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Attentional factors in conceptual congruency

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Abstract

Conceptual congruency effects are biases induced by an irrelevant conceptual dimension of a task (e.g., location in vertical space) on the processing of another, relevant dimension (e.g., judging words' emotional evaluation). Such effects are a central empirical pillar for recent views about how the mind/brain represents concepts. In the present paper we show how attentional cueing (both exogenous and endogenous) to each conceptual dimension succeeds in modifying both the manifestation and the symmetry of the effect. The theoretical implications of this finding are discussed.

KEYWORDS: embodiment, symbol grounding, mental metaphor, attention, common coding, ATOM, neural reuse, conceptual recycling, Coherent Working Models.

Abstract concepts, concepts without a clear reference in the perceptual world, constitute an essential part of the human conceptual system. Think of morality, time, magnitude, social status or intimacy, to name just a few well-studied examples. Lacking direct correspondences with perceptuo-motor experiences, how can people represent them and reason about them? A prominent answer to this question is the Metaphor View (Boroditsky, 2000; Casasanto & Boroditsky, 2008; Lakoff & Johnson, 1980, 1999; Williams, Huang, & Bargh, 2009), which proposes that our conceptual system recycles concrete concepts to help understanding the abstract. Representations of location, motion, size, colour, brightness, weight, smell, temperature and other perceptually-based dimensions of experience are used to understand more abstract concepts as if, at least in part, the latter were examples of such concrete experiences. Take time as a case in point. There is now ample evidence supporting that time is often understood as motion along a path, from a past location to a future location, either along the front-back axis (Borodistky, 2000; Clark, 1973; Lakoff & Johnson, 1980, 1999) or along the left-right axis (Furhman & Boroditsky, 2010; Frassinetti, Magnani, & Oliveri, 2009; Oliveri, Koch, & Caltagirone, 2009; Santiago, Lupiáñez, Pérez, & Funes, 2007; Santiago, Román, Ouellet, Rodríguez, & Pérez-Azor, 2008; Torralbo, Santiago, & Lupiáñez, 2006; Tversky, Kugelmass, & Winter, 1991; Vallesi, Binns, & Shallice, 2008). Experimental evidence regarding many other conceptual mappings also seems to be mostly consistent with the Metaphor View. Numerical sequence also runs in space from side to side (originally reported by Dehaene, Bossini, & Giraux, 1993, and widely replicated later), as well as agency and action flowing (Chatterjee, Maher, Gonzalez-Rothi, & Heilman, 1995; Chatterjee, Southwood, & Basilico, 1999; Maas & Russo, 2003; Maher, Chatterjee, Gonzalez-Rothi, & Heilman, 1995). Numerical magnitude is related to physical size (Besner & Coltheart, 1979; Henik & Tzelgov, 1982). Social status is thought of as deploying people along a vertical spatial axis (Giessner & Schubert, 2007; Schubert, 2005) or as objects of varying size (Marsh, Yu, Schechter, & Blair, 2009; Schubert, Waldzus, & Giessner, 2009). Social relations vary in temperature (Ijzerman & Semin, 2009, 2010; Kang, Williams, Clark, Gray, & Bargh, 2010; Williams & Bargh, 2008; Zhong & Leonardelli , 2008). Gender-related personality styles are related to tactile sensations of softness-hardness (Slepian, Weisbuch, Rule, & Ambady, 2010). Both morality and emotional valence have to do with cleanliness (Schnall, Benton, & Harvey, 2008), brightness (Sherman & Clore, 2009; Meier, Robinson, & Clore, 2004; Meier, Robinson, Crawford, & Alhvers, 2007), vertical locations (Meier & Robinson, 2004, 2006), and lateral left-right locations (Casasanto, 2009; Casasanto & Jasmin, 2010; Casasanto & Chrysikou, 2011). Importance has to do with weight (Jostmann, Lakens, & Schubert, 2009) and similarity with proximity (Casasanto, 2008a).

The vast majority of this research relies on conceptual congruency tasks. In such tasks, participants are typically asked to carry out a judgment on an abstract conceptual dimension (e.g., discriminate past from future, good from bad, higher status from lower status), while a concrete conceptual dimension is manipulated (e.g., stimuli are responded to with the left or right hand, presented at different locations, with different levels of brightness, weight, softness, temperature, size and so on). The levels of the concrete dimension are fully crossed with the abstract dimension and they are completely irrelevant to the task. Nevertheless, conceptual congruency effects can be found: the values of the concurrent concrete experiences being able to affect the easiness (speed and/or accuracy) of the abstract conceptual judgment or to bias the judgment itself in a particular direction. Conceptual congruency effects are the central empirical pillar of the Metaphor View of concepts, as they lend support to the idea that concrete experiences are somehow involved in highly abstract thinking.

Conceptual congruency effects can be symmetric or asymmetric. Symmetry is observed when it is possible to find a corresponding same-sized influence of the abstract dimension on the processing of the concrete dimension. The issue of the symmetry or asymmetry of conceptual congruency effects carries important theoretical implications (Boroditsky, 2000; Casasanto & Boroditsky, 2008; Casasanto, Fotakopoulou, & Boroditsky, 2010; Merritt, Casasanto & Brannon, 2010).

Lakoff and Johnson (1980) first noted that it is much more common to talk about abstract concepts in terms of more concrete concepts than the opposite (e.g., “the future is ahead of us”, where time is talked about as if it were a location, versus “the station is one minute away”, where distance is talked about in terms of duration). They suggested that such linguistic patterns unveil the structure of the human conceptual system: more abstract, less delineated concepts are thought about in terms of concrete concepts, of which we have more detailed knowledge. Under this view, in order to think of an abstract concept, it would be necessary to activate the concrete domain on which it is construed. Boroditsky (2000) called this the Strong Metaphor View, and distinguished it from a Weak Metaphor View. The weaker formulation allows for the borrowed structure to be stored directly at the abstract domain, such that the concrete domain does not need to be activated every time people think about the abstract domain. Boroditsky (2000) reasoned that the Strong View predicts symmetric cross-domain priming effects, whereas the Weak View predicts asymmetric priming effects: processing the concrete domain should bias subsequent processing of the abstract domain, whereas processing the abstract domain would not necessarily entail activation (priming) of the concrete domain. She observed that spatial primes were able to bias temporal thought, whereas analogous temporal primes did not bias spatial thought, thereby supporting the Weak View.

In subsequent writings in this tradition (Casasanto, 2008b, 2009; Casasanto & Boroditsky, 2008) the prediction of asymmetry in cross-domain effects was linked to the exposure to the asymmetric linguistic patterns noted by Lakoff and Johnson (1980). It is assumed that mental metaphors can thus arise both from perceptuo-motor experiences (such as the experience of moving from one location to another and arriving at a later time) as well as from conceptualizations induced by language. Under this account, language can guide how people think about concepts in terms of other concepts. From here it follows that if linguistic expressions that talk about the abstract in terms of the concrete are more frequent than the converse, people will tend to think of the abstract in terms of the concrete. However, sometimes people can also think about the concrete in terms of the abstract (as when distances are described in terms of durations, see above). Therefore, the degree of asymmetry in cross-domain priming is expected to follow the degree in which linguistic patterns are themselves asymmetric. If two concepts were talked about in terms of the other with roughly the same frequency, symmetric priming would be expected.

