

# The Sensory–Motor Grounding of the *Time Is Space* Conceptual Metaphor

Las bases sensorio–motoras de la metáfora conceptual *El tiempo es espacio*  
As bases sensório–motoras da metáfora conceitual *Tempo é espaço*

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## Abstract

The conceptual metaphor theory postulates that interpreting metaphorical expressions requires mentally simulating the base sensory-motor experiences of the conceptual metaphor from which they derived. Even though *Time Is Space* is one of the most studied conceptual metaphors, the evidence about its embodied basis is scarce and equivocal. An experiment was carried out to test the hypothesis that interpreting Ego Moving metaphorical expressions involves simulating the experience of moving forward towards a fixed destination. While participants in the experimental group read Ego Moving metaphorical expressions after performing the sensory-motor activity that corresponded

to the base domain, participants in the control group read those metaphorical expressions after performing an unrelated physical activity. No differences in reading times were found between the two conditions. Implications of these results are discussed in the context of previous research on the embodied perspective on metaphor comprehension.

*Keywords:* Conceptual metaphor, time, space, embodied cognition.

## Resumen

La teoría de la metáfora conceptual postula que la interpretación de expresiones metafóricas implica simular mentalmente las experiencias sensoriomotoras base de

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las metáforas conceptuales de las que derivan. A pesar de que *El tiempo es espacio* es una de las metáforas conceptuales más estudiadas, la evidencia acerca de su carácter corporeizado es escasa y difícil de interpretar. Se llevó a cabo un experimento para poner a prueba la hipótesis de que interpretar expresiones metafóricas derivadas de la metáfora conceptual *Persona en movimiento* involucra simular la experiencia de avanzar hacia un objetivo fijo. Mientras que los participantes pertenecientes al grupo experimental leyeron este tipo de expresiones metafóricas después de realizar una actividad sensoriomotora correspondiente al dominio base, los participantes del grupo control leyeron las mismas expresiones después de realizar una actividad física no relacionada. No se encontraron diferencias en los tiempos de lectura de ambas condiciones. Se discuten las implicaciones de estos resultados en el contexto de las investigaciones previas sobre la perspectiva corporeizada acerca de la comprensión de metáforas.

*Palabras clave:* metáfora conceptual, tiempo, espacio, cognición corporeizada.

## Resumo

A teoria da metáfora conceitual postula que a interpretação de expressões metafóricas leva a simular mentalmente as experiências sensório-motoras base das metáforas conceituais das que se derivam. Apesar de *o tempo é espaço* é uma das metáforas conceituais mais estudadas, a evidência acerca de seu carácter corporeizado é escassa e difícil de interpretar. Levou-se a cabo um experimento para pôr a prova a hipótese que interpretar expressões metafóricas derivadas da metáfora conceitual *pessoa em movimento* envolve simular a experiência de avançar para um objeto fixo. Enquanto os participantes pertencentes ao grupo experimental leram este tipo de expressões metafóricas depois de realizar uma atividade sensório-motora correspondente ao domínio base desta metáfora conceitual, os participantes do grupo controle, leram as mesmas expressões metafóricas depois de realizar uma atividade física não relacionada. Não se encontraram diferenças nos tempos de leitura de ambas as condições. Discutem-se as implicações destes resultados no contexto das pes-

quisas prévias sobre a perspectiva corporeizada acerca da compreensão de metáforas.

*Palavras-chave:* metáfora conceitual, tempo, espaço, cognição corporeizada.

“We are approaching Friday” and “Christmas will soon be upon us” are metaphorical expressions (MES) in which words about spatial movement are employed to talk about the passage of time. Lakoff and Johnson (1980) identified a large number of systems of MES in which abstract concepts (e.g., time) are regularly understood in terms of more concrete ones (e.g., spatial movement) by means of culturally shared analogies or conceptual metaphors (e.g., the *Time Is Space* conceptual metaphor).

*Time Is Space* is one of the most studied conceptual metaphors, and it has many variations across languages and cultures (Casasanto, 2009). In the *Ego Moving* version (Boroditsky, 2000), the person moves ahead along a straight line in which successive points represent moments in the future. The amount of time that will need to elapse for the future moment to occur is represented as the distance the person has to advance in order to reach its corresponding point in the line. As the person advances, the locations that are left behind him or her represent past moments. In contrast, in the *Time Moving* version, the person is represented as remaining in a fixed location, with moments in time (portrayed as objects) passing by him/her. In this case, the amount of time necessary for the future moment to take place is represented as the distance the moving moment has to cover to reach the person. Again, while objects approaching the observer represent future moments, objects leaving the observer behind represent moments that have already occurred. There is plenty of evidence that the *Ego Moving* and the *Time Moving* versions are profusely used in languages like English (Alloway, Corley, & Ramscar, 2006; Boroditsky & Ramscar, 2002; Gentner, Imai, & Boroditsky, 2002; Teuscher, McQuire, Collins, & Coulson,

