judgment tasks with words as items to be valuated might reflect the effect of statistical linguistic frequencies on response times rather than perceptual simulation. According to the Symbol Interdependency Hypothesis (Louwerse, 2007), language encodes perceptual information and it is used by language comprehenders when fast but adequate representations are formed. When fully accurate representations are created, comprehenders would rely on—and benefit from—perceptual simulation processes.

Given this state of affairs, the aim of the present study is to ascertain whether, all other variables held constant, contextual bodily cues, namely participants' hand position while interacting with the response pad, are able to modulate the conceptual projection of valence onto space, as reflected by conceptual congruency effects. In Experiment 1, using an experimental paradigm similar to that by Meier and Robinson (2004, experiment 1), we tested whether the introduction of a slight change in the experimental setup intended to induce the simultaneous activation of both vertical and horizontal space in working memory caused disruption in the spacialization of valence along the vertical axis. In Experiment 2, we explored to what extent a subtle bodily manipulation aimed to raise the salience of vertical space while reducing to a minimum the attention drawn to the horizontal axis was able to avoid inconsistencies in the activation of spatial information during task performance and bring about significant congruency effects along the vertical axis. Since coherence criteria crucially constrain the working memory representations set up for task performance, we posited that the vertical alignment of both stimulus presentation and hand position (this time participants held the response pad vertically) would reduce the presence of incoherent content in working memory, which should facilitate the construction of a maximally coherent mental model and strengthen vertical congruency effects.

2. Experiment 1

Experiment 1 was based on a conceptual-congruency task similar to that by Meier and Robinson (2004, experiment 1) except for the fact that in the current experiment participants were instructed to hold the response pad slightly below their eye level and make valence judgments by pressing a left or right key. This response arrangement should minimize participants' up-down eye movements when programming responses and increase the activation of the horizontal axis that manual response has been found to induce (Santiago et al., 2012; Torralbo et al., 2006). We hypothesized that the increased salience of the lateral dimension would allow the simultaneous activation of both vertical and horizontal space, which might result in two scenarios: (a) the activation of the horizontal axis that manual response intended to trigger could interfere with the vertical spatialization of valence, reducing or eliminating the RT advantage that positive and negative word show when presented in locations metaphorically congruent with the GOOD IS UP and BAD IS DOWN conceptual metaphor and (b) given the fact that the vertical axis has greater intrinsic salience (Franklin & Tversky, 1990; Rock, 1973) and that in the current experiment its activation was further enhanced by means of visual cues, the attention drawn to the horizontal axis could be insufficient to disrupt or prevent vertical congruency effects.

2.1. Material and methods

2.1.1. Participants

Forty undergraduate students from the Faculty of Psychology at the University of Barcelona participated in the experiment for course credits. All of them were native or near native Catalan speakers and right handed. Two participants were excluded from analysis because they reported low proficiency in Catalan. These participants stated that their mother tongue was Spanish, that they had learned Catalan at the age of 18 and 12, respectively and that they only spoke Catalan occasionally. Thus the final sample was reduced to 38 participants (28 women, M_{age} 20.3 ± 3.3).

2.1.2. Stimuli

A total of 120 adjectives selected from a frequency dictionary of Catalan (Rafael-i-Fontanals, 1996) were used (see Appendix B). Half of them were positive adjectives and the rest were negative. Stimuli were matched for frequency (medium- to high-frequency range) and word length (ranging from 4 to 9 letters; *M*: 6.5 letters) across conditions and their valence was validated by means of a norming task.

2.1.3. Procedure

Participants first completed the Edinburgh handedness inventory test (EHI) (Oldfield, 1971) and answered a brief language questionnaire. Then, they were asked to judge the valence of the word targets as quickly as possible. The experiment was programmed using e-prime 2.0 (Schneider, Eschman, & Zuccolotto, 2001) and was structured as follows: each trial began with the presentation of a white fixation cross (+) at the center of a black screen followed by two other consecutive strings of crosses [(++) and (+++)], which appeared 1.6 cm and 3.2 cm either below or above the fixation point. Each cue was flashed for 300 ms with a fixed inter-stimulus interval (ISI) of 0 ms and immediately after the last cue was presented a word was displayed on the screen 1.6 cm below (for downwards cues) or above (for upwards cues) the last cue. It remained on the screen until participants responded. The monitor was then cleared and 500 ms later the next trial began. All stimuli were presented in white, Courier New font, size 18 (visual angle ~3.2°), on a black background and repeated twice throughout the experiment, once at the top of the display and once at the bottom. Their presentation was randomized. Participants were seated 65 cm from the screen with their eyes aligned to the center of the screen and their elbows resting on the table, so that their forearms formed an angle of about 45° with the surface of the table. They held the response pad horizontally placing their left and right thumbs on the left and right buttons, respectively (see Fig. 1). The assignment of the response buttons (right/left—positive/negative) was counterbalanced across participants.