Before we turn to review the available evidence regarding the degree of symmetry in cross-domain priming, it is very important to note that asymmetric priming plays a crucial theoretical role for the Metaphor View. If cross-domain priming is symmetric, it could mean that the representation of abstract conceptual domains is fully parasitic on more concrete domains, as suggested by the Strong View. However, it could just as well support the alternative views that a) the representation of concrete domains completely depends on the conceptualization of abstract domains; or b) that both concrete and abstract domains share an underlying representation or mechanism responsible for the cross-domain interactions. In other words, asymmetric cross-domain priming fulfils the crucial role of providing an empirical index of the progressive building of upper (abstract) levels of the human conceptual structure on the lower (concrete) levels, which grounds the whole structure on perceptuo-motor foundations (a view that Santiago, Román and Ouellet, in press, termed the Solid Foundations View of concepts). Without asymmetric priming, only the asymmetric linguistic patterns remain as evidence for this view. However, relying only on how people speak is widely considered to be insufficient to substantiate claims about underlying thought representations (Murphy, 1996, 1997). This view, thus, looks much less solid without asymmetric priming.

It could be argued that the alternative views mentioned above are not plausible. However, a view like option b above has actually been proposed and is receiving considerable attention in the psychological and neuroscientific literature. Walsh (2003) proposed the ATOM (A Theory of Magnitude) view, which suggests that the parietal lobes hold a common representation for all prothetic dimensions, that is, all dimensions that can be characterized by “more than” - “less than” relations. Walsh (2003) explicitly mentioned three of them: space, time and number, but later work extended this view to other dimensions such as weight (Lu, Hodges, Zhang, & Zhang, 2009), brightness and size (Pinel, Piazza, Le Bihan, & Dehaene, 2004). The reasons why such a common representational substrate may have evolved have to do with representational and processing economy, or it might be just a consequence of the evolutionary strategy of reusing neural substrates for new tasks (Anderson, 2010). Most research in this tradition has also used conceptual congruency tasks, but no claims of differences in terms of degree of abstraction are made regarding the manipulated dimensions. Thus, space, time, size, brightness and number are often pitted against each other (e.g., Agrillo, Ranpura, & Butterworth, 2010; Cappelletti, Freeman, & Cipolotti, 2009; Dormal, Seron, & Pesenti, 2006; Kiesel & Vierck, 2009; Lu et al, 2009; Oliveri et al, 2008; Roitman, Brannon, Andrews, & Platt, 2007; Vicario et al, 2008; Xuan, Zhang, He, & Chen, 2007). In contrast to the Metaphor View, ATOM predicts symmetric effects between all pairs of prothetic dimensions. ATOM has the advantage of being able to integrate observed congruency effects between dimensions which seem to be at similar levels of concreteness, such as time and number (e.g., Dormal et al, 2006) or space and pitch (Rusconi, Kwan, Giordano, Umiltà & Butterworth, 2006).

What does available evidence say about the symmetry or asymmetry of conceptual congruency effects? Several studies have tested both directions of influence, but few have done it in a single design, and even fewer have focused on the more theoretically diagnostic kind of conceptual metaphor for this debate: those that have an asymmetric manifestation in language. The overall pattern of results is far from providing a clear picture.

The clearest case for unidirectional effects has been made for the relation of time to the domain of space. As mentioned above, time is talked about in terms of space more often than space is talked about in terms of time. Boroditsky (2000) reported that spatial primes were able to bias a subsequent temporal judgment, but that temporal primes did not succeed in biasing an analogous spatial judgment. Using non-linguistic tasks (estimating either the length or duration of a growing line), Casasanto and Boroditsky (2008) observed clear effects of irrelevant spatial length on duration judgments, whereas irrelevant durations were unable to affect spatial judgments. Several manipulations intended to increase the saliency of time were also ineffective (see also Casasanto et al, 2010, for developmental data, and Merritt et al, 2010, for additional adult data). In a very interesting contrast with human data, Merritt et al (2010) recently reported that monkeys do show bidirectional effects between space and time.

However, effects of temporal primes on spatial judgments have been found using a variety of paradigms and measures by Teuscher, McQuire, Collins and Coulson (2008) and Ouellet, Santiago, Funes and Lupiáñez (2010). The main problem of these cross-study comparisons to evaluate the degree of asymmetry of the effects is the diversity in tasks and measures. A closer procedural correspondence is found in the studies of two classic psychophysic effects, the Tau and Kappa effects, which suggest that both space and time can affect each other (Cohen, Hansel, & Sylvester, 1953; Helson & King, 1931; see Jones & Huang, 1982, for a review of the initial findings; for more recent studies, see Kawabe, Miura, & Yamada, 2008; Sarrazin, Giraudo, Pailhous, & Bootsma, 2004; Sarrazin, Giraudo, & Pittenger, 2007; Sarrazin, Tonnelier, & Alexandre, 2005). The standard task involves the sequential presentation of three stimuli at different spatial locations. This defines two spatial and two temporal intervals between stimuli. When the spatial intervals are unequal and participants are asked to adjust the temporal intervals until they seem equal, they are affected by the distance between the stimuli (the Kappa effect): a greater spatial interval is perceived as having a longer duration. Conversely, when the temporal intervals are unequal and participants are asked to make the spatial intervals equal, they are affected by the duration of the intervals (the Tau effect): a longer temporal interval seems to encompass a greater space. Nevertheless, to our knowledge no direct comparisons of effect sizes are available.

Emotional valence (positive-negative) and its relation to vertical space provide another interesting case to test, as emotions are often talked about in spatial terms (e.g., “I am feeling low today"), but the opposite pattern is not attested (e.g., "I am going happier", meaning to go up). However, here we also find similar difficulties for symmetry comparisons in published studies: Meier and Robinson (2004) observed clear effects of an evaluative judgment on a subsequent spatial discrimination (Study 2), whereas no effects of a spatial discrimination were found on an evaluative judgment (Study 3). Unfortunately, the procedures of these two studies varied in crucial aspects and are not, therefore, directly comparable.

A better comparison is available for the relation between emotional valence and brightness, although this conceptual metaphor is not so asymmetrical in its linguistic manifestation: it is common both to talk about evaluations in terms of brightness (e.g., "the dark side") and, to a certain extent, about brightness in terms of emotions (e.g., "she was dressed in sad colours"). Meier et al (2004) asked their participants to judge either the affective evaluation of words (Study 1a) or the brightness of the words' font (Study 4) in tasks otherwise identical. Brightness affected evaluative judgments, but evaluation did not affect brightness judgments, supporting asymmetric effects. However, in a different study, when Meier et al (2007) made the brightness judgment more difficult, they did find an effect of evaluation on brightness.

If the clearest case for asymmetric effects comes from the study of time and space, the clearest case for symmetric effects comes from number magnitude and size. However, this conceptual projection is also highly symmetric in linguistic patterns, being common to talk about numbers in terms of size (e.g., "a large number") as of size in terms of numbers (e.g., "a 25-ton truck"). When two numbers are compared, judgments of their magnitude are affected by their relative physical sizes (Besner & Coltheart, 1979). It is faster to judge that 2 is a smaller number than 6 when 2 is presented in small font and 6 in large font (2-6) than the opposite (2-6). The converse influence of numerical magnitude on judgments of physical size has also been reported (Henik & Tzelgov, 1982; see Pansky & Algom, 1999, for detailed references). Importantly, some studies have manipulated the relative discriminability and perceptual salience of numerical and size information within a single study (Fitousi & Algom, 2006; Pansky & Algom, 1999, 2002; Schwarz & Ischebeck, 2003). The more discriminable-salient dimension always had stronger effects on the less discriminable-salient dimension. When stimuli were matched in discriminability and salience, effects were completely symmetric in both directions.

Finally, studies including more than two dimensions in a single design are scarce, and their results puzzling. Pinel et al (2004) assessed the influence of number, size and brightness on each other. They observed that the dimensions of size and number, on one hand, and of size and brightness, on the other hand, showed symmetric interference. Size and number, as mentioned above, are often talked about in terms of each other in language, but size and brightness are never used to talk about each other. Moreover, number interfered with brightness judgments, but brightness did not interfere with number judgments, showing that it is also possible to find asymmetric effects between dimensions which show similar (in this case, null) frequencies of linguistic patterns. Note that such variations in the size of the effects in each direction cannot be explained by differences in neural overlap, as this construct is inherently symmetric.