2008), Spanish (Torralbo, Santiago, & Lupiáñez, 2006), German (Ulrich, Eikmeier, De la Vega, Ruiz-Fernández, Alex-Ruf, & Maienborn, 2012), Swedish (Rothe-Wulf, Beller, & Bender, 2014), and Mandarin Chinese (Bender, Beller, & Bennardo, 2010). Other variations of *Time Is Space* depend on conventional factors such as the direction of writing, with English speakers representing the future on the right side (Ouellet, Santiago, Israeli, & Gabay, 2010), Hebrew and Arabic speakers representing it on the left (Fuhrman, & Boroditsky, 2010) and Mandarin Chinese speakers representing it on the bottom (e.g., Fuhrman, McCormick, Chen, Jiang, Shu, Mao, & Boroditsky, 2011).<sup>1</sup> The different variations of the *Time Is Space* conceptual metaphor have manifestations in several motor and cognitive processes, ranging from the interpretation of metaphorical language (e.g., Boroditsky, 2000) to co-speech gestures (e.g., Casasanto & Jasmin, 2012), postural sway (e.g., Miles, Nind, & Macrae, 2010), duration estimations (e.g., Casasanto, & Boroditsky, 2008), categorical judgments (e.g., Santiago, Lupiáñez, Pérez, & Funes, 2007), and spatial attention (e.g., Ouellet, Santiago, Funez, & Lupiáñez, 2010).

Many psycholinguistic studies have provided experimental evidence for conceptual metaphor theorists' claim that understanding MES involves the activation of conceptual metaphors (e.g., Albritton, McKoon, & Gerrig, 1995; Gentner & Boronat, 1991; Gibbs, Bogdanovich, Sykes, & Barr, 1997; Langston, 2002; Thibodeau, & Durgin, 2008; see Gibbs, 2006a for further evidence). In particular, there is plenty of evidence that the *Ego Moving* and the *Time Moving* conceptual metaphors are used to interpret MES derived from them (e.g., Boroditsky, 2000, 2001; Gentner, Imai, & Boroditsky, 2002; McGlone, & Harding, 1998; Núñez, Motz, & Teuscher, 2006). For instance,

McGlone and Harding (1998, Experiment 2) presented participants with blocks of MES in which the expression “The meeting originally scheduled for next Wednesday has been moved forward two days” was preceded either by three *Time Moving* or *Ego Moving* sentences. Whereas, according to the *Ego Moving* perspective, the target expression would be interpreted as implying that the meeting would take place on Friday, lining up to the *Time Moving* one it would be understood as implying that the meeting would take place on Monday. Results showed that participants tended to disambiguate the target sentence in a manner consistent with the prior ones.

The conceptual metaphor theory postulates that abstract concepts—whose meaning does not directly refer to sensory-motor experiences—borrow their semantic contents from more concrete base concepts that emerge directly from our physical and cultural experiences with the environment. Conceptual metaphors' cognitive function would then consist in providing abstract concepts with sensory-motor grounding (Gibbs, 2006b; Lakoff, 2008). This way, the interpretation of MES implies the projection of image schemas (Johnson, 1987; for an extended discussion on it, see Hampe, & Grady, 2005) of the conceptual metaphor from which such ME derived. Image schemas designate generic structures that capture the shared features among a variety of sensory-motor experiences that we repeatedly perform in our exchanges with the physical and social environment, which are encoded in an analogical format of a perceptive and motor type. For instance, the Source-Path-Goal image schema—which constitutes the base domain of the *Ego Moving* metaphor—arises from the daily and recurrent childhood experiences of moving our bodies through space in search of a physical object. Within the neural proposal of conceptual metaphor theory, the construct of image schema has been more recently redefined in terms of sensory-motor simulations of the base domains (Feldman, 2006; Gallese & Lakoff, 2005). Under this

<sup>1</sup> See Bender and Beller (2014) for a systematic review of different versions of the *Time Is Space* conceptual metaphor across cultures.

reformulation, the comprehension of MES would involve simulating the sensory-motor actions upon which a conceptual metaphor is grounded, by emphatically replicating the experiential state of the speaker who conveyed the MES (Gibbs, 2006b).