The experiment began with a 40-trial training block with equal proportion of positive and negative words. These stimuli were different from those used in the main experiment.

2.1.4. Data analysis

After removing incorrect responses (3.66% of the trails), reaction times were log-transformed and fitted to a linear mixed effects model using the R-package lme4 (Bates et al., 2015). The variables valence (positive vs. negative), stimulus position (top vs. down) and response assignment (right-positive/left-negative vs. right-negative/left positive) were entered in the model as fixed effects, whereas the intercepts for subjects and items were entered as random effects. The overall fit of each effect was assessed using p-values obtained by likelihood ratio test of the model with the effect against the same model

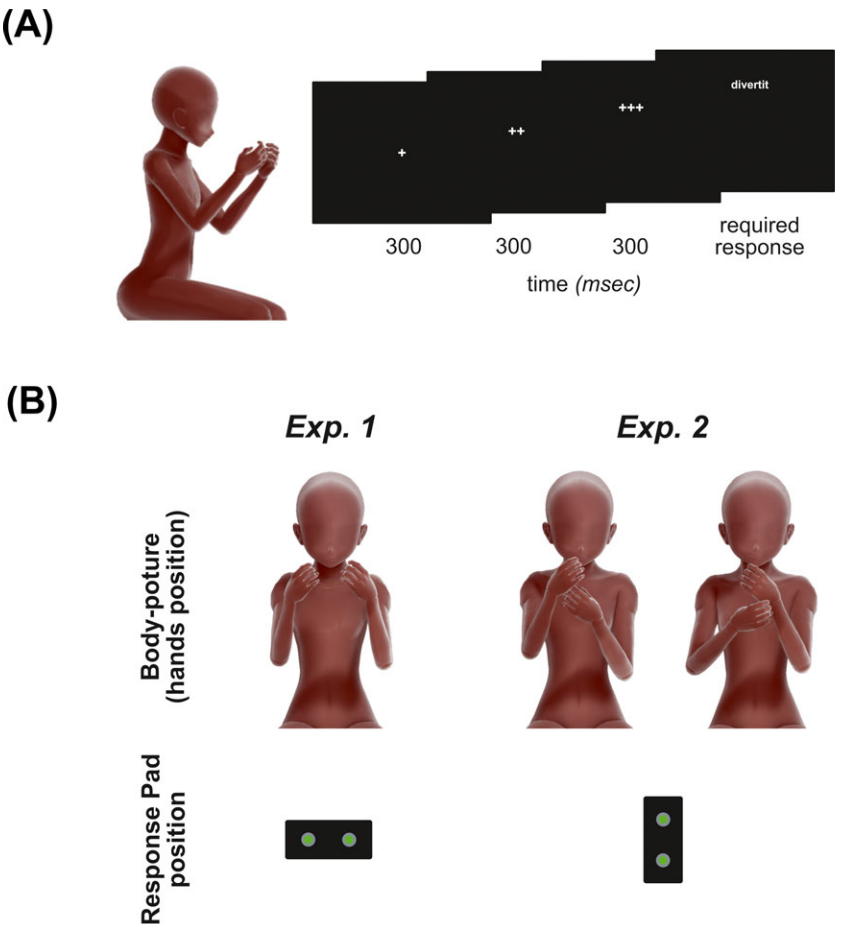

Fig. 1. Schematic diagram of the experimental procedure and participants' hand position in all three experiments. (A) Example of one full trial with the target presented at the top of the screen. The trial began with the presentation of a fixation cross at the center of the screen followed by two other consecutive cues. Each cue was flashed for 300 ms and immediately after the last one the target word was displayed. (B) Illustration of the experimental set-up for Experiments 1 and 2. The upper part of the figure shows participant's hand position, whereas the lower part illustrates the way participants held the response pad in each experiment.

without the effect. The simplest model included valence as a fixed effect and by-subjects and by-items random intercepts. The interaction between fixed effects was analyzed by successively adding each interaction term to the model and comparing it with a model without the interaction and the same random effects structure. Furthermore, a repeated measure analysis of variance (ANOVA), treating participants (F_1) or items (F_2) as random factors, was also performed on the log transformed latencies (Ratcliff, 1993) in a $2 \times 2 \times 2$ design. This complementary set of analyses can be found as supplementary material.