To summarize, currently available evidence partially supports asymmetric conceptual congruency effects when the relevant conceptual metaphor also shows asymmetric linguistic manifestations, whereas the effects tend to be more symmetric as the patterns in language are also more symmetric. However, the issue is far from being settled, and there are clear exceptions to this rule (e.g., the Kappa effect and the interactions reported by Pinel et al, 2004) , so available evidence does not clearly support either the metaphoric or the ATOM views. The evidence also points at several mediating factors, such as the relative saliency, discriminability or processing difficulty of the manipulated dimensions (see Santiago et al, in press, for a review). Thus, available evidence succeeds in showing the limitations of both approaches: none of them postulates mechanisms that could account for conceptual congruency effects of varying sizes in the same task under different conditions.

Recently, Santiago et al (in press) proposed a model that includes such mechanisms. This view defends a profound change in the way conceptual congruency effects have been interpreted so far. Instead of being taken as direct empirical indexes of the structure of long-term semantic memory representations, this view proposed that conceptual congruency effects arise because of interactions between the representations included in the working memory model of the current task. Thus, congruency interactions are indexes of working memory processes and representations, and only indirectly do they index long-term semantic representations. The theory proposes a view of working memory as consisting of mental models which are set up to deal with the task at hand and which are constrained to be as internally coherent as possible (thus the chosen name Coherent Working Models theory). It is proposed that all the elements of working models (including abstract conceptual dimensions) are represented as concrete perceptually-based elements, either objects, properties, relations or spatio-temporal dimensions. When abstract concepts have to be included in the model of the task, they take the form of concrete elements (for example, when the task includes affective evaluation, this dimension may be introduced in the model as one of a number of possible concrete alternatives: a vertical spatial dimension, a brightness dimension, and so on). All elements vary in activation level, which is a weighted sum of the influence of a number of factors, including attentional cueing, task requirements, prior practice, salience, and discriminability. The constrain of internal coherence leads to interactions among the elements. Configurations which are not internally coherent (such as a word located in upper physical space and also in lower evaluative space) are more difficult to process. Such a non-optimally coherent configuration will produce behavioural effects whenever the response is based on the less active dimension in the task (otherwise, the troublesome elements may be removed from the model). Santiago et al (in press) describe and discuss the representational and processing assumptions of the theory in detail.

One central prediction from this view is that the manifestation and the directionality of congruency interactions may be manipulated by changing the level of activation of the interacting conceptual dimensions. For conceptual congruency effects to be observed, both dimensions must be part of the working model of the task, and the response must be based on the weaker dimension. If the dimension that guides responding is stronger, the irrelevant dimension will not be able to pose constraints on its processing, and will probably be dropped altogether from the model and no congruency effect will be observed. If the level of activation of the irrelevant dimension is increased by any of many possible means, it will gain the ability of constraining the processing of the relevant dimension and the effect will be observed.

The aim of the present research is to assess the effect of one of the many ways in which such level of activation can be changed: attention. It is a well-established fact that attention can be directed to a stimulus either endogenously or exogenously (Jonides, 1981; Posner, 1980; Müller & Rabbitt, 1989). While endogenous attention is driven by instructions or by signals needing to be semantically processed, exogenous attention is automatically captured by aspects of the signal (abrupt onset, motion, sudden changes and so on). Together with a third system controlling the general level of vigilance or alertness, these are the attentional systems of the brain (Corbetta, Patel & Shulman, 2008; Posner & Petersen, 1990). Our aim was to evaluate whether exogenous and endogenous attentional cues are an efficient modulating factor of conceptual congruency effects. In other words, we set up to assess whether it is possible to observe conceptual congruency effects when the level of activation of the irrelevant dimension is boosted by either exogenous or endogenous means, and whether this modulation varies depending on whether the irrelevant dimension is the more concrete or the more abstract one.

In the present experiments, we will use the vertical space - affective valence conceptual metaphor as our testbed, because it is a clear case in which asymmetric cross-domain effects are predicted by the Metaphor View. As discussed above, emotional valence is often talked about in vertical terms (e.g., "I'm feeling up", "That boosted my spirits", "My spirits rose", "I fell into depression"; Lakoff & Johnson, 1980), but the opposite is never attested (e.g., "A happy mountain", meaning a high mountain). In this respect, Spanish (the language in which the experiments were run) behaves exactly as English. Under the Metaphor View, effects of vertical space over evaluation judgments should be stronger than the reverse. Under the ATOM view, symmetric effects are expected. Only the Coherent Working Models theory predicts that attentional cueing will be able to control the presence-absence of the congruency effect.

In a well-known study, Meier and Robinson (2004, Study 1) found that the vertical location of a word on a screen (upper or lower) affects the speed of judging its valence (positive or negative). They suggested that this was a proof of the existence of a conceptual mapping between valence and vertical space in semantic memory. We will first try to replicate Meier & Robinson's results (Experiment 1) and then show how they depend critically on the presence of an automatic (exogenous) attentional cuing calling attention to word location (Experiment 2). Next, we will show how the same effect can be obtained by voluntarily (endogenously) directing attention to the vertical spatial axis (Experiment 3). We will then proceed to explore the effect in the opposite direction, from evaluative meaning on spatial processing (Experiments 4 to 6), without finding it. Finally, we will show how an attentional voluntary strategy succeeds in obtaining the effect in this opposite direction (Experiment 7).

Experiment 1

Experiment 1 was analogous to Meier and Robinson (2004, Study 1) in all central respects, although there were some minor differences in the procedure. We presented Spanish adjectives denoting positive (e.g., “alegre” - happy) or negative (“triste” - sad) emotions, and the participants were asked to discriminate their emotional valence. Words were presented in the upper or lower part of the screen, and were responded to vocally by pronouncing the words "positivo" (positive) or "negativo" (negative). A face silhouette looking rightwards was presented in the centre of the screen during the whole experiment, and participants were instructed that those words were emotions felt by that "person".

All the procedural differences with Meier and Robinson (2004, Study 1) were meant to secure a clearer interpretation of the results. Affective valence has been related in the literature to the vertical (Casasanto & Dijsktra, 2010; Meier & Robinson, 2004), horizontal left-right (Casasanto, 2009; Casasanto & Chrysikou, 2010; Casasanto & Jasmin, 2010) and horizontal close-far (Cacciopo, Priester, & Berntson, 1993; Centerbar & Clore, 2006; Chen & Bargh, 1999; Tops & de Jong, 2006; Wentura, Rothermund, & Bak, 2000) dimensions. Moreover, spatial reference frames and deictic origin can be quite freely moved (Markman & Brendl, 2005; Seibt, Neumann, Nussinson, & Strack, 2008). All this made us worry about the possibility that participants would relate affective valence to a horizontal axis centered on themselves, instead of to the vertical axis, therefore precluding any vertical congruency effects (Torralbo et al, 2006). So, instead of all kinds of affectively loaded terms (from "baby" to "mosquito"), we used only positive or negative emotion terms. Emotions are more often talked about in vertical terms than generally positive or negative objects (this is why Lakoff & Johnson, 1980, called this mapping HAPPY IS UP). Moreover, the instructions presented those emotion terms as referred to the central human silhouette. These modifications should give us a better chance of replicating the basic results obtained by Meier and Robinson (2004, Study 1): a congruency effect between emotional evaluation and vertical space, such that positive emotion words would be processed more efficiently when presented in the upper position and negative emotion words in the lower position.