Although several studies have dealt with the embodied nature of other conceptual metaphors (e.g., Gibbs, 2013, Experiment 1b; Santana & de Vega, 2011, Experiment 2; and Wilson & Gibbs, 2007, Experiment 1), the study carried out by Boroditsky and Ramscar (2002; Experiments 2 and 4) represents the only available investigation on the activation of spatial sensory-motor patterns during the interpretation of MES in which time is understood in terms of space. These authors sought to determine whether the interpretation of such expressions can be biased by previously performing vs. thinking about a particular sensory-motor activity. In Experiment 2, they presented McGlone and Harding's (1998) ambiguous question (i.e., "The meeting originally scheduled for next Wednesday has been moved forward two days. What day is the meeting now that it has been rescheduled?") to actual passengers in a moving train. The authors conjectured that participants who had just boarded the train or were about to get off probably had been thinking about their movement more intensely than those who were in the middle of the trip. Hence, these participants would be relatively more prone to disambiguating the target expression in a manner consistent with the *Ego Moving* perspective. Upon confirming this prediction, the authors interpreted that thinking about movement, rather than movement itself, was what determined participants' interpretations. In Experiment 4, the same ambiguous question was asked to participants who were waiting in a lunch line. In order to separate the influence of thinking about motion from that of actual movement on participants' responses, the experimenters asked them how long they felt they had waited in line (an indicator of thinking about their motion), while also recording in which line quartile they were located at the moment they

were interviewed (physical movement). In contrast with the results from the train experiment, the lunch line experiment showed that it was actual movement, rather than participants thought about it, what determined their responses.<sup>2</sup>

Several common limitations of these two experiments make it difficult to extract conclusions from them, and even more to explain their inconsistent results. In the first place, the very task of disambiguating Wednesday's meeting question does not seem appropriate for studying the *Ego Moving* conceptual metaphor. As posited by Nuñez and Sweetser (2006), the ambiguous expression may correspond to the Time-Reference-Point conceptual metaphor, in terms of which earlier times are placed in front of later times in a mental timeline, without making reference to an ego. Secondly, a comparison between the relative effects of actually performing some actions and simply thinking about them does not seem appropriate to assess the effect of sensory-motor priming on the comprehension of MES, since there is evidence that real actions and merely thinking about them can give rise to similar sensory-motor activations, thus yielding comparable priming effects in metaphor comprehension (e.g., Wilson & Gibbs, 2007).

In the present study, we set forth to assess whether the interpretation of *Ego Moving* MES involves simulating the sensory-motor actions corresponding to the base domain of the conceptual metaphor. To this end, we resorted to a more

<sup>2</sup> Besides these experiments, Boroditsky and Ramscar (2002) performed another one in which they presented participants in an airport the ambiguous question. While some of them were waiting for other people to arrive, others were waiting to fly, and others had just arrived. Results showed that people who had just flown in were more likely to answer, according to the *Ego Moving* perspective than people who were waiting to depart, and that in turn, the latter gave the *Ego Moving* answer more frequently than people who were waiting for other people to arrive. Given that there is no comparison between participants performing a sensory-motor activity vs. participants thinking about such movement, we did not take into account this experiment.

traditional procedure that consists in having two groups of participants read MES corresponding to the *Ego Moving* perspective and recording the time taken to comprehend them.<sup>3</sup> While one of the groups read the MES after having performed a physical activity that was consistent with the *Ego Moving* perspective (walking), the other group received such expressions after having performed a physical activity that was unrelated to the *Ego Moving* perspective (sitting down and standing up). Participants in the walking condition moved forward towards successive computers arranged in a line (see figure 1), at which they stopped to complete their tasks. At Computer 1, they just waited for a moment, and then walked to Computer 2, where they read a group of MES. Afterward, they walked to Computer 3, on which they read another group of MES, and then walked back to Computer 1. They repeated this circuit several times. In contrast, participants in the sitting down condition completed their tasks standing in front of a single computer, sitting down and standing up again before reading each group of MES. Our objective was to establish whether the interpretation of MES was facilitated (as observed in reading times) after performing the consistent physical action, in comparison to the neutral condition. Before presenting the experiment proper, we describe a pilot study aimed at selecting an appropriate set of MES.

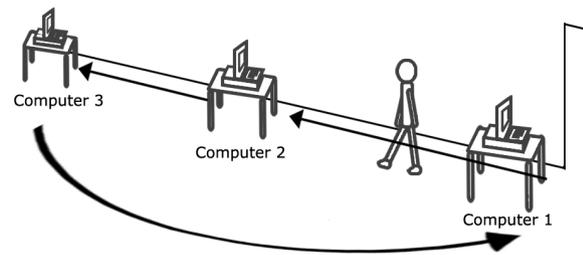


Figure 1. A circuit as completed by participants in the walking condition. In each circuit, they walked forward stopping to wait (at Computer 1) or to interpret MES and then press a button as soon as they had understood them (at Computers 2 and 3).

