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Identification of opposites and intermediates by eye and by hand

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ABSTRACT

In this eye-tracking and drawing study, we investigate the perceptual grounding of different types of spatial dimensions such as DENSE–SPARSE and TOP–BOTTOM, focusing both on the participants' experiences of the opposite regions, e.g., O1: DENSE; O2: SPARSE, and the region that is experienced as intermediate, e.g., INT: NEITHER DENSE NOR SPARSE. Six spatial dimensions expected to have three different perceptual structures in terms of the point and range nature of O1, INT and O2 were analysed. Presented with images, the participants were instructed to identify each region (O1, INT, O2), first by looking at the region, and then circumscribing it using the computer mouse. We measured the eye movements, identification times and various characteristics of the drawings such as the relative size of the three regions, overlaps and gaps. Three main results emerged. Firstly, generally speaking, intermediate regions were not different from the poles on any of the indicators: overall identification times, number of fixations, and locations. Some differences emerged with regard to the duration of fixations for point INTs and the number of fixations for range INTs between two range poles (O1, O2). Secondly, the analyses of the fixation locations showed that the poles support the identification of the intermediate region as much as the intermediate region supports the identification of the poles. Finally, the relative size of the three areas selected in the drawing task were consistent with the classification of the regions as points or ranges. The analyses of the gaps and the overlaps between the three areas showed that the intermediate is neither O1 nor O2, but an entity in its own right.

1. Introduction

A puzzling observation that has received a fair amount of attention in science was Galilei's discovery of the isochronous motion of the pendulum. When observing the swinging motion of the chandelier in Pisa Cathedral, Galilei was surprised to note that it appeared to swing slower than he expected it to swing. Subsequent and more recent studies in the field of naïve physics have demonstrated that there is in fact a range of oscillation speed that human observers perceive as natural, i.e., as neither too fast nor too slow (Bozzi, 1958–59; Bressanelli, Bianchi, Burro, & Savardi, 2008; Frick, Huber, Reips, & Krist, 2005; Pittenger, 1990). Galilei's observation is interesting for two reasons. Firstly, it points to the fact that human beings seem to have an intuitive feeling for natural movements of physical phenomena with respect to speed. Secondly, it suggests that humans organize their experiences both in relation to the poles and to the intermediate region. In the case of the chandelier in Pisa, the dimension is SPEED and the opposing poles are FAST and SLOW. In the middle, there is an intermediate range perceived to be the natural speed.

Now, a natural state of perceived intermediateness is by no means restricted to Galilei's observations in Pisa, but applies to much more mundane situations. Several times every day, we are engaged in situations that have to do with the identification of opposites and intermediates. For instance, there are places in our town that we perceive to be near the house where we live, others that we perceive to be far away, and still others that we perceive to be neither near nor far away. The human ability to perceive intermediate regions is by no means restricted to spatial dimensions, but applies in a similar way to various domains such as temperature, smell, touch, taste, and sound. For instance, when we adjust the volume of the radio or the temperature of the air-conditioner, we usually adjust them so that they are neither too high nor too low but at an intermediate level.

In spite of the fundamental role of intermediateness for nearly all doings in our daily lives, there is hardly any research at all on

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intermediate states in psychology or cognitive science. This study aims to start filling that gap by specifically focusing on the nature of intermediateness in perception and cognition. Using pictures, we explore the grounding of participants' perception of the intermediate region (INT) of spatial dimensions, namely the part of the dimension that is perceived as neither one nor the other of the opposite regions (O1, O2).

Dimensional contrast and binary opposition in language have been given a fair amount of attention (Fellbaum, 1995, 1998; Israel, 2004; Jones, Murphy, Paradis, & Willners, 2012; Ogden, 1932; Osgood & Richards, 1973; Paradis, Löhndorf, van de Weijer, & Willners, 2015; Paradis & Willners, 2011). Findings from those studies suggest that opposition is a salient, binary configurational construal along meaning dimensions (Paradis & Willners, 2011), and both behavioral and neurophysiological experiments have shown that opposing expressions (antonyms) along particularly salient dimensions have strong priming effects on one another, both outside and within a specific context (van de Weijer, Paradis, Willners, & Lindgren, 2012, 2014). However, the intermediate region has so far been disregarded in these linguistic studies. The reason may be that there is a conspicuous lack of domain-specific words for intermediateness in many languages of the world. What language users do instead when they talk about intermediate properties is that they say that something is *neither long nor short, neither small nor large*. Speakers may use words such as *middle, in between, half*, or they may add degree modifiers such as *fairly long* or *not short*, which are expressive of a region that may coincide with INT, but is not INT proper since they take the perspective of one of the opposite properties, e.g., *fairly long, fairly short, not long, not short* (Paradis, 1997, 2001, 2008; Paradis & Willners, 2006, 2013). There are, in fact, a few exceptions to this general observation of lack of domain specific words. For instance, along the dimension of temperature, there are expressions such as *lukewarm, tepid* (En), *lau, lauwarm* (Ge), *tibio, templado* (Sp), *tiède* (Fr), *tiepido* (It), *ljum* (Sw), *haalea* (Fi), and there is *oblique,* which refers to a state that is neither perpendicular nor parallel to a given line or a surface along a spatial dimension. *Oblique* is, however, more of a technical term than an expression used in everyday communication. Why some intermediates are lexicalized while others are not is an interesting question to pursue, but before we can do that, we need to determine whether intermediates are indeed real in the sense that they are *experienced as spatial components of dimensions that do not coincide with either of the opposite spatial components*. Should this be the case, future investigations of dimensions and meaning construals of opposing properties and their expressions in language will have to take a new look at the perceptual and conceptual underpinnings of intermediates.

