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Congenitally Blind do not Comprehend Better *I Grasp the Idea* than *I See the Idea*: A Challenge to the Use of Sensory-motor Conceptual Metaphors in the Comprehension of Metaphorical Expressions

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Abstract

An experiment was carried out to test the thesis that people employ sensory-motor conceptual metaphors to understand metaphorical expressions. Congenitally blind and sighted participants paraphrased metaphorical expressions derived from the UNDERSTANDING is GRASPING and UNDERSTANDING is SEEING conceptual metaphors, and evaluated to what extent they felt they had understood them. On the one hand, congenitally blind participants did not comprehend better UNDERSTANDING is GRASPING expressions than UNDERSTANDING is SEEING expressions. On the other hand, sighted participants did not comprehend UNDERSTANDING is SEEING expressions better than the blind. The implications of the results for the embodied Conceptual Metaphor Theory of Lakoff and Johnson are discussed.

Keywords: conceptual metaphor; embodiment; blind; concepts

Introduction

There are some obscure points in the theory and *This is an illuminating paper on the subject* are part of an English family of *metaphorical expressions* (MEs), in which words corresponding to the domain of seeing are employed to talk about understanding. According to the Conceptual Metaphor Theory (CMT) of Lakoff and Johnson (1980, 1999) and other cognitive linguists (e.g., Kövecses, 2000), such a cluster provides evidence for the existence of a *conceptual metaphor* (CM) in English speakers' minds, that is, an analogy between the concepts of seeing (the *base domain*) and understanding (the *target domain*). A huge body of research demonstrates that there are a large number of such clusters, also documented in other languages (Gibbs, 2006). According to the *linguistic assumption* of the CMT, CMs are used to produce and interpret MEs (Lakoff, 1993). Moreover, in terms of CMT we need to employ CMs to understand MEs because the abstract target concepts of such CMs have acquired their meaning from more concrete base concepts, and their semantic structure is still dependent on them (the *conceptual assumption*).

Classic cognitive science has tended to consider concepts as amodal and arbitrary symbols, whereas embodied cognition theorists have proposed that concepts consist in modal and analogical symbols (see Barsalou, 1999) and, finally, of neural patterns of sensory-motor activity (Lakoff & Gallese, 2005; Lakoff, 2008). If one adopts the first perspective, CMs should be conceived as analogies between symbols represented in an amodal code (e.g., Gentner and colleagues extended their structure-mapping view–a theory that asumes a propositional format of representations–to explain CMs; cf. Bowdle & Gentner, 2005). In contrast, in terms of the embodied theory of concepts proposed by CMT, CMs are modally represented, in the sense that they allow conceptualization of abstract target concepts through mental simulations of the sensory-motor experiences we have had with the referents of their corresponding concrete base concepts (Lakoff & Gallese, 2005; Lakoff, 2008). At least for certain basic CMs, CMT (Grady, Taub & Morgan, 1996; Lakoff & Johnson, 1980, 1999) defends the thesis that they originate in experiential correlations between certain cognitive states (e.g., subjective feeling of comprehending) and sensory-motor activities (e.g., the activity of exploring objects visually) that take place in early childhood.

The present study was interested in determining whether sensory-motor CMs enrich our understanding of MEs derived from them. We reasoned that if those sensory-motor CMs are indeed acquired through experiential correlation during infancy, then people exposed to such correlations should differ from people not exposed to them in their comprehension of MEs corresponding to those sensory-motor CMs. We thus compared how sighted and congenitally blind people comprehend MEs derived from UNDERSTANDING is GRASPING (a CM whose correlational basis was experienced by both populations) and from UNDERSTANDING is SEEING (a CM whose correlational basis was only experienced by sighted people). The central empirical questions were: 1) Do the congenitally blind comprehend better MEs derived from UNDERSTANDING is GRASPING than MEs derived from

UNDERSTANDING is SEEING?, and 2) Do the sighted comprehend MEs derived from UNDERSTANDING is SEEING better than the congenitally blind?

In the next section we will present the available psychological data supporting the linguistic assumption of CMT.

Evidence for the Linguistic Assumption of Conceptual Metaphor Theory

We will describe two studies that can be taken as examples of the kind of experiments that have been done to prove the linguistic assumption of the CMT. The first of such experiments considered CMs as represented in terms of amodal symbols, whereas the second one took into account their possible sensory-motor grounding.