2.2. Results

A summary of the results can be seen in Table 1 and Fig. 2. RTs were shorter for positive (708 ms) than for negative words (741 ms) (see Table 1 and Fig. 2). As predicted by conceptual metaphor, word valence evaluation was faster in the spatial positions which were congruent with the metaphor (positive words, top: 707 ms; bottom: 710/negative words, top: 747 ms; bottom: 734 ms), although RT differences between spatial locations were more marked for negative words.

Convergence was reached in all the models that were constructed. The estimates of the full model are reported in Table 2. The comparison of a model with *valence* as the only fixed effect factor with another model in which both *valence* and *stimuli position* were treated as fixed factors did not yield significant differences ($\chi^2(1) = 1.7520$; $p = 0.18562$). However, a significant improvement of the model fit was observed when the interaction between these two fixed factors was incorporated into the model ($\chi^2(2) = 6.0538$; $p = 0.04847$).

To examine the relevance of the third fixed factor, *Response Assignment*, to our results, a new analysis was conducted. In this case, a model including *valence*, *stimulus position*, and *response assignment* together with their interaction was compared with a simpler model in which only *valence*, *stimuli position*, and their interaction were considered. The comparison of these two models revealed that *Response Assignment* improved the model fit ($\chi^2(8) = 14.577$; $p = 0.005665$). Thus, to further explore the relevance of *Response Assignment* to the model fit, we also compared a model with valence as the only fixed-effect factor with another model in which valence, response assignment, and the interaction between these two factors were incorporated. This analysis confirmed the importance of response assignment to our results ($\chi^2(8) = 12.694$; $p = 0.001752$—see Tables 1 and 2 and Fig. 2 for further details).

2.3. Discussion

Experiment 1 showed a processing bias in favor of positive words coherent with the preferential processing of positive material that other studies have previously reported (Damjanovic & Santiago, 2016; Herbert, Junghofer, & Kissler, 2008; Kissler, 2013; Lynott & Coventry, 2014). Likewise, Experiment 1 also evidenced a significant

Table 1
Experiment 1. Reaction times [mean (*M*) and standard error of the mean (*SEM*)], and % of correct responses

	Negative				Positive			
	RT (ms)		Errors (%)		RT (ms)		Errors (%)	
Target Location	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Top	747	17.7	3.9	0.6	707	17.3	2.9	0.4
Bottom	734	17.8	4.4	0.6	710	16.6	3.5	0.6

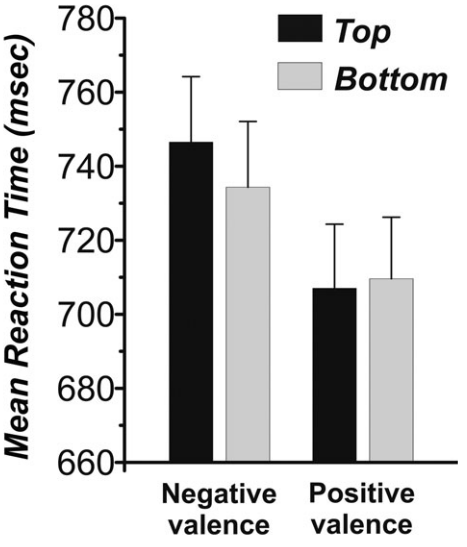

Fig. 2. Experiment 1. Reaction times [mean (*M*) and standard error of the mean (*SEM*)].

Table 2
Summary of linear mixed effects analysis for Experiment 1. Estimates, Standard Error, and t-values of the fixed effects

Fixed Effects	Estimates	*SE*	*t* value
(Intercept)	6.582e+00	3.325e−02	197.994
Valence	−5.989e−02	1.676e−02	−3.574
Stimuli Position	1.282e−02	1.016e−02	1.262
Response Assignment	−2.892e−02	4.507e−02	−0.642
Valence: Stimuli Position	−7.749e−03	1.431e−02	−0.541
Valence:Resp. Assign.	4.919e−02	1.432e−02	3.436
Stimuli Position:Resp. Assign.	8.636e−03	1.433e−02	0.603
Valence:Stimuli Position:Resp. Assign.	−2.641e−02	2.022e−02	−1.306

interaction between valence and word position, which suggests that perceptual representations congruent with the metaphors GOOD IS UP and BAD IS DOWN were activated during conceptual processing.

