Acta Psychologica 156 (2015) 179–191

Contents lists available at ScienceDirect

Acta Psychologica

journal homepage: www.elsevier.com/locate/actpsy

Can conceptual congruency effects between number, time, and space be accounted for by polarity correspondence?

Julio Santiago [a,b,*], Daniël Lakens [c,1]

[a] Mind, Brain, and Behavior Research Center, University of Granada, 18071 Granada, Spain
[b] Dept. of Experimental Psychology, University of Granada, 18071 Granada, Spain
[c] School of Innovation Sciences, Eindhoven University of Technology, Faculty of IE&IS, Room IPO 1.24, Postbus 513, 5600 MB Eindhoven, The Netherlands

A R T I C L E I N F O

Available online 24 December 2014

PsycINFO code:
2340

Keywords:
Conceptual metaphor
Polarity correspondence
Space
Time
Number
Conceptual congruency

A B S T R A C T

Conceptual congruency effects have been interpreted as evidence for the idea that the representations of abstract conceptual dimensions (e.g., power, affective valence, time, number, importance) rest on more concrete dimensions (e.g., space, brightness, weight). However, an alternative theoretical explanation based on the notion of polarity correspondence has recently received empirical support in the domains of valence and morality, which are related to vertical space (e.g., good things are up). In the present study we provide empirical arguments against the applicability of the polarity correspondence account to congruency effects in two conceptual domains related to lateral space: number and time. Following earlier research, we varied the polarity of the response dimension (left-right) by manipulating keyboard eccentricity. In a first experiment we successfully replicated the congruency effect between vertical and lateral space and its interaction with response eccentricity. We then examined whether this modulation of a concrete-concrete congruency effect can be extended to two types of concrete-abstract effects, those between left-right space and number (in both parity and magnitude judgment tasks), and temporal reference. In all three tasks response eccentricity failed to modulate the congruency effects. We conclude that polarity correspondence does not provide an adequate explanation of conceptual congruency effects in the domains of number and time.

1. Introduction

Recent years have witnessed a strong interest in the possibility that the mental representation of abstract concepts relies in a deep sense on more concrete concepts (Dehaene, 1997; Lakoff and Johnson, 1999; Mandler, 1992; Walsh, 2003). Under this view, an abstract conceptual domain imports structure and content from a better understood, more clearly delineated, more concrete conceptual domain. For example, time is understood as physical motion from one location to another, either along the front-back axis (Boroditsky, 2000) or the left-right axis (Santiago et al., 2007). Other examples include power and size (Sorokowski, 2010), affective evaluation and vertical location (Crawford et al., 2006) or brightness (Meier, Meier et al., 2004), gender stereotypes and toughness (Slepian et al., 2011) and numerical magnitude and the left-right axis (Dehaene et al., 1993). Such a view suggests that the mental representation of concepts is hierarchically structured, such that more concrete concepts are more directly linked to perceptual-motor experiences, and these in turn are used to support the understanding of more abstract levels (Lakoff and Johnson, 1999). According to this theoretical viewpoint, the whole human conceptual structure is anchored to, or grounded in our embodied interaction with the external world (see Lakens, 2014; Santiago et al., 2011).

An important source of evidence for such a view comes from conceptual congruency tasks. In these tasks, bi-polar endpoints of a concrete and an abstract dimension are factorially crossed. Participants' main task requires the processing of the abstract dimension (e.g., by categorizing words on their meaning), and the effects of the concrete, task-irrelevant dimension (e.g., their spatial position on the screen) are measured. When task-irrelevant cues interact with semantic categorization judgments, the congruency effect is often interpreted as support for the idea that people use concrete representations to mentally scaffold abstract judgments. A well-known example is the Spatial-Numerical Association of Response Codes (SNARC) effect (Dehaene et al., 1993). In a typical SNARC task, the participant has to make a numerical categorization, such as deciding whether a number is odd or even (a "parity task"), by means of left or right key presses. The response location (left or right) is the task-irrelevant concrete dimension. The standard result, now widely replicated, consists in faster categorizations when responding to a small number with the left hand and to a large number with the right hand versus using the reverse mapping (for reviews, see Gevers

* Corresponding author at: Dept. de Psicología Experimental, Universidad de Granada, Campus de Cartuja s/n, 18071 Granada, Spain. Tel.: +34 958 246278; fax: +34 958 246239.

E-mail addresses: santiago@ugr.es (J. Santiago), D.Lakens@tue.nl (D. Lakens).

[1] Tel.: +31 40 2474581.

http://dx.doi.org/10.1016/j.actpsy.2014.09.016
0001-6918/

and Lammertyn, 2005; Wood et al., 2008). Analogous findings have been observed for temporal concepts, with better performance when past is mapped to left and future to right space (for a review, see Bonato et al., 2012). These congruency effects are often interpreted as evidence for the use of a spatial left-right line to mentally represent the abstract concepts of number magnitude and time.

1.1. Polarity correspondence

Interpreting congruency effects as evidence for how people mentally represent concepts has not been free from criticism, both on theoretical (e.g., Dove, 2009; Kranjec and Chatterjee, 2010; Machery, 2009; Mahon and Caramazza, 2008; Paivio, 1986) and empirical grounds (e.g., Eder and Rothermund, 2008; Hutchinson and Louwerse, 2014; Kemmerer, 2005; Santens and Gevers, 2008). One recent alternative account for conceptual congruency effects is based on the concept of markedness and the principle of polarity correspondence (Proctor and Cho, 2006; see Lakens, 2011; Louwerse, 2011; Van Dantzig and Pecher, 2011). According to the polarity correspondence view, concrete representations of any kind may not be needed to account for many of the published conceptual congruency effects: mappings between two bi-polar dimensions can emerge based on purely structural features.