Employing a classic paradigm, McGlone and Harding (1998) showed that people employed moving-ego CMs (in which temporal events are conceived as stationary relative to a moving observer) or moving-time CMs (in which temporal events are conceived as moving relative to a stationary observer) to interpret MEs about time. Their participants read a series of MEs derived from the same CM (e.g., *We're approaching the deadline; We have reached the deadline*, etc., consistent with the moving-ego CM) and afterwards a target ME. While in a consistent condition the same CM was maintained throughout, in an inconsistent condition the CM was changed between the initial series and the target ME (e.g., the initial sentences consisted of moving-ego MEs whereas the final one consisted of a moving-time ME, as in *The deadline is drawing nearer to us*). Given that the participants' reading times for the final sentence were longer for the inconsistent condition than for the consistent one, the authors inferred that the lecture of such MEs required the use of the CMs they were derived from.

Studies like McGlone and Harding (1998) and many others (e.g., Boroditsky, 2000; Thibodeau & Durgin, 2007). have not been particularly concerned with the sensory-motor nature of CMs (i.e., they mostly used conceptual stimuli), their results being compatible with a disembodied conception of CMs. On the other hand, a very recent line of work has intended to investigate the sensory-motor basis of CMs. For example, Wilson and Gibbs (2007) demonstrated that performing an action associated with a base concept (e.g., grasping) facilitates reading MEs in which this concept is employed metaphorically (e.g., *John grasps the idea*). They concluded that reading MEs entails the activation of sensory-motor CMs. However, it is doubtful that this kind of data demonstrate the sensory-motor nature of CMs. As Wilson and Gibbs (2007, pp. 729-730) themselves recognized, the following explanation about the phenomena encountered is still compatible with a view that conceives CMs as represented in terms of amodal symbols: a) performing an action keeps activated the sensory-motor pattern associated with that action, b) this pattern in turn activates the base amodal literal concept to which it isassociated, c) since this amodal literal concept, as part of the CM, is employed in the interpretation of MEs, the task of comprehending them becomes facilitated (for a similar argument, see Mahon & Caramazza, 2008). In sum, to our knowledge, there is no conclusive evidence about the use of sensory-motor CMs to interpret MEs.

We now turn to see the thesis of the CMT about the origins of sensory-motor CMs.

The development of Primary and Complex Conceptual Metaphors

CMT distinguishes between two kinds of CMs: *primary* and *complex* (Grady et al., 1996; Lakoff & Johnson, 1999). Primary CMs derive directly from our common bodily experience, whereas complex CMs are combinations of primary CMs and cultural beliefs. Primary metaphors arise from correlations in everyday experience. In each primary metaphor, such as UNDERSTANDING is SEEING or UNDERSTANDING is GRASPING—Gibbs (2006) and Lakoff & Johnson (1999) classify these two CMs as primary ones—, an experience brings together a subjective judgment (here, judgments about comprehension) and a sensory-motor occurrence (here, the act of seeing or the act of grasping, respectively). From the neural perspective of the CMT (Lakoff, 2008) this coactivation causes the strengthening of connections between the neural circuits supporting the different experiences. These connections give rise to CMs, thus determining that abstract target concepts will be understood in terms of sensory-motor activities corresponding to the base domain. To the extent to which certain sensory-motor components of base concepts constitute the meaning of the abstract metaphorical concepts, the CMT states that understanding MEs involves some partial simulation of the sensory-motor activities implied by these MEs (Lakoff & Gallese, 2005; Lakoff, 2008).

Complex CMs are built out of primary CMs plus cultural models. For instance, a CM such as PURPOSEFUL LIFE is A JOURNEY—that is the source of MEs like *She's living without direction*—is composed of the primary CMs PURPOSES are DESTINATIONS and ACTIONS are MOTIONS plus cultural beliefs such as that people should act so as to achieve their purposes; Lakoff & Johnson, 1999. Complex CMs do not arise from direct correlational experiences (e.g., there is no correlation between purposeful lives and journeys) but its sensory-motor nature is inherited from the grounding of each primary component CM.