Method

The methods of Experiment 1 are presented here in full detail. The remaining 6 experiments in this series followed Experiment 1 closely in all respects, except for very specific changes that are explained for each experiment. To facilitate following the rationale of the changes across experiments, Table 1 provides an overview of the whole series, including a brief description of the procedure and sample size. It also includes general aspects of the results (such as number of outliers and grand mean latency and accuracy), and most importantly, the size and statistical significance of the observed congruency effect on latency, both over the whole experiment and across the two halves of the session. Table 1 will serve to simplify the exposition of the following experiments.

Insert Table 1 about here

Participants

Forty native Spanish students from the Psychology degree at the University of Granada volunteered to take part in the study and received course credit for their participation. All of them had normal or corrected-to-normal vision. The participants in the following experiments of this series were always new samples from the same population.

Materials

Forty-eight Spanish adjectives denoting emotional states were used. Half of them referred to positive emotions and the other half to negative emotions (see the Appendix). Five pilot participants pre-tested the valence of the words. For a word to be used in the experiment, an agreement of at least 4 out of 5 judgments was required.

Apparatus and procedure

The experiment was written in MicroExperimental (MEL) code (Schneider, 1988) and run in an IBM PS/2 30 286 PC. Participants were tested individually in a quiet room. First, the participant read the instructions, which explained that a silhouette of a face would be presented on the screen, and then words referring to emotional states would be displayed one at a time. They were told that words referred to emotions felt by the person on the screen and that the participant was to judge whether the person was having a positive or a negative emotion by saying aloud “positivo” (positive) or “negativo” (negative). Mention was made that the words would appear in different screen positions, but that this was irrelevant to the task.

A face silhouette facing to the right was presented, which remained in view during the whole block of trials. Each trial consisted of the presentation of the fixation stimuli (see below) and a word either above or below the silhouette. Following Meier and Robinson (2004), within each trial, two strings of crosses ("+++++") preceded the target word. They were presented progressively approaching the point of word presentation. The first appeared at one third and the second at two thirds of the distance to word location. Each one was presented for 300 ms with no interstimulus delay. The last fixation line was followed by a word that stayed in view until a response was detected or 3000 ms had elapsed. Words were presented horizontally centered on rows 3 (upper position) and 22 (lower position) on a text-mode screen of 80 columns and 24 rows. After a maximum time of 3000 ms to respond, the trial was aborted and a message of "no response has been detected" was shown. The intertrial interval was counted from the start of a vocal response, and allowed 1000 ms for the participant to finish responding plus 1000 ms for the experimenter to press the space bar. As most trials did not elicit errors, words were presented at a rate of 1 every 2600 ms plus the vocal latency. Fig. 1 shows the trial structure.

The onset of vocal activity was recorded by means of a vocal key connected to the computer. The experimenter sat next to the participant, facing another screen with the same display (out of the participant's sight). The experimenter was informed in her screen of the correct response for the next trial. If the participant made an error, the experimenter stopped the experiment by pressing the "enter" key and notated down the error in full detail. An error was defined as anything but a fluent rendition of the correct response word. Therefore, error responses included disfluencies (filled pauses and stutterings), misnamings (producing the wrong response) and noises (lip smacks, coughs). The experimenter then resumed the sequence of trials by pressing the space bar. This procedure also gave participants the possibility of recovering from the error.

There was a short practice block of 8 trials plus two blocks of 48 trials, which were presented with no break. Materials were divided into two lists, containing an equal number of positive and negative words. In the first experimental block, the words in one list were presented in the upper screen location, and words in the other list were presented in the lower location. In the second block, lists switched positions. List to block assignation was counterbalanced across participants. Therefore, each participant saw the same word twice, once in each screen position.

Design and data analysis

The factors were: Evaluation (positive or negative) X Position (upper or lower screen position) X Block (first versus second half). Both latency and accuracy data were independently analyzed by means of three-way within-subjects ANOVAs. Latencies of correct trials were trimmed before being submitted to the ANOVAs. In order to make the experiments in this series more comparable, fixed cut-off points were calculated for each experiment such that they left out about 1% of correct trials (see Table 1). The lower cut-off was common to all experiments and set at 250 ms.

Results

There were a total of 3840 trials in the experiment. The vocal response failed to activate the vocal key in 19 trials (0.49%). Errors were produced in 156 trials (4.06%). Fixed cut-offs for correct trials were set at 250 and 1850 ms, what excluded 40 trials (1.09%). These general details of the results are presented in Table 1 for all experiments in the series.

Insert Table 2 about here

Cell means are shown in Table 2. The latency analysis revealed main effects of all three factors: there was a clear practice effect along the experiment ($F(1,39) = 45.71$, $MSE = 10307.80$, $p < 0.001$), words were responded to marginally faster in the upper than the lower position ($F(1,39) = 3.68$, $MSE = 3340.36$, $p = 0.06$), and positive words had faster latencies than negative words ($F(1,39) = 8.45$, $MSE = 4912.10$, $p < 0.01$). There was also an interaction between Block and Evaluation ($F(1,39) = 12.49$, $MSE = 3155.11$, $p < 0.01$): the difference between positive and negative words was smaller in the second block, perhaps due to some degree of semantic satiation.

All these results speak of the sensitivity of the task, but are not directly relevant to our hypotheses. The crucial effect for present purposes is the interaction between Evaluation and Position, which was significant ($F(1,39) = 4.16$, $MSE = 3191.26$, $p < 0.05$). The congruency effect (defined as the metaphorically incongruent minus congruent conditions) amounted to 13 ms. This effect did not vary across blocks (three-way interaction non-significant: $F < 1$).

The analysis of accuracy revealed only one significant effect: the interaction of all three factors ($F(1,39) = 4.25$, $MSE = 0.004072$, $p < 0.05$). This interaction arose because Evaluation and Position interacted in the second block ($F(1,39) = 4.87$, $MSE = 0.002572$, $p < 0.05$), but not in the first ($F(1,39) = 1.42$, $MSE = 0.003879$, $p = 0.24$). The shape of the interaction in the second block was against the expected conceptual congruency effect (incongruent conditions being more accurate than congruent conditions).

Discussion

The first experiment in this series successfully replicated the metaphorical congruency effect reported by Meier and Robinson (2004, Study 1). Congruent conditions (positive words presented in upper locations and negative words presented in lower locations) were responded to faster than metaphorically incongruent conditions. This effect was present along the two blocks of the experiment (see Table 1).

The trend toward a counter-metaphorical interaction in accuracy during the second block may suggest that (at least some of the) participants strategically tried in this block to speed up responses, resulting in a speed-accuracy trade-off. The reasons why this may have occurred remain unclear. Before trying to explore this effect in greater detail, we checked in the following experiments if it could be replicated. As it was never observed again, we decided not to pursue the issue further.

Experiment 2

Experiment 2 replicated Experiment 1 in all respects, with the only exception of the removal of the fixation stimuli (trial duration was thus reduced in 600 ms). If the fixation stimuli are acting as an exogenous cue which automatically attracts attention to word location, they may be boosting the activation of the spatial dimension, and this in turn is allowing the possibility for space to interfere with the processing of evaluation. If so, removing the fixation stimuli should reduce, or even completely remove, the congruency effect observed in Experiment 1.

Results

Insert Table 3 about here

Cell means are presented in Table 3. In the analysis of latency, the main effects of all three factors were replicated (Block: $F(1, 41) = 89.71$, $MSE = 6038.44$, $p < 0.001$; Position: $F(1,41) = 11.43$, $MSE = 2701.21$, $p < 0.01$; Evaluation: $F(1,41) = 15.57$, $MSE = 5134.36$, $p < 0.001$), and the interaction between Block and Evaluation approached significance ($F(1,41) = 2.85$, $MSE = 2184.52$, $p = 0.09$). Crucially, the interaction between Evaluation and Position disappeared ($F < 1$). There was also no interaction between the three factors ($F < 1$). By removing the fixation crosses, the size of the congruency effect shrinked from 13 ms in Experiment 1 to only 1 ms in Experiment 2 (see Table 1). The analysis of accuracy only showed a significant effect of Block ($F(1,41) = 4.71$, $MSE = 0.002026$, $p < 0.05$). All other *F*s were smaller than one.