The fact that stimulus position itself had a null impact on the model fit lends little support to the possibility that our results were driven by polarity differences—that is, asymmetries in the way the various dimensions that intervene in the task are processed. The polarity account (Lakens, 2012) attributes conceptual congruency effects to structural factors rather than to metaphor activation arguing that each dimension in a task (i.e., stimulus, spatial location, and response code) has a marked (−polar) and an unmarked (+polar) endpoint, which show processing asymmetries that benefit the +polar endpoints, over the −polar endpoints and that when congruent polarities overlap in an experimental trial (e.g., positive words are presented at the top of the screen and negative words are presented at the bottom of the screen), processing benefits increase. On this view, and contrary to the postulates of conceptual metaphor, which only predicts space-valence interactions, both main effects and their interactions are predicted. Our results, against the polarity account's expectations, showed no effect of stimulus position on the model fit, which suggests that the findings presented here might be better interpreted as a context-dependent instantiation of the valence-space metaphor.

Finally, results also evidenced an interaction between valence and response assignment, which supports the view that the subtle change in the experimental setup that was introduced in Experiment 1 contributed to enhance the activation of the horizontal axis leading to congruency effects coherent with the implicit association between valence and left-right space.

Overall, these results seem to suggest that the increased salience of the lateral dimension that the experimental setup brought about was able to compete for attention with the vertical axis leading to the simultaneous activation of inconsistent spatial mappings and interfering in the vertical spatialization of valence. To explore this possibility, in Experiment 2, we tried to shift attention away from the left-right dimension while increasing the salience of vertical space. We manipulated participants' hand position so that both stimulus and response were vertically aligned and tested the impact that such alignment had on congruency effects.

3. Experiment 2

Previous research has shown that body posture and active and passive body movements are able to guide spatial attention and modulate affective responses in experimental settings, even when such bodily manipulations are irrelevant to the task (Casasanto & Dijkstra, 2010; Riskind, 1983; Wilson & Peper, 2004). In the light of such results, in Experiment 2, an implicit manipulation of participants' hand position was applied to our experimental procedure to draw attention to vertical space. This time, subjects were instructed to hold the response pad vertically (see Fig. 1) so that both participants' hands and stimulus presentation were vertically aligned. In so doing, we tried to increase the attention paid to the vertical axis while bringing to a minimum the salience of the horizontal dimension. Given that certain aspects of our knowledge and representation of objects seem to be determined by motor experience and the canonical position of objects, that is, the prototypical way we interact with them (Chrysikou, Casasanto, & Thompson-Schill, 2017), we hypothesized that a change in the conventional position of the response pad and the customary way participants use their hand to interact with it should attract attention to the new body-object spatial configuration enhancing the salience of the vertical axis and making it the only relevant spatial frame for the task. In this context, we predicted that the conceptual projection of valence onto vertical space would be favored provided that the response pattern that participants were assigned to was spatially congruent with the conceptual metaphors GOOD IS UP and BAD IS DOWN. No significant reaction time differences were expected when the reverse pattern of response was used (i.e., when participants responded to positive words by pressing the lower button of the response box and to negative words by pressing the upper button). Importantly, given the fact that valence spatialization also varies as a function of handedness and that previous research has reported response facilitation in the area where the dominant hand operates (Peters & Ivanoff, 1999; Shen & Franz, 2005), in Experiment 2, we controlled for the effect of participants' hand position on congruency effects by using two different response arrangements: right hand-above/left hand-below and right hand-below/left hand-above.

3.1. Material and methods

3.1.1. Participants

Two groups of undergraduate students from the Faculty of Psychology at the University of Barcelona—making a total of 89 participants—took part in the experiment for course credits. All of them were native or near native Catalan speakers and right-handed. Data from six participants were discarded because they reported low proficiency in Catalan (2), were classified as left handed based on EHI (1), or their error rates were larger than 10% (3). Thus, the sample was reduced to 37 participants in one group (33 women, M_{age} 20.5 ± 3.0) and to 46 participants (37 women, M_{age} 20.4 ± 4.5).

3.1.2. Stimuli

The same set of stimuli as in Experiment 1 was used in this experiment.

3.1.3. Procedure

Experiment 2 was analogous to Experiment 1, except that the response pad was vertically oriented now. Participants in Group 1 made their responses by pressing the top button on their response device with their right thumb and the bottom button with their left thumb, whereas participants in Group 2 held their hands in the opposite configuration.