As was already analyzed, evidence bearing on the use of sensory-motor CMs during the comprehension of MEs is scarce and equivocal. We reasoned that a proper way of testing whether having a sensory-motor CM has some influence on the comprehension of MEs derived from it would be to compare to what extent people that have (or have not) passed through correlational experiences understand abstract target concepts when metaphorically conceptualized in terms of its corresponding base concepts. According a hard version of the embodied linguistic thesis, those participants who have not undergone the correlational experiences relevant to a given sensory-motor CM should

show no comprehension at all of MEs derived from it, since having sensory-motor CMs is necessary to perform this task. This prediction sounds extremely crude. Perhaps, a soft embodied linguistic assumption may sound more sensible. It is possible that the people who have undergone correlational experiencies haver their amodal CMs grounded in those experiential basis. As such embodied grounding would enrich their understanding of the CMs and the MEs derived from them. In this sense, they should surpass people who had not undergone such correlational experiences (for a similar hybrid proposal, see Mahon & Caramazza, 2008)

With this objective in mind we compared how sighted and congenitally blind comprehend MEs derived from the UNDERSTANDING is SEEING and the UNDERSTANDING is GRASPING CMs. According to the CMT, sighted subjects build their concept of comprehending projecting sensory-motor schemata taken from vision (among other modalities) onto it. On the other hand, as it is obvious, congenitally blind subjects have not experienced correlations between visual phenomena and subjective states of comprehension. The haptic sense seems to be the best substitute for their lack of vision to provide enough information about the characteristics and functions of objects in the world (Landau & Gleitman, 1985). According to the soft embodied linguistic assumption considered above, they should comprehend grasping MEs better that seeing MEs. It also follows that the sighted should comprehend seeing MEs better than the blind.

Participants were presented with a series of MEs; they had to paraphrase them and to evaluate to what extent they felt they had understood them. Paraphrases were rated by independent judges. Taking into account that a paraphrase of the meaning of a ME will be rather conceptual (it may go well for making explicit an amodal CM but not so well for informing of sensory-motor simulations), we considered that these expressions would not be completely capable of capturing blind-sighted differences in the subjective sense of comprehension derived from being able to engage in sensory-motor simulations. If differences were only found for subjective evaluations, we reasoned, we could attribute this difference to that experiential –not conceptual- plus which is not capable of being paraphrased so well[1].

[1] The standard measure employed in the area to evaluate differences in comprehension of MEs is reading time. This measure is not adequate for the purposes of our study, since we are only trying to compare if the blind and sighted's final understanding of seeing and grasping MEs are equivalent, no matter how much effort it is involved in the processes they employ. If blind and sighted people can understand seeing MEs equally well as reflected in both objective and subjective measures, it should be concluded that sensory-motor grounding of CMs gives no advantage to the sighted. If the sighted advantage the blind in comprehension, this advantage should be attributed to their capacities to complement amodal comprehension with sensory-motor simulations. Given this, differences in reading times would be difficult to interpret, since it is not clear whether the amodal or the amodal-plus-modal processing would consume more time.

Experiment

Method

Participants Fifteen congenitally blind and 15 sighted participants volunteered to take part in the experiment. All of them were 1st and 2nd year undergraduates studying Natural Sciences at major Argentine universities. In each group there were seven woman and eight men. They received payment in return for their participation.

Materials We generated a total of 36 MEs: 12 UNDERSTANDING is SEEING, 12 UNDERSTANDING is GRASPING and 12 fillers in which the target domain was not understanding and the base domains were neither grasping nor seeing. Fillers were included so as to prevent blind subjects from acknowledging that they were being evaluated for comprehension of MEs related to vision (post experiment questions indicated that only one blind person suspected she was being evaluated in her comprehension of seeing MEs). To be sure that MEs were equivalent in all respects except for the base domain (i.e., the variable being manipulated) we generated pairs of MEs consisting of a seeing ME and a grasping ME. The seeing ME of a pair expressed the same idea about the same dimension of the target topic than the grasping ME (see examples in Table 1). In this way, we intended to control for any variables that could affect comprehension of MEs besides the base domain employed in the MEs (e.g., grammatical aspects, wording, extension, complexity of the stated idea, target dimension referred, etc.). Given that it was near impossible to construct pairs of novel MEs about comprehension that were identical in all aspects except for the base domain (grasping or seeing), we employed conventional MEs. We evaluated conventionality empirically (see procedure below). We performed a 2 x 2 analysis of variance (ANOVA) to evaluate the effects of visual condition (blind and sighted) and type of ME (seeing and grasping) on conventionality scores given to MEs. The conventionality score given by the blind for seeing MEs was 4.78 (SD = .52) and 4.30 for sighted (SD = .55). The conventionality score given by the blind for grasping MEs was 4.32 (SD = .56) and 4.35 for sighted (SD = .54). Main effects were neither found for type of ME, F (1, 28) = .013, MSE = .038, $p > .05$, nor for visual condition, F (1, 28) = .056, MSE = .077, $p > .05$. The interaction between these variables was also non significant F (1, 28) = 1.421 MSE = .038, $p > .05$, thus indicating that both sighted and blind subjects rated our COMPREHENDING is SEEING and our COMPREHENDING is GRASPING sets of MEs as being equally conventional. The COMPREHENDING is SEEING MEs received similar scores of conventionality from the sighted and the congenitally blind groups. The order of presentation of the MEs was counterbalanced. The members of each pair of ME always appeared separated by at least four other MEs.