The concept of markedness has a long tradition in linguistics (Greenberg, 1963) and psycholinguistics (Clark, 1969). The two poles of most conceptual dimensions (e.g., happiness or tallness) do not seem to enjoy the same representational status. One endpoint, which we will refer to as the *+pole*, is used to refer to the whole dimension (e.g., tall, happy), whereas the other, the *−pole*, is used to refer only to itself (e.g., sad, shot). For example, compare the sentence "how tall is John?" versus "how short is John?". Whereas the first question does not presuppose that John's height is in any specific range, the second question implies that John is short. The *+pole* is more frequent in language and enjoys a processing advantage compared to the *−pole* (Clark, 1969). Proctor and Cho (2006), drawing on ideas first put forward by Seymour (1974), proposed that when two or more dimensions are crossed in a reaction time task, the final pattern of latencies can be predicted from the degree of correspondence between the polarity of the dimensions. When applied to the case of two bi-polar dimensions, this *polarity correspondence principle* predicts that there will be a processing advantage in those conditions where the two polar signs match. Because both the marked polarity of dimensions as well as the principle of polarity correspondence are purely structural features of the mental representation of conceptual dimensions, a polarity correspondence account of conceptual congruency effects does not require the postulation of concrete mental representations (Lakens, 2012).

Proctor and Cho (2006) review many different literatures where the polarity correspondence principle applies or could apply, including stimulus-response compatibility tasks, picture-sentence matching tasks, and orthogonal Simon tasks. The latter are central to the rationale of the present experiment series, so we will describe them in some detail. In a typical orthogonal Simon task, participants are presented with a stimulus in one of two vertical locations (e.g., above or below a fixation point) and are asked to discriminate the location of the stimulus by means of a left or right key-press or a leftward or rightward response with a joystick.[2] The basic finding is that people respond faster when the upper location is mapped onto the right response (and down locations are mapped onto left responses), compared to an up-left down-right mapping (see Proctor and Cho, 2006, for an overview). Following Weeks and Proctor (1990), Proctor and Cho (2006) proposed that the up-right advantage is due to the polarity correspondence principle, because up and right are the *+poles* of the vertical and lateral spatial dimensions.

One central characteristic of the polarity correspondence account is that polarities are flexible and can be changed by manipulating the salience or attention paid to each endpoint. This makes it possible to manipulate polarity benefits experimentally. One way to do it is varying response eccentricity, that is, the lateral displacement of the response device. Response eccentricity has been shown to modulate the observed up-right advantage in orthogonal Simon tasks. When the response box, keyboard, or joystick is placed to the right of the screen, the up-right advantage grows stronger. When the response set is located in left space, an up-left advantage is observed instead (Proctor and Cho, 2003). Proctor and Cho (2003); see also Cho and Proctor, 2003; Proctor and Cho, 2006; Weeks et al., 1995) suggested that response eccentricity changes the saliency of the right and left poles of the lateral spatial dimension, effectively turning the left pole into the *+pole* when the responses are placed on left space and thus generating the up-left advantage through polarity correspondence. This reasoning is in line with data that show that the endpoint taking *+polar* value depends on context (e.g., Banks et al., 1975).

1.2. Applying polarity correspondence to concrete–abstract congruency

The orthogonal Simon effect arises when two concrete (spatial) dimensions are crossed, but the hypothesis of polarity correspondence can be straightforwardly generalized to situations where one concrete and one abstract dimension are crossed. Lakens (2012) adopted this perspective to examine conceptual congruency effects between vertical locations (up vs. down) and the abstract dimensions of power and valence. He reasoned that the conceptual metaphor account predicts a cross-over interaction without main effects, whereas the polarity correspondence account predicts main effects of each dimension (due to the processing advantage of the *+pole*) as well as an interaction due to polarity correspondence. When both main effects and their interaction are put together, the polarity correspondence account predicts that moral or positive words will be categorized faster when presented in upper versus lower space, but categorization times for immoral or negative words will be overall slower and will not depend on the spatial position of the stimulus. A meta-analysis of prior studies supported this prediction. Lynott and Coventry (2014) have similarly found the pattern predicted by the polarity correspondence account using happy and sad faces presented up or down on the screen (see also de la Vega et al., 2013).

Polarity correspondence therefore stands as an important theoretical contender in conceptual congruency studies. The importance to differentiate between polarity correspondence and conceptual metaphor accounts has been discussed repeatedly (e.g., de la Vega et al., 2013; Gozli et al., 2013; Schubert, 2005; Ulrich and Maienborn, 2010; Vallesi et al., 2008. However, discriminating between the two alternatives is more difficult than it seems.

1.3. The problem of the interpretation of main effects

The main difficulty is related to the interpretation of the main effects of the dimensions that are crossed in the congruency task. The crucial point is that the conceptual metaphor account does not predict null main effects, but it is instead *silent* about them. Its main prediction is the interaction between the two dimensions, but many other factors may produce main effects for independent reasons. For example, when participants judge the affective valence of positive and negative words, the two conditions may differ in length, frequency of use, bigram or syllable frequency, morphological complexity, and a myriad other factors which are known to affect reading and lexical access. Perceiving upper versus lower stimuli may be affected by extended practice with scanning written texts from top to bottom or the way the task is framed (e.g., Banks et al., 1975). In general, main effects of any concrete or

[2] Typical orthogonal Simon tasks differ from standard Simon tasks in that the vertical location of the stimulus is task relevant, as the participant is instructed to respond to it. In contrast, in a standard Simon task, lateral location of the stimulus is task irrelevant, as the participant is asked to classify other stimulus dimension (often colour).