3.1.4. Data analysis

Overall the experimental procedure and statistical treatment of the measured data were identical to Experiment 1, except for the fact that a new fixed factor, Hand position (right-up/left-down vs. right-down/left-up), was incorporated. A repeated measure analysis of variance (ANOVA), treating participants (F_1) or items (F_2) as random factors, was also performed on the log transformed latencies in a 2 × 2 × 2 design. This complementary set of analyses can be found as supplementary material.

3.2. Results

Similarly to Experiment 1, shorter RTs were found for positive in comparison to negative words (see Table 3 and Fig. 3). Importantly, RTs seemed to be modulated in its preferential metaphorical position by word, but only in the group of participants in which positive words were responded by pressing the upper button of the response pad.

Reaction times were log-transformed after removing incorrect response trials (4.03%) from the data matrix. Results are presented in Tables 3, 4, and Fig. 3. In a first set of analyses the data from the group of participants that were asked to judge the valence of words by pressing the upper button of the response box with their right hand and the lower button with their left hand were explored. As in Experiment 1, first, a model in which *valence* was the only fixed-effect factor with random intercepts for subjects and items was compared with another model where both *valence* and *stimuli position* were incorporated as fixed effect factors, this comparison did not reveal significant differences between the two models ($\chi^2(1) = 1.1797$; $p = 0.2774$). As opposed to Experiment 1, incorporating the interaction *valence* × *stimuli position* did not result in an improvement

Table 3
Experiment 2. Reaction times [mean (M) and standard error of the mean (SEM)], and % of incorrect responses for the two response assignments (positive-up/negative-down and negative-up/positive-down)

	Negative				Positive			
	RT (ms)		Errors (%)		RT (ms)		Errors (%)	
Target Location	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Positive-up/negative-down								
Top	748	17.2	4.2	0.5	693	15.5	2.8	0.5
Bottom	737	17.1	3.0	0.5	712	15.4	3.6	0.4
Negative-up/positive-down								
Top	773	17.8	4.3	0.5	720	16.0	3.3	0.5
Bottom	777	17.7	4.8	0.9	714	15.9	3.5	0.5

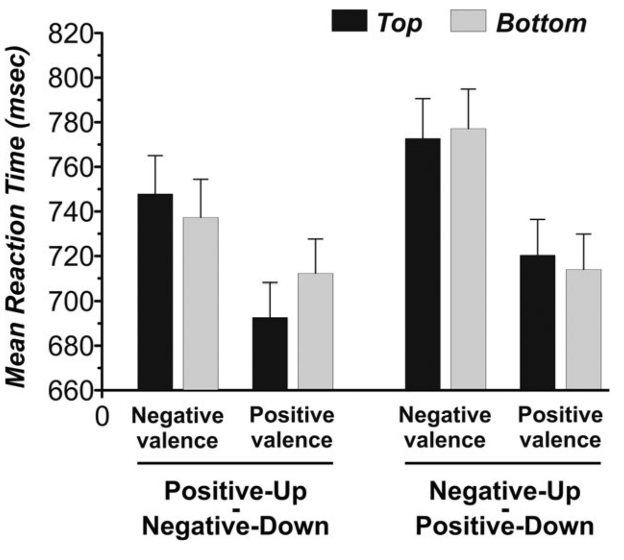

Fig. 3. Experiment 2. Reaction times [mean (*M*) and standard error of the mean (*SEM*)], for the two response assignments (positive-up/negative-down and negative-up/positive-down).

of the model fit ($\chi^2(2) = 2.6175$; $p = 0.2702$). However, the comparison of the maximal model (which included three fixed-effect factors, *valence*, *stimulus position,* and *response assignment*, and their interactions) with a reduced model in which only the factors *valence* and *stimuli position* and their interaction were considered revealed that the inclusion of the factor *Response Assignment* significantly improved the model fit ($\chi^2(4) = 16.784$; $p = 0.002129$).

A second set of analyses was conducted to examine the data from the group of participants that performed the judgment task by pressing the upper button of the response box with their left hand and the lower button with their right hand. As in the previous case, incorrect responses (3.29%) were removed from the data and reaction times were log-transformed. The analysis showed no improvement of the model fit either when *stimuli position* was entered as a fixed factor ($\chi^2(1) = 0.4691$; $p = 0.4934$; see Table 5) or when the interaction between *valence* and *stimuli position* was incorporated into the model ($\chi^2(2) = 2.8058$; $p = 0.09392$). As in the previous analysis, the comparison of the maximal model (three fixed-effect factors and their interactions) with a reduced model including *valence*, *stimuli position,* and their interaction also evidenced that the addition of *Response Assignment* significantly improved the model fit ($\chi^2(4) = 20.408$; $p = 0.0004148$).