Table 1: Examples of MEs employed in the experiment.

UNDERSTANDING IS SEEING	UNDERSTANDING IS GRASPING
Juan tiene mucho ***ojo*** [eye] *para los negocios* (*Juan has much knowledge and ability for business*)	*Juan tiene mucha* ***mano*** [hand] *para los negocios* (*Juan has much knowledge and ability for business*)
Ver [seeing] *las ideas centrales de un texto facilita su comprensión* (*Identifying the central ideas of a text facilitates its comprehension*)	***Agarrar*** [grasping] *las ideas centrales de un texto facilita su comprensión* (*Identifying the central ideas of a text facilitates its comprehension*)

Design and procedure We used a mixed design, in which the independent variables were *type of metaphorical expression* (seeing MEs, grasping MEs and filler MEs), a within-subjects variable, and *visual experience* (congenitally blind vs. sighted), a between-subjects variable. The dependent variables were subjective comprehension and objective comprehension of MEs. Each participant was evaluated individually in a quiet room. Participants were told that they were going to listen to a series of metaphors and that, for each one of them, they would have to answer some questions with no time limit. The procedure for each ME would be as follows: after listening to each metaphor twice they would have to explain, in their own words, what did the person intend to say with such metaphor. In addition they would have to evaluate in a scale ranging from 1 (*poor comprehension*) to 5 (*very good comprehension*) to what extent they felt they had comprehended it. Finally, they were asked to evaluate the degree of conventionality of the ME. After being told that "a metaphor is highly conventional when it is frequently used in our culture" they were asked to rate the ME on a scale ranging from 1 (*highly novel*) to 5 (*highly conventional*). Before starting the experiment, participants were trained in the procedure. Next, they were presented with the MEs. All the materials had been previously recorded by an adult that did not know the purpose of the study, and were presented to participants with the help of a computer. The answers of the participants were tape-recorded.

Results

Paraphrases given by participants were transcribed and handed to two judges (advanced literature students at University of Buenos Aires) who independently scored them for comprehension of their corresponding MEs. The judges proved highly reliable, Cronbach's $\alpha = .8586$. Table 2 displays the mean scores of objective comprehension for sighted and blind participants.

A 2 x 3 mixed analysis of variance (ANOVA) with visual condition (blind and sighted) as between-subjects factor and type of ME (seeing, grasping and filler) as within-subjects factor, was carried out to reveal the effects of these variables on the degree of objective comprehension. Main effects were found for type of ME, F (2, 56) = 6.421, MSE = .009, $p < .01$, but not for visual condition, F (1, 28) = .010, MSE = .165, $p > .05$. The interaction between these variables was significant, F (2, 56) = 3.640, MSE = .009, $p < .05$.

Table 2: Objective comprehension of MEs

	Sighted		Blind	
	M	*SD*	*M*	*SD*
Seeing MEs	3.71	.27	3.64	.26
Grasping MEs	3.60	.19	3.58	.22
Filler MEs	3.60	.25	3.66	.28