1.1. Perceptual grounding of opposites and intermediates

While there is a fair number of studies on binary contrast, boundaries and ranges in language and cognition based on the assumption that they are perceptually grounded (Paradis, 2008; Paradis & Willners, 2006, 2013; Paradis, Willners, & Jones, 2009), only two previous studies have specifically addressed the question of whether what lies in between the poles is perceived as a gradient extension of the poles, rather than an experience specifically recognized as being neither one pole nor the other (Bianchi, Burro, Torquati, & Savardi, 2013; Bianchi, Savardi, & Kubovy, 2011). In these studies, the perceptual structure of 37 spatial dimensions, e.g., NEAR–FAR, NARROW–WIDE, HIGH–LOW, END–BEGINNING, IN FRONT OF–BEHIND, in terms of three, and not two, components was examined, namely the two opposite poles and the intermediate region. The extensions of the two poles and the intermediate regions were metrically defined by the number of instances in proportion to the whole dimension that adults recognize as different experiences of a property, for instance SMALLNESS, the opposite property, LARGENESS, and the intermediate state, NEITHER LARGE NOR SMALL. The two poles and the intermediate region were also topologically classified, either as points or ranges. For example, along the aperture dimension OPEN–CLOSED, CLOSED is a singular, unique state, a point, whereas OPEN is a range, which comprises various different degrees of OPENNESS, and it was shown that, in most of the cases, the sum of the instances of the two poles did not exhaust the entire dimension (Savardi, Bianchi, & Burro, 2009, pp. 287ff). These experiments resulted in three important findings of relevance for the research presented in this article. Firstly, the participants frequently identified intermediate experiences as neither one pole nor the other (INTs). This intermediate region sometimes consisted in a single experience, i.e., a point (P) property such as 'neither in front of nor behind' (and therefore it has very limited extension within the whole dimension) or a range (R) such as 'neither the end nor the beginning' or 'neither near nor far away' (and therefore it has a larger spatial extension within the dimension). Secondly, they showed that INTs do not necessarily occupy a pivotal position, but can be located closer to one or the other of the opposite poles. Thirdly, INTs were rated at the same speed as the opposite poles, which is a finding of particular importance for the study presented in this article because it suggests that the identification of INT does not involve an operation of double exclusion of the opposite poles as expressions such as *neither–nor* might lead one to think.

In this study, we make use of the above findings about the nature of points and ranges for opposites and intermediates as a springboard for the formulation of new research questions using two different observational techniques: an online eye-tracking task and an offline, drawing task. In order to tap into the participants' perceptual experiences, images showing three spatial Dimension Types are included in the tasks. The component parts of the Dimension Types are O1–INT–O2, where Range–Range–Range (RRR) is represented by NEAR–FAR AWAY and DENSE–SPARSE, Point–Range–Point (PRP) by END–BEGINNING and TOP–BOTTOM, and Range–Point–Range (RPR) by IN FRONT OF–BEHIND and ABOVE–BELOW. The main questions are whether the intermediates are perceived in the same way as the opposite poles, and whether we find additional evidence in support of their nature as points or ranges. More generally, the study is meant to be a contribution to the rather extensive literature in cognitive science and psychology on embodiment and situated cognition (e.g., Barsalou, 2010; Borghi & Cimatti, 2010; Gibbs, 2006; Lakoff & Johnson, 1999), to theories of semantics that make claims about the grounding of language and cognition in perception, and theories of semantics that see language, cognition and perception as communicating vessels (Caballero & Paradis, 2015; Gärdenfors, 2014; Langacker, 1987; Paradis, 2015a; Talmy, 2000; Zwaan, 2004). By adding more experimental research on the perception of intermediates along various binary dimensions (by means of eye-tracking and new behavioral drawing data) to the relatively few findings in the literature, the results of this study contribute to stressing the need to rethink the modeling of opposites in terms of three rather than simply two components, i.e., the two opposite poles. Also, the results raise important questions about why only opposites, and not intermediates, are worthy of lexicalization in natural languages. Is the reason a matter of perceptual salience, epistemic informativeness, priority in terms of ontogenetic development or something else? These questions cannot be answered based on the results of the present study, but if this study adds more experimental evidence of the direct perception of intermediates along dimensions, questions of this kind will arise as a natural consequence.

In the next section, we elaborate on the reasons for why we expect the perceptual system to be sensitive to the intermediate region, not only to the poles, along oppositional dimensions.

2. Intermediates and opposite poles

From work in philosophy, psychology, cognitive science, and linguistics, we know that our perception of space is anchored in our bodies (e.g., Barsalou, 1999, 2010; Beveridge & Pickering, 2013; Bianchi, Savardi, Burro, & Martelli, 2014; Borghi & Cimatti, 2010; Caballero & Paradis, 2015; Gibbs, 2006; Gibson, 1979; Howard & Templeton, 1966; Lakoff & Johnson, 1980, 1999; Paradis, Hudson, & Magnusson, 2013; Varela, Thompson, & Rosch, 1991). We, as human beings, experience ourselves to be in the middle of space that opens up around us. We are neither at one nor the other of the extremes of the sagittal axis