Finally, we considered all participants together and compared a model in which *valence*, *stimuli position*, and *response assignment* were entered as fixed-effect factors with a new model in which a fourth fixed-effect factor, *dominant—non-dominant hand position*, was entered into the model. The results of this test revealed that *the position of the dominant—non-dominant hand* did not improve the overall fit of the data ($\chi^2(8) = 7.6526$; $p = 0.4681$). Convergence was reached in all models that were constructed. The estimates of the full model are reported in Tables 4 and 5.

3.3. Discussion

Experiment 2 evidenced that the bodily manipulation applied to enhance the salience of the vertical axis and prevent the simultaneous activation of incongruent spatial frames

Table 4
Summary of linear mixed effects analysis for Experiment 2: estimates, standard error, and t-values of the fixed effects for the right hand-up assignment

Fixed Effects	Estimates	*SE*	*t* value
(Intercept)	6.621e+00	3.400e−02	194.714
Valence	−8.847e−02	1.798e−02	−4.921
Stimuli Position	−7.478e−03	1.020e−02	−0.733
Response Assignment	−4.603e−02	4.513e−02	−1.020
Valence: Stimuli Position	2.011e−02	1.440e−02	1.397
Valence:Resp. Assign.	5.196e−02	1.418e−02	3.665
Stimuli Position:Resp. Assign.	1.543e−02	1.418e−02	1.088
Valence:Stimuli Position:Resp. Assign.	−6.201e−02	2.002e−02	−3.097

Table 5
Summary of linear mixed effects analysis for Experiment 2: estimates, standard error, and t-values of the fixed effects for the right hand-down assignment

Fixed Effects	Estimates	*SE*	*t* value
(Intercept)	6.628e+00	3.227e−02	205.348
Valence	−8.936e−02	1.624e−02	−5.502
Stimuli Position	−1.275e−02	9.876e−03	−1.291
Response Assignment	−6.159e−02	4.285e−02	−1.437
Valence: Stimuli Position	1.570e−02	1.390e−02	1.129
Valence:Resp. Assign.	6.054e−02	1.360e−02	4.450
Stimuli Position:Resp. Assign.	3.349e−02	1.365e−02	2.454
Valence:Stimuli Position:Resp. Assign.	−6.099e−02	1.926e−02	−3.167

influenced task performance. Moreover, as expected, our data also showed that the up-positive/down-negative response pattern resulted in shorter reaction times and more accurate responses when positive and negative words were presented in locations congruent with the GOOD IS UP—BAD IS DOWN conceptual metaphors. Similar to Experiment 1, when stimulus position was considered as a fixed-factor no improvement of the model fit was observed, which suggests that our results do not reflect polarity differences. Likewise, results also showed that the position of participants' dominant hand (either above or below) while they held the response box does not improve the fitting of the data to the model. Finally, it also noteworthy to mention that, as the results of the ANOVA support, the interaction between stimulus position and response assignment did not even approach significance. Consequently, a Simon-type effect can be ruled out as a plausible explanation for these data. Thus, these findings confirmed that the vertical alignment of the response set influenced the processing of affective valence in a way consistent with our predictions.

Together, Experiment 2 showed that the vertical alignment of the response pad and the subtle change in participants' bodily posture that it implied increased the activation of the up-down spatial frame of reference making it more prominent, reducing inconsistences in the type of spatial information that competed for attention in the working memory representation that subjects were creating to solve the task and biasing the conceptual projection of valence onto space toward the vertical axis.

4. General discussion

Taken together, the experiments reported here support the claim that conceptual congruency effects are contextually malleable (Brookshire et al., 2010; Lebois et al., 2014; Santiago et al., 2012; Torralbo et al., 2006) and depend on the overall coherence of the working memory model set up for the task (Santiago et al., 2011). They also provide evidence that bodily manipulations are one of the various ways in which the projection of conceptual metaphors onto space can be modulated. Experiment 1 showed that, given the fact that the metaphorical conceptualization of valence flexibly relies on vertical and horizontal space, conflicts in the spatialization of valence, with the consequent weakening of congruency effects, may arise when task conditions allow for the concurrent activation of both spatial axes. Experiment 2 showed that a subtle change in participants' hand position can modulate spatial attention and bias the conceptual projection of valence onto space toward the spatial axis that in that particular contexts enjoys greater salience. In the case at hand, the vertical alignment of participants' hands while interacting with the response box resulted in the strengthening of vertical congruency effects providing that the pattern of response was congruent with the metaphor that the experimental setting intended to activate (i.e., GOOD IS UP/BAD IS DOWN). These findings build on previous research on the impact of the body on metaphor activation (Casasanto & Dijkstra, 2010; Dijkstra et al., 2012; Oppenheimer & Trail, 2010) and provide a deeper insight into the type of bodily changes that can influence affective valence evaluations. Our data indicate that along with the manipulation of the whole body (Dehaene et al., 1993; Hartmann et al., 2012) and the execution of simple motor actions, such as vertical arm movements (Casasanto & Dijkstra, 2010; Oppenheimer & Trail, 2010), more subtle manipulations of the body like a slight variation in hand position can also affect subjects' performance in valence judgment tasks.