Discussion

Experiment 2 showed a complete removal of the congruency effect observed in Experiment 1. Therefore, the progressive fixation points as used by Meier and Robinson (2004) were instrumental in generating the effect in Experiment 1. In all likelihood, they were also responsible for the effect observed by Meier and Robinson (2004). We suggest that they induce the interaction between the physical dimension of location in vertical space and the abstract dimension of affective evaluation by acting as an exogenous cue to vertical location, thereby increasing its activation and opening the door to spatial effects on the processing of evaluative judgments. In the following experiment we tested whether the congruency effect can be reintroduced by means of endogenous attention.

Experiment 3

The present experiment replicated Experiment 2 in all respects but one: participants were warned that more words would be presented at one of the two screen positions and that they should report at the end of the session in which position more words had appeared. The task was presented as a difficult task, as the number of words appearing at each position would be only slightly different. Actually, as in Experiment 2, there were exactly 50% words at each site.

Note that this procedure did not call attention to the meaning of the words whatsoever, nor to its metaphorical relation to the vertical axis. By receiving this instruction, participants were expected to endogenously direct their attention to the vertical location of the words, without affecting how word meanings are processed.

Results

Insert Table 4 about here

Cell means are shown in Table 4. The analysis of latency replicated the main effects of Block ($F(1,41) = 78.88$, $MSE = 9706.25$, $p < 0.001$), Evaluation ($F(1,41) = 9.35$, $MSE = 5529.5$, $p < 0.01$) and Position ($F(1,41) = 20.12$, $MSE = 3485.688$, $p < 0.001$), as well as the interaction between Block and Evaluation ($F(1,41) = 6.10$, $MSE = 1991.98$, $p < 0.05$). Importantly, the interaction of Evaluation and Position approached significance ($F(1,41) = 2.91$, $MSE = 2233.21$, $p = 0.09$), and there was a significant three-way interaction between Block, Evaluation and Position ($F(1,41) = 5.05$, $MSE = 3109.53$, $p < 0.05$). This interaction was due to the congruency effect being clearer in the first half of the experiment ($F(1,41) = 7.44$, $MSE = 2850.62$, $p < 0.01$), and disappearing in the second half ($F < 1$). In size, the effect changed from 22 ms in the first block to -5 ms in the second block (see Table 1).

In the analysis of accuracy only the main effects were significant or approached significance (Evaluation: $F(1,41) = 5.43$, $MSE = 0.003159$, $p < 0.05$; Block: $F(1,41) = 2.40$, $MSE = 0.002499$, $p = 0.12$; Position: $F(1,41) = 3.40$, $MSE = 0.003126$, $p = 0.07$). No other F was greater than one.

Discussion

The instruction provided to the participants in Experiment 3 was able to reintroduce the congruency effect between spatial location and evaluative meaning in the first block of the task. Upon debriefing, several participants spontaneously commented that they started the experiment trying to keep a running count of the number of words presented at each location, but that they found the task extremely difficult and after a while they just gave up. If this was the case for a large enough number of participants, it may explain why the congruency effect was restricted to the first block.

Whatever the reason why the effect was manifested only in the first block, the important result of Experiment 3 is that the mere instruction to pay attention to the vertical dimension of space was able to induce an interaction between vertical location and evaluative meaning. We now turn to assess the other direction of the congruency effect: from word meaning to spatial judgments.

Experiment 4

In Experiment 4, the task was to decide whether a word had been presented at the upper or lower position. The experiment was an exact replication of Experiment 2 above, with the only change of the type of judgment from affective evaluation (“positive” vs. “negative”) to location (“up” vs. “down”). Participants were informed that words referring to an emotional state would be presented on the screen and that their task was to judge the place of presentation of the word by pronouncing aloud “arriba” (up) or “abajo” (down). It was emphasized that the emotional meaning was irrelevant to the task, and that they should concentrate only on discriminating the locus of word presentation.

Results

Insert Table 5 about here

Cell means are presented in Table 5. In the latency analysis, there was an interaction between Block and Position ($F(1,39) = 3.81$, $MSE = 523.94$, $p < 0.05$), and the interaction between Block and Evaluation approached significance ($F(1,39) = 3.15$, $MSE = 613.54$, $p = 0.08$). No other F was greater than one. Therefore, there was no trace of an interaction between Position and Evaluation. The size of the overall congruency effect was 0 ms (see Table 1). The accuracy analysis also showed the interaction of Block and Position ($F(1,39) = 6$, $MSE = 0.000231$, $p < 0.05$). No other F was greater than one, with the only exception of the interaction between Evaluation and Position ($F(1,39) = 2.32$, $MSE = 0.000336$, $p = 0.13$).

Comparisons across Experiments 2 and 4 showed that the use of a spatial judgment made the task much easier, leading to an important increase in overall speed (from 1059 ms in Experiment 2 to 506 ms in Experiment 4, $t(80) = 21.85$, $p < 0.001$) and an increase in accuracy (from 96.6% in Experiment 2 to 99.6% in Experiment 4, $t(80) = -8.03$, $p < 0.01$).

Discussion

The change from an evaluative judgment to a spatial judgment made the task much easier for the participants, indicating that the dimension of vertical space is much easier to discriminate than the dimension of evaluative meaning. No traces of an interaction between evaluation and position were found, which may be interpreted as favouring the notion of asymmetric congruency effects: the processing of irrelevant evaluatively loaded primes were unable to affect spatial discriminations.

However, it might be argued that the lack of congruency effect observed in this experiment was due simply to the fact that participants did not need to read the words at all to carry out the task. If this were the case, it would be hardly surprising that their meaning did not interact with the position of the word on the screen. In order to control for this possibility, we ran a control experiment to ensure that participants did actually read the words.

Experiment 5

In this experiment, we replicated Experiment 4 in all details, with only one additional feature: on 20% of the trials, the participant was prompted to repeat aloud the word that had just been presented. This procedure should secure that participants read (at least most of) the words and commit them to memory.

The prompt was a string of question marks ("????") presented at the same location as the word. It was presented in one randomly chosen trial out of every five correct trials, after the participant's response, the removal of the word, and the 1000 ms interval during which the experimenter could stop the experiment if she detected an error. Participants were instructed to respond to the prompt by saying aloud the word that had just been presented. This second vocal response was not timed, and the instructions emphasized only the importance of being precise. The experimenter was informed of the correct response on her screen, and coded the accuracy of the participant's response by pressing one of two keys. Anything but the exact presented word was marked as an error, although disfluencies were permitted.

Results

Overall, participants performed quite well on the control question, reporting the presented word accurately 94.7% of the time. Even though this procedure made participants to respond more slowly on the main task (from an average latency of 506 ms in Experiment 4 to 776 ms in Experiment 5, a significant difference: $t(82) = -9.94$, $p < 0.001$), it did not make the task more difficult (99.6% in Experiment 4 versus 99.5%, $t(82) = 0.90$, $p = 0.36$).

Insert Table 6 about here

Cell means are presented in Table 6. In the analysis of latency, only Block was marginally significant ($F(1,43) = 4.02$, $MSE = 9129.18$, $p = 0.05$). The only other effects with an F value under 1 were Position ($F(1,43) = 2.28$, $MSE = 3204.09$, $p = 0.13$) and the interaction of Block and Evaluation ($F(1,43) = 2.33$, $MSE = 2169.47$, $p = 0.13$). Thus, there was no trace of the Evaluation X Position interaction. The overall congruency effect amounted to 2 ms.