Note. MEs: metaphorical expressions

Within the blind group, seeing MEs and Filler MEs were better comprehended than grasping MEs, $t(14) = 2.250$, $p < .05$, and $t(14) = 3.698$, $p < .01$, respectively. Filler MEs were not better comprehended than seeing MEs, $t(14) = 1.132$, $p > .05$. Within the sighted group seeing MEs were better comprehended than grasping MEs, $t(14) = 2.223$, $p < .05$, and also better comprehended that filler MEs, $t(14) = 2.420$, $p < .05$. Filler MEs were not better comprehended than grasping MEs, $t(14) = 0.021$, $p > .05$. Finally, no significant differences were found between blind and sighted on seeing MEs, $t(28) = .662$, $p > .05$ Cohen's $d = .25$, nor on grasping MEs, $t(28) = .312$, $p > .05$ or on filler MEs, $t(28) = .650$, $p > .05$, nor on filler MEs, $t(28) = .650$, $p > .05$. Data thus showed that the sighted and the blind participants comprehend seeing MEs equally well, suggesting that exposure to correlations between the subjective experiences of seeing and understanding does not yield noticeable advantages for the comprehension of MEs. Additionally, data showed that the blind do not comprehend better grasping MEs than seeing MEs—as a matter of fact, they comprehended better seeing MEs than grasping MEs—again showing that going through experiential correlations does not enhance comprehension of their corresponding metaphorical expressions.

In light of the possibility that the objective measure of comprehension was not suitable to capture embodied aspects of comprehension, we included a subjective measure, which was obtained through asking participants to evaluate in a 5 point Likert scale (1 = poor comprehension; 5 = very good comprehension) to what extent they considered they had comprehended a given ME. Table 3 displays the mean subjective measures given by blind and sighted subjects to each type of MEs.

We performed a 2 x 3 mixed analysis of variance (ANOVA) with visual condition (blind and sighted) as between-subjects factor and type of ME (seeing, grasping and filler) as within-subjects factor in order to reveal the effects of these variables on the degree of subjective comprehension. Main effects were neither found for visual condition, F (1, 28) = .013, MSE = .391, $p > .05$, nor for type of ME, F (2, 56) = .003, MSE = .016, $p > .05$.

However, the interaction between variables was significant, F (2, 56) = 4.266, MSE = .016, p < .05.

Table 3: Subjective comprehension of seeing and grasping MEs by the blind and the sighted

	Sighted		Blind	
	M	*SD*	*M*	*SD*
Seeing ME	4.50	.34	4.59	.36
Grasping Mes	4.60	.29	4.49	.46
Filler Mes	4.57	.31	4.55	.46

Note. MEs: metaphorical expressions

Within sighted subjects, no significant differences were found between seeing MEs and grasping MEs, $t(14)$ = 1.734, p > .05, nor between seeing MEs and filler MEs, $t(14)$ = 1.674, p > .05, nor between filler MEs and grasping MEs, $t(14)$ = .565, p > .05, Within the blind, significant differences were found between filler MEs and grasping MEs, $t(14)$ = 2.330, p < .05. No significant differences were found between seeing MEs and grasping MEs, $t(14)$ = 1.705, p > .05, Cohen's d = .91 nor between seeing MEs and filler MEs, $t(14)$ = .719, p > .05. No significant differences were found between the blind and the sighted on seeing MEs, $t(28)$ = .659, p > .05, Cohen's d = .25, nor on grasping MEs, $t(28)$ = .758, p > .05, or on filler MEs, $t(28)$ = .153, p > .05. As with the objective measure of comprehension, these data suggest that having been exposed to correlations between the subjective experiences of seeing and understanding does not influence the subjective sense of comprehending UNDER-STANDING is SEEING MEs. On the other hand, rates of subjective comprehension given by the blind participants showed they feel they had comprehended seeing and grasping MEs equally well. This lack of difference again suggests that having been exposed to correlations between the subjective experiences of understanding and grasping—while not to correlations between comprehending and seeing—did not affect subject's sense of comprehension of the MEs derived from these two CMs.

In general, subjective comprehension measures were superior to the objective comprehension measures obtained from judge's evaluation of the paraphrases. It is likely that this difference is caused by an overconfidence bias in subjects self estimation of their comprehension as well as by the difficulty implied in paraphrasing the meaning of MEs.