Many studies have demonstrated in the last few years that perceptual representations are active during conceptual processing, although a debate exists on whether perceptual, symbolic, or both processes are either necessary and/or sufficient for conceptual processing (Louwerse et al., 2015). In semantic judgment tasks, it has been observed that high-frequency words are processed faster than low-frequency words (Monsell, Doyle, & Haggard, 1989) and that lexical co-occurrence frequencies influence and predict response times which directly supports the symbolic account (Louwerse et al., 2015). In the case of valence, it has been reported that positive words are significantly more frequent than negative words (Warriner, Kuperman, & Brysbaert, 2013) and that the frequency of word sequences, where positive words precede negative words, tends to be significantly higher than that of sequences where the reverse order applies (Louwerse et al., 2015). These results point out that linguistic factors are particularly relevant in semantic judgment tasks where positive and negative valence word pairs are presented horizontally relative to when they are presented vertically (Hutchinson & Louwerse, 2012). In this study, the nature of the cognitive task and the experimental constraints that were imposed on word frequency and co-occurrence make highly unlikely that linguistic factors alone determined the encountered results. Only mid-frequency positive and negative adjectives, which did not show significant statistical differences in terms of frequency, were not direct opposites in a valence dimension and were not morphologically related to one another, were included in the experiment.[1] Moreover, it is also important to highlight that words were presented sequentially (i.e., participants did not judge pairs of words) and in a vertical configuration, which makes embodied factor more salient (Hutchinson & Louwerse, 2012).[2]

The results reported here can, therefore, be interpreted as context-dependent instantiations of the valence-space metaphor. This reading of our findings is congruent with a dynamic view of meaning construction on which meaning is shaped by the physical and social context that co-occurs with every instantiation of a word (Casasanto & Lupyan, 2015; Evans, 2009). In this respect, our results evidenced that the conceptual projection of valence onto space varies as a function of contextual factors, such as the use of visual cues, or participant's motor experience relative to the way objects are used. These contextual factors prompt the activation of the conceptual metaphor that best fits the situation that is being confronted. In other words, context amplifies or weakens metaphorical effects.

5. Conclusion

In summary, this study showed that valence-space metaphorical associations and conceptual congruency effects are shaped by contextual factors such as subjects' body posture. Our results evidenced that the vertical alignment of hands facilitates the evaluation of positive and negative words, but only when stimulus position and response assignment are metaphorically congruent with the GOOD IS UP—BAD IS DOWN conceptual metaphor. From an ad hoc view of meaning construction (Casasanto & Lupyan, 2015), these findings provide further support for the idea that source domain representations are dynamically activated in response to the context and that bodily states are an integral part of that context.

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Notes

1. Words with the prefixes in- and des-, which are commonly used in Catalan to turn positive adjectives into negative adjectives, and direct antonyms were discarded in 94% of the cases.

2. Six raters analyzed the stimuli searching for potential unmarked-marked word pairs that could facilitate the processing of the second item in the pair, which led to the identification of only 4 well-related word pairs (out of 60). The analysis of stimulus presentation order for each participant in Experiment 1 showed that participants seldom found these word pairs while performing the task and that in the few cases where some of these word sequences were found their presentation rarely matched the pattern positive-up, negative-down.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article:

Appendix S1. Results of Experiments 1 and 2.