In the analysis of accuracy there were no significant effects, but two interactions approached significance: the interaction of Block and Position ($F(1,43) = 2.95$, $MSE = 0.000551$, $p = 0.09$) and the interaction of Position and Evaluation ($F(1,43) = 3.06$, $MSE = 0.000324$, $p = 0.08$). The shape of the latter agreed with the expected congruency effect, with greater accuracy in congruent than incongruent conditions.

Discussion

In Experiment 5, participants were asked to report the presented word on one fifth of the trials, after giving their spatial judgment. Again, no congruency effect between Position and Evaluation was observed. However, it is interesting to note that there was a trend toward such effect in the accuracy analysis. This leaves open the possibility that a stronger congruency effect could be found if participants are forced to process the words even more carefully. In the following experiment, instead of checking their processing of the words in one fifth of the trials, we used a go-no go lexical decision task that should force them to read very carefully each word before starting to prepare their spatial judgment.

Experiment 6

In this experiment, everything was kept the same as in Experiment 4, with the exception that the same amount of pseudowords were added to the prior word set, and the spatial judgment was to be produced only if the presented string was a real word. Otherwise, the participant was to remain silent. The 48 pseudowords were perfectly pronounceable in Spanish and matched the experimental words in number of syllables and stress pattern. If the vocal key detected any noise during pseudoword trials, a feedback message (“ERROR”) was presented for 500 ms one line above the string.

Results

Participants correctly refrained from responding in 96.4% of pseudoword trials. The go-no go lexical decision made latencies even longer (1042 ms versus 776 ms, $t(82) = 8.59$, $p < 0.001$) and significantly reduced the overall accuracy of the task with respect to Experiment 4 (99.2% versus 99.6%, $t(78) = -2.52$, $p < 0.05$) but not with respect to Experiment 5 (99.2% versus 99.5%, $t(82) = -1.65$, $p = 0.10$).

Insert Table 7 about here

Cell means are shown in Table 7. In the analysis of latency there were significant effects of Block ($F(1,39) = 5.30$, $MSE = 6336.70$, $p < 0.05$) and of Evaluation ($F(1,39) = 42.87$, $MSE = 2992.90$, $p < 0.001$). The only other effect that approached statistical significance was the three-way interaction of Block, Position and Evaluation ($F(1,39) = 2.11$, $MSE = 3232.25$, $p = 0.15$). Numerically, this resulted in a congruency effect of -4 ms in the first block which raised to 14 ms in the second block. An ANOVA on only the second block showed that this effect was nonetheless still non-significant ($F(1,39) = 2.98$, $MSE = 2763.38$, $p = 0.09$).

The analysis of accuracy revealed a main effect of Evaluation ($F(1,39) = 6.64$, $MSE = 0.000539$, $p < 0.05$), a marginal interaction between Block and Position ($F(1,39) = 3.90$, $MSE = 0.000655$, $p = 0.06$) and an also marginal interaction between Block, Position and Evaluation ($F(1,39) = 3.45$, $MSE = 0.000782$, $p = 0.07$). In contrast to the observations on the latency measure, the non-significant congruency effect on accuracy was numerically stronger in the first block than in the second.

Discussion

Experiment 6 introduced a go-no go lexical decision before the spatial judgment. This manipulation made the task more difficult and slow, which suggests that participants did invest a greater effort in processing the meaning of the words. Indeed, a very clear main effect of evaluative meaning arose on both latency and accuracy, which had not been observed in the prior experiment. However, once again we only found some non-significant traces of a congruency effect. So far, a safe conclusion would be that affective evaluation has a smaller (if any) effect on space than space has on evaluation, and that this asymmetry is not due to a defective processing of the words used in the task.

In the next, and last, experiment of this series we will test whether an endogenous attentional cue to evaluative meaning is effective in making word meaning able to induce a clear conceptual congruency effect on the processing of spatial judgments.

Experiment 7

In this experiment we used an endogenous attentional paradigm to increase the activation of the evaluative dimension, in a way analogous to that used in Experiment 3. The procedure was kept identical to Experiment 4 with only one exception: participants were instructed that there would be more words referring to positive or negative emotions and that they should report which was the category with more words at the end of the experiment. Apart from this instruction, there were no other changes in the procedure (that is, there were exactly 50% positive and 50% negative words). The task was presented as a difficult task, so it was emphasized that they should pay close attention to the words.

Results

Insert Table 8 about here

Cell means are presented in Table 8. The analysis of latency found main effects of Block ($F(1,39) = 12.89$, $MSE = 7383.19$, $p < 0.001$) and Position ($F(1,39) = 11.96$, $MSE = 3363.48$, $p < 0.01$). Importantly, the analysis revealed the expected interaction between Evaluation and Position ($F(1,39) = 6.25$, $MSE = 1080.14$, $p < 0.05$). The congruency effect amounted to 9 ms (see Table 1). There were no other effects with a p value smaller than 0.15, so the effect did not change across blocks. There were no significant effects on accuracy data. The only p value smaller than 0.15 corresponded to the interaction between Block and Position ($F(1,39) = 2.55$, $MSE = 0.000543$, $p = 0.11$).

Discussion

The instruction to attend to the evaluative meaning of the words resulted in a congruency effect between evaluation and vertical position. In contrast to Experiment 3, which used an analogous manipulation with respect to the dimension of space in an evaluative judgment task, the congruency effect did not vary along the experiment. For some as yet unknown reason, the participants decided to stick to the instructions all along the session, instead of giving up the task after the first block, as they possibly did in Experiment 3.

Regardless of why the congruency effect was observed in the two blocks instead of only one, the fact remains that the instruction to attend to the emotional meaning was able to induce the interaction between the vertical spatial dimension and the evaluative dimension. This occurred in the face of clear differences in the easiness of making discriminations on the dimensions of space and evaluation. Overall, experiments using a spatial discrimination task were easier (more accurate) than those using an affective evaluation judgment. If we compare the spatial task with the lowest accuracy (Experiment 6 with the go - no go lexical decision task, 99.2% overall accuracy) with the evaluative task with the highest accuracy (Experiment 2, 96.6% accuracy), it is clear that the latter is more difficult ($t(80) = -6.46$, $p < 0.001$). There is, thus, a processing disadvantage toward the evaluative dimension. However, this disadvantage was not enough to preclude the irrelevant dimension of evaluation to interfere with the processing of vertical space. An attentional manipulation was able to make a dimension which is more difficult to process (such as evaluation) affect the processing of another dimension which is much easier to process (such as vertical space).

The observed congruency effect was not just a by-product of a more detailed processing of the words or an overall slower responding in the present experiment. Experiment 7 was actually faster (with a grand average of 657 ms) than the two prior controls, Experiments 5 (776 ms, $t(82) = -3.98$, $p < 0.001$) and 6 (1042 ms, $t(82) = -13.55$, $p < 0.001$). What is more, Experiment 7 was not significantly less accurate (99.2%) than Experiment 5 (99.5%, $t(82) = -1.45$, $p = 0.15$) nor was it than Experiment 6 (99.2%). Whereas the two prior control experiments only found non-significant traces of a congruency effect from evaluation on space, Experiment 7 found a clearly significant interaction between evaluation and space.

General discussion

In the present study, conceptual congruency effects between the dimensions of affective evaluation and vertical space were assessed in both directions: space on evaluative judgments, and evaluation on spatial judgments, and the mediating influence of attentional factors was explored.