Discussion

The CMT has postulated that sensory-motor CMs are necessary to interpret MEs. As has been said, evidence in favor of any version of the sensory-motor linguistic assumption is scarce and ambiguous. According to the hard version of the linguistic assumption of CMT, people that do not have a particular sensory-motor CM (e.g., the blind have not passed through correlational experiences that give rise to them) should not be capable of understanding MEs derived from such CMs at all. According to the soft version of such linguistic assumption, people have amodal CMs but, in the case they have passed through correlational experiences like the ones postulated by CMT, such CMs should also have a sensory-motor grounding. Therefore, their corresponding abstract target concepts should have a richer semantics. We examined the second version by testing if such grounding of CMs allows the sighted to comprehend seeing MEs better than the blind. On the other hand, we intended to find out if, given the reasons mentioned above, the congenitally blind have a better understanding of grasping MEs than of seeing MEs.

We found no differences between the blind and the sighted in neither objective comprehension nor subjective feelings of comprehension of seeing MEs. Moreover, the blind did not show better objective comprehension or superior feelings of comprehension for grasping MEs than for seeing MEs. The fact that we did not find such differences cannot be attributed to the effect of other variables that could affect comprehension, since in the preparation of materials each seeing ME was paired with a grasping ME that was identical to the former except for the base concept which corresponded to the domain of grasping or seeing. It also cannot be ascribed to the differences in the degree of conventionality of the seeing and grasping MEs, since we found no such differences.

We worked with highly conventional MEs because generating the desired controls with novel MEs resulted to be an intrinsically difficult task. Regarding this, a possible objection to the obtained results would underline the fact that we only worked with such kind of MEs. It would be certainly interesting to test the claim that having sensory-motor CMs has some incidence on the comprehension of novel MEs. However, it is worth considering that the linguistic assumption of CMT concerns conventional MEs as much as novel ones. The idea that this assumption could only be valid for novel MEs is advocated by theories that are confronted with CMT, such as the career of metaphor theory (Bowdle & Gentner, 2005), in terms of which conventional metaphorical concepts are independent of the literal concepts from which they originated. This proposal is rejected by CMT followers like Gibbs et al. (Gibbs, 2006; Wilson & Gibbs, 2007).

A possible interpretation of these results would consist in proposing that the literal concepts of seeing are abstract concepts than can be acquired via intercultural exchange with the sighted, maybe through analogies between these visual concepts and certain haptic concepts (Landau & Gleitman, 1985). Once the blind have acquired these literal concepts, they become capable of understanding their metaphorical extensions to the domain of understanding (i.e., they acquire an amodal version of the COMPREHENSION is SEEING CM). This CM is then used to understand conventional and novel MEs (e.g., Thibodeau & Durgin, 2007). According to a second interpretation of these results, given that the employed metaphorical concepts were highly conventional (e.g.,

"obscure" means "difficult to understand"), it is possible that the blind interpreted the MEs without activating an amodal CM, but directly activating a second meaning of such metaphorical concepts which was already available in their mental lexicon and that has lost its link with the corresponding original literal meaning (Glucksberg, 2001; Bowdle & Gentner, 2005).

In terms of any of these possible disembodied interpretations, not only the linguistic assumption of CMT (both in its hard and soft versions) is taken into question, but also the sensory-motor conceptual assumption of CMT, since if it is true that engaging in sensory-motor simulations of vision is not necessary to understand metaphorical uses of the seeing concept, it should also be the case that the semantics of such metaphorical concepts is independent of any experiential grounding. However, there is still the possibility that the negative findings presented in this experiment were due to the fact that the blind, just like the sighted, do have and use a sensory-motor COMPREHENSION is SEEING CM. It is possible that the blind acquire this CM in a way alternative to the one postulated by the CMT for the sighted, for instance, by forming visuospatial images out of their tactile exchanges with the world (Kerr, 1983). In this line of argument, we could postulate that their subjective experiences of understanding "correlate"—via touching and grasping—with the activity of forming visuospatial images. This reformulation implies, however, weakening to a large extent the meaning of "having experiences of seeing", since it would imply accepting the claim that the activity of forming visuospatial images is experientially equivalent to the sighted's experience of vision (this would be necessary in order to explain the lack of differences observed between the blind and sighted in their comprehension of seeing MEs). It would also imply that forming these images would have the same experiential weight as the very activity of grasping that gives rise to the formation of such visuospatial images (this would be necessary in order to explain that the blind do not comprehend better grasping ME than seeing ones). However, as an explanation of our results, the disembodied options presented above appear simpler and more plausible. The embodied view of CMT would need to reformulate central aspects of its developmental assumptions and/or its sensory-motor linguistic assumptions to accommodate results like the ones obtained in our experiment.

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