Appendix A: Mean word length and lemma frequency, standard error of the mean between brackets, for the pool of words (n = 120) used in study

Word Length (number of letters)				Word Lemma Frequency			
Negative	Positive	t value (d.f.:118)	p-value	Negative	Positive	t value (d.f.:118)	p-value
6.8 (1.4)	6.8 (1.4)	−0.13	0.9	23.8 (35.3)	32.2 (29.1)	−1.43	0.15

d.f., degree of freedom

Appendix B: List of positive and negative Catalan adjectives and nouns used in the experiments

List of positive and negative Catalan adjectives and nouns used in the experiments. Words are listed in alphabetic order and the English translation for each word is provided in brackets. To create the final word list, we began by selecting 270 Catalan adjectives. The list consisted in 90 positive, 90 neutral, and 90 positive words. All words were selected from a Catalan dictionary (Rafael-i-Fontanals, 1996) and were selected on the bases of word lemma frequency (middle-high frequency range) and word length (range 4–9 letters). Afterward, to validate the stimuli, we divided each of the two original word lists into three lists of 90 words, each one with 30 positive, 30 negative, and 30 neutral words. The order of appearance of the words in the list was randomized in each list with the constraint that no more than three words of each valence category appeared in a row. Approximately 70 participants evaluated each list. For each word in the list, participants were asked to select one valence category (positive, neutral or negative) and to rate his confidence on the giving their response using a four-point Likert scale (1—not sure, 4—completely sure). Then, participants completed a brief language questionnaire that was used to assess their Catalan language skills. We considered for validating the stimuli data, only participants reporting to have a high Catalan level. For the final experimental list of 60 words per category, we selected the items with higher agreement in each category (agreement for positive words: 88.7%; negative words: 86.9%; $t(59) = 1.4$; $p = 0.15$) and confidence score over 3 points.

Positive	Negative
Actiu (active)	Abandonat (abandoned)
Adequat (appropiate)	Abatut (dejected)
Admirable (remarkable)	Agressiu (aggressive)
Adorable (adorable)	Aspre (rough)
Afortunat (lucky)	Avorrit (bored)

(continued)

Appendix B. (continued)

Positive	Negative
Àgil (quick)	Barroer (coarse)
Agradable (pleasant)	Brut (messy)
Agraït (grateful)	Condemnat (convicted)
Alegre (cheerful)	Confús (confused)
Amable (kind)	Cruel (cruel)
Animat (lively)	Culpable (guilty)
Atent (attentive)	Dèbil (weak)
Atractiu (attractive)	Difícil (difficult)
Bonic (pretty)	Dolent (bad)
Brillant (bright)	Dolorós (painful)
Càlid (warm)	Enfonsat (depressed)
Capaç (capable)	Espantat (frightened)
Competent (competent)	Espantós (dreadful)
Content (pleased)	Estúpid (stupid)
Decidit (determined)	Fals (false)
Dinàmic (dynamic)	Fatal (awful)
Divertit (funny)	Fracassat (failed)
Dolç (sweet)	Fúnebre (gloomy)
Educat (polite)	Furiós (furious)
Eficaç (effective)	Greu (serious)
Eficient (efficient)	Groller (rude)
Elegant (elegant)	Horrible (horrible)
Esplèndid (splendid)	Ignorant (ignorant)
Exquisit (delicious)	Impotent (helpless)
Fabulós (fabulous)	Indecís (indecisive)
Fantàstic (fantastic)	Inestable (unstable)
Favorable (favourable)	Injust (unfair)
Feliç (happy)	Insegur (insecure)
Festiu (merry)	Inútil (useless)
Fidel (faithful)	Lleig (ugly)
Generós (generous)	Maligne (evil)
Graciós (amusing)	Mediocre (mediocre)
Hàbil (skilled)	Mesquí (mean)
Honest (honest)	Miserable (wretched)
Honrat (honest)	Molest (annoyed)
Ideal (ideal)	Mutilat (mutilated)
Lleial (faithful)	Nefast (terrible)
Optimista (optimistic)	Negatiu (negative)
Perfecte (perfect)	Neuròtic (neurotic)
Preciós (gorgeous)	Odiós (hateful)
Productiu (fruitful)	Patètic (pathetic)
Prudent (cautious)	Perdut (lost)
Radiant (joyful)	Perillós (dangerous)
Rialler (smiling)	Podrit (rotten)

(continued)

Appendix B. (continued)

Positive	Negative
Saludable (healthy)	Rabiós (furious)
Satisfet (satisfied)	Repugnant (disgusting)
Segur (safe)	Ridícul (ridiculous)
Simpàtic (nice)	Sinistre (scary)
Sincer (sincere)	Sospitós (suspicious)
Solidari (supportive)	Terrible (terrible)
Tendre (tender)	Tòxic (toxic)
Útil (useful)	Tràgic (tragic)
Valent (brave)	Trencat (broken)
Valuós (valuable)	Trist (sad)
Vital (lively)	Vulgar (rude)