This conceptual mapping was selected as a testbed because the frequency with which one domain is talked in terms of the other in language shows a strong asymmetry: whereas it is common to talk about emotion using vertical terms, emotion terms are never used to denote vertical locations or motion. In these conditions, the Metaphor View (Boroditsky, 2000; Casasanto & Boroditsky, 2008) predicts asymmetric effects: the effect of space on evaluation should be stronger than the converse effect of evaluation on space. In contrast, ATOM (Walsh, 2003) predicts bidirectional, similarly sized, effects, because both dimensions are prothetic and should be processed by accessing a common underlying representation. Importantly, none of these approaches predicts any flexibility in the congruency effects linked to mediating factors such as attentional cueing to one or another of the intervening dimensions. A third view, Coherent Working Models theory (Santiago et al, in press) does predict that congruency effects on both directions should be possible, and that their relative size should depend on the overall level of activation of the conceptual dimensions, which would be in turn dependent on factors such as relative saliency, discriminability, automaticity, and the presence of attentional cues.

Two pairs of experiments provided identical conditions to test the directionality of the congruency effects: Experiments 2 versus 4, and Experiments 3 versus 7 (see Table 1). The contrast between Experiments 2 and 4 provided conditions with no attentional cueing to any dimension. Experiments 3 and 7 added instructions to endogenously orient attention to the irrelevant dimension. The first member of each pair used an evaluative judgment and the second a spatial judgment. Present results clearly showed no differences between the two directions of the congruency effect. Experiment 2 found a congruency effect of 1 ms versus 0 ms in Experiment 4. Experiment 3 found an overall congruency effect of 9 ms versus 9 ms in Experiment 7. If we look only to the first block, Experiment 3 found an effect of 22 ms versus 11 ms in Experiment 7, a non-significant difference ($t(80) = 1.10$, $p = 0.27$).

Regarding the effect of attentional cueing, present results show that, in conditions without attentional cueing to any dimension (Experiment 2 for an evaluative judgment, and Experiments 4, 5, and 6 for a spatial judgment), no clear congruency effects are found in any direction. When attention is cued to the spatial dimension, either by exogenous (Experiment 1) or endogenous means (Experiment 3), spatial location influences evaluative judgments. When attention is, instead, endogenously cued to the evaluative dimension (Experiment 7), evaluative meaning is able to affect spatial judgments. The size of the congruency effect in both directions was statistically indistinguishable, in spite of the fact that the spatial judgment was clearly easier to perform. Attention does seem to be able to effectively modulate the manifestation of conceptual congruency effects in both directions and to the same extent.

The present experiments question the general validity of the Metaphor View. As discussed in the introduction, the clearest evidence favouring asymmetric priming effects in the context of asymmetric linguistic patterns comes from the conceptual mapping of space and time (Casasanto & Boroditsky, 2008; Casasanto et al, 2010). Lacking a definitive test for the domain of space and time, we can conclude that the prediction of asymmetric priming effects between concrete and abstract domains is not a general property of all conceptual mappings. The pattern of results is broadly more consistent with symmetric effects, as predicted by ATOM. Present results also extend ATOM with the inclusion of a new prothetic dimension which had not been tested so far, emotional evaluation, which comes to join the better studied dimensions of space, time, number, size, and brightness.

However, it is important to note that present results qualify both theoretical views, as none of them include mechanisms that may account for the mediating effects of attentional cueing. In contrast, the model proposed by Santiago et al (in press) can readily explain the results of Experiments 1 and 3: the cueing of space (either exogenously or endogenously) made participants pay attention to the words' vertical location, and therefore, the vertical spatial dimension was included in the working model of the task. The evaluative dimension was also included in the model because it was necessary to guide responses in the task, and it was represented as another vertical axis. Attentional cueing and the greater easiness of processing the vertical spatial dimension made its activation level greater than the activation level of the evaluative dimension. Thus, both dimensions were retained in the working model. When a word was presented in incongruent trials, its representation in working memory was simultaneously located in two different positions in the model (high in the spatial axis, low in the evaluative axis, or viceversa), which led to a non-optimal level of internal coherence responsible for slowing down the response. For analogous reasons, when evaluative meaning was attentionally cued (endogenously) in Experiment 7, the evaluative dimension was retained and the resulting model was less-than-optimally coherent in the incongruent conditions, making the congruency effect appear on spatial judgments.

Why, then, no congruency effect was observed in Experiments 2 and 4? We suggest that the vertical axis representing the irrelevant dimension was not included in the model of the task at all in these cases. In Experiment 2, locating the words in space in order to read them and access their meaning did not require placing them in a specific position on the vertical axis. In a classic treatment of deixis in language, Levelt (1989, p. 52) noted that “there is local reference without an implicit or an explicit coordinate system” and offered the locatives “here” and “there” as examples. These locatives only specify a certain distance from the speaker, without resort to any reference frame. A pointing gesture identifies its referent in a similar vein. We suggest that an evaluative task can be carried out just by locating the words in this way, as “there”. If this is the case, evaluative judgments can proceed unimpeded by vertical word location, as this is not present in the model of the situation. For analogous reasons, in Experiment 4 the evaluative dimension was probably not included in the model of the task at all, and so, it had no chance to affect spatial judgments. When Experiments 5 and 6 forced participants to ponder the words' meaning to a greater depth and for longer time, probably some of them included the evaluative dimension in the model of the task. But, not being required by the task, this strategic choice was not consistently taken, which led to the observed non-significant traces of congruency effects.

The reader is referred to Santiago et al (in press) for a detailed exposition of the components of the model, as well as of its wider implications for the problems of symbol grounding and the notion of embodiment. The main point to be noted here is that the effects of mediating factors, such as attentional cueing, on conceptual congruency effects suggest the need of an important change in the theoretical interpretation of these effects, a change from the currently standard emphasis on fixed, stable semantic memory representations to an emphasis on flexible, strategic working memory representations and processes.

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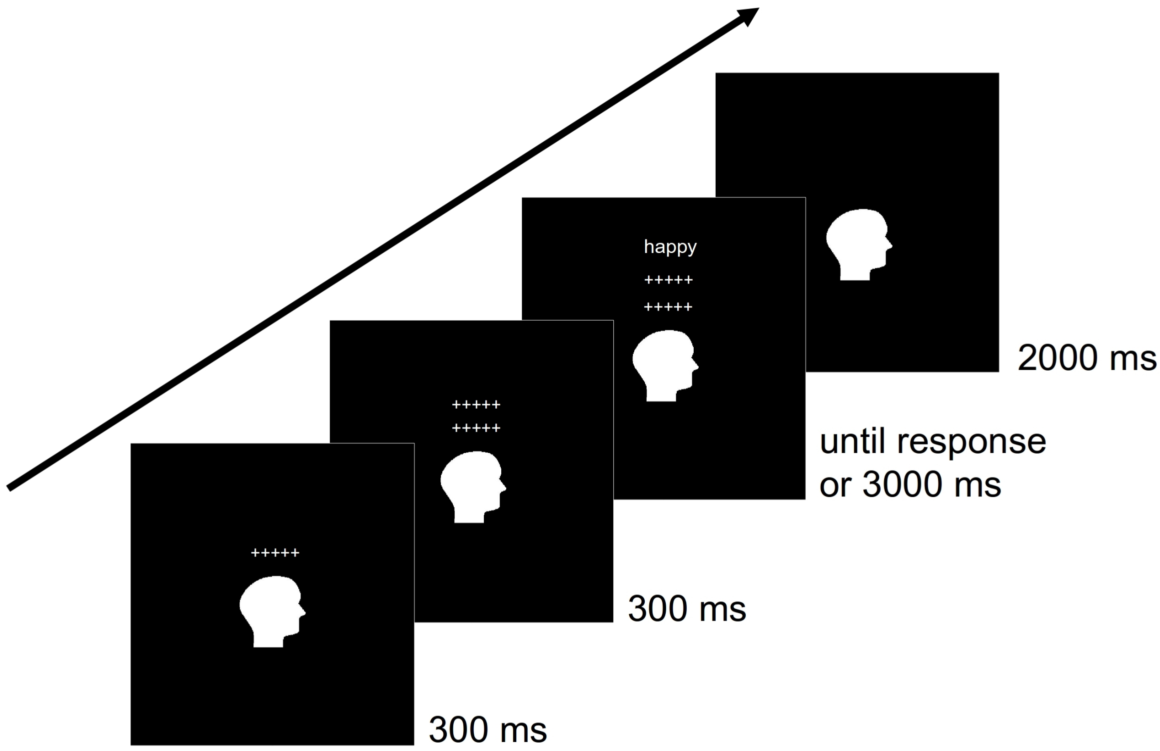
APPENDIX

Positive words	Negative words
alegre (happy)	triste (sad)
enamorado (in love)	inseguro (insecure)
ilusionado (looking forward to, eager)	miedoso (fearful)
animado (cheerful)	tímido (shy)
seguro (sure)	aburrido (boring)
valeroso (brave)	apocado (timid)
extrovertido (extroverted)	apenado (sad)
divertido (funny)	desesperado (desperate)
energético (full of energy)	desilusionado (dissilusioned)
entusiasmado (enthusiastic)	angustiado (anguished)
bromista (joker)	ansioso (anxious)
tranquilo (relaxed)	desgraciado (unhappy)
contento (happy)	avergonzado (ashamed, embarrassed)
orgulloso (proud)	acomplejado (full of complexes)
simpático (nice, charming)	preocupado (worry)
sereno (calmed)	decepcionado (disappointed)
atrevido (daring)	asustado (frightened)
apasionado (passionate)	acongojado (distressed)
relajado (relaxed)	indefenso (unhelpless)
confiado (confident)	melancólico (melancholic)
gozoso (joyful)	desolado (devastated)
incansable (tireless)	frustrado (frustrated)
encantado (delighted)	abrumado (overwhelmed)
satisfecho (satisfied)	aterrado (scared)

Figure captions

Fig. 1.- Trial structure in Experiment 1.

Figure 1



Tables

Table 1.- Overview of the experimental series and its main results, focusing on the congruency effect on latencies both overall and within blocks. “M&R” refers to the general guidelines of Meier & Robinson's (2004) procedure: words presented on upper and lower locations preceded by progressively approaching fixation crosses. “Task” refers to the type of judgment requested from the participants: either affective evaluation or space (location). The lower cut-off for trimming of outliers was set at 250 ms and held constant across experiments. The upper cut-off varied to adapt to differing global speeds, such that the total amount of rejected outliers would approach 1% of correct trials. An asterisk means that the corresponding *p* value was smaller than 0.05. The significance of the congruency effect within each block is presented only when the interaction of Block, Position and Evaluation was significant.

Exp#	Brief description	Task	N	Vocal key failures	Total errors	Upper cut-off	Total outliers	Grand mean latency (in ms)	Grand mean accuracy	Overall congruency effect (in ms)	*p* of Block X Position X Eval.	Block 1 congruency effect (in ms)	Block 2 congruency effect (in ms)
1	M&R	Eval.	40	19 (0.49%)	156	1850	40 (1.09%)	933	95.9%	13*	n.s.	13	13
2	M&R without fixation	Eval.	42	18 (0.44%)	135	1900	42 (1.08%)	1059	96.6%	1	n.s.	-1	2
3	M&R without fixation + attention to space	Eval.	42	27 (0.67%)	136	2000	38 (0.98%)	1121	96.6%	9	*	22*	-5
4	M&R without fixation	Space	40	13 (0.34%)	12	875	41 (1.07%)	506	99.6%	0	n.s.	2	-2
5	M&R without fixation + 20% word check	Space	44	30 (0.71%)	19	1700	45 (1.08%)	776	99.5%	2	n.s.	4	0
6	M&R without fixation + lex. dec.	Space	40	66 (1.71%)	29	2000	34 (0.9%)	1042	99.2%	5	n.s.	-4	14
7	M&R without fixation + attention to evaluation	Space	40	25 (0.65%)	32	1300	40 (1.05%)	657	99.2%	9*	n.s.	11	7

Table 2.- Cell means in Experiment 1. Latency is rounded to the nearest millisecond. Accuracy is presented as proportion of correct trials (in brackets).

Position	Evaluation	Block 1	Block 2	Total
up	positive	936 (0.964)	883 (0.949)	909 (0.957)
up	negative	994 (0.941)	896 (0.970)	945 (0.956)
down	positive	963 (0.953)	907 (0.976)	935 (0.965)
down	negative	994 (0.954)	895 (0.962)	945 (0.958)

Table 3.- Cell means in Experiment 2. Latency is rounded to the nearest millisecond. Accuracy is presented as proportion of correct trials (in brackets).

Position	Evaluation	Block 1	Block 2	Total
up	positive	1068 (0.963)	999 (0.976)	1034 (0.969)
up	negative	1107 (0.960)	1024 (0.970)	1065 (0.965)
down	positive	1091 (0.957)	1016 (0.970)	1053 (0.963)
down	negative	1131 (0.962)	1036 (0.970)	1084 (0.966)

Table 4.- Cell means in Experiment 3. Latency is rounded to the nearest millisecond. Accuracy is presented as proportion of correct trials (in brackets).

Position	Evaluation	Block 1	Block 2	Total
up	positive	1126 (0.961)	1053 (0.966)	1090 (0.964)
up	negative	1186 (0.975)	1061 (0.981)	1123 (0.978)
down	positive	1174 (0.944)	1081 (0.961)	1128 (0.953)
down	negative	1189 (0.964)	1098 (0.970)	1144 (0.967)

Table 5.- Cell means in Experiment 4. Latency is rounded to the nearest millisecond. Accuracy is presented as proportion of correct trials (in brackets).

Position	Evaluation	Block 1	Block 2	Total
up	positive	505 (1.0)	512 (0.997)	508 (0.998)
up	negative	502 (0.997)	515 (0.991)	509 (0.994)
down	positive	508 (0.993)	501 (0.997)	504 (0.995)
down	negative	501 (0.995)	508 (1.0)	504 (0.997)

Table 6.- Cell means in Experiment 5. Latency is rounded to the nearest millisecond. Accuracy is presented as proportion of correct trials (in brackets).

Position	Evaluation	Block 1	Block 2	Total
up	positive	793 (0.992)	767 (0.998)	780 (0.995)
up	negative	788 (0.988)	773 (0.998)	780 (0.993)
down	positive	788 (0.996)	758 (0.992)	773 (0.994)
down	negative	775 (0.998)	764 (1.0)	769 (0.999)

Table 7.- Cell means in Experiment 6. Latency is rounded to the nearest millisecond. Accuracy is presented as proportion of correct trials (in brackets).

Position	Evaluation	Block 1	Block 2	Total
up	positive	1038 (0.993)	1009 (0.987)	1024 (0.990)
up	negative	1076 (0.993)	1061 (0.993)	1069 (0.993)
down	positive	1024 (0.978)	1016 (0.995)	1020 (0.987)
down	negative	1070 (0.997)	1040 (0.997)	1055 (0.997)

Table 8.- Cell means in Experiment 7. Latency is rounded to the nearest millisecond. Accuracy is presented as proportion of correct trials (in brackets).

Position	Evaluation	Block 1	Block 2	Total
up	positive	677 (0.987)	650 (0.993)	663 (0.990)
up	negative	689 (0.989)	657 (0.997)	673 (0.993)
down	positive	670 (0.991)	630 (0.995)	650 (0.993)
down	negative	660 (0.991)	622 (0.985)	641 (0.988)