### Pilot Study

Given that engaging in a walking activity could lead participants to activate words related to such activity (e.g., *approach*), such lexical activation could, in turn, facilitate the processing of MES including those words (e.g., “We were approaching the new millennium”). We carried out a pilot study to ensure that the words to be included in the critical MES of the experiment are not automatically activated by the action of walking. To this end, the sensory-motor words that comprised the MES that were candidates for being employed in the main study were included in a lexical decision task that participants had to carry out immediately after having either walked (consistent motor activity) or stood up and sat down (inconsistent motor activity). The control study was intended to rule out a possible confounding between sensory-motor and lexical facilitations.<sup>4</sup>

<sup>3</sup> We decided to use *Ego Moving* MES and not *Time Moving* MES because while the *Time Moving* perspective is associated with a simple perceptive and passive activity, the *Ego Moving* perspective is associated with a more complex and active sensory-motor activity.

<sup>4</sup> Similar studies aimed at determining whether the interpretation of MES entails performing sensory-motor simulations did not control for the possibility of confounding between sensory-motor and lexical facilitation, or they did it in inadequate ways. For instance, Wilson and Gibbs (2007, Experiment 1) had participants learn to perform different actions they watched on a computer screen. After performing the action, they had learned, they read a ME and pressed a key once they had comprehended it. Whereas in half of the cases the ME was preceded by an action that, according to the sensory-motor hypothesis, would be required for its comprehension (e.g., reading *Grasp a concept* after grasping), in the other half

## Participants

Sixty undergraduate students from the University of Comahue (25 male and 35 female,  $M = 22.1$  years,  $SD = 2.45$  years) gave informed consent to take part in the study, conducted in accordance with Helsinki's revised declaration. They were native speakers of Spanish and had either normal or corrected to normal sight. They were randomly assigned to the congruent and incongruent motor priming condition.

## Materials

We selected all the words referred to sensory-motor activities from an initial pool of MES. For example, “ponían” (set) and “pies” (feet) were extracted from “Ya casi ponían sus pies en Diciembre” (They were about to set their feet on December). In the case of compound verbs, we selected the main verb

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of the cases such ME was preceded by an unrelated action (e.g., reading *Grasp a concept* after blinking an eye). As reading times were shorter in the consistent condition, the comprehension of MES was thought to entail the activation of the grasping sensory-motor schema. However, it is possible to explain the results obtained by Wilson and Gibbs (2007) in terms of lexical priming. Engaging in an action such as grasping could lead participants to activate the word “grasp”, which in turn would facilitate the reading of MES that include that word (e.g., *Grasp the concept*). The authors performed an independent study to rule out this possibility. In order to determine whether the execution of the relevant action indeed led to the activation of the words included in the MES, they asked an independent group to engage in the same actions performed by the subjects in the experimental group and then to verbally describe such actions. As the MES that showed the greatest priming effect in the main experiment contained words that were different from the ones used to describe actions in the control study, the authors interpreted that the lexical account could be ruled out. Nonetheless, a possible deficit could reside in the fact that in order to find out if any lexical priming effect elicited, the authors relied on participant reports about the words that could best describe the actions performed. It is likely that although participants in the control study did not mention the same words that were included in the MES, these words received an unconscious activation from the sensory-motor activity. If this was also the case for participants in the main experiment, the activation of such words could have facilitated the reading of MES in which such words were included.

and not its auxiliaries. On the other hand, neither prepositions nor adverbs were selected. Appendix A shows the initial set of 15 MES, as well as the sensory-motor words selected for this pilot study. All selected verbs appeared in infinitive tense during the lexical decision task. The total number of critical sensory-motor words was 24. Forty-six non-critical words were included to prevent participants from realizing that words referred to sensory-motor activities (see Appendix B). Seventy non-words were also included to equate the probabilities of positive and negative responses.

Twenty-four blocks of items were presented in both conditions, each one comprising a critical word, a non-critical word, and two non-words. While in half of the blocks, the critical sensory-motor word was shown first, in the other half, it was shown second. This was done to ensure that they were processed right after they had carried out the sensory-motor activity. Moreover, as a further measure to prevent participants from predicting the correct responses (i.e., that if the first item was a word, the second one should be a non-word), 20 item blocks were added in which all items were non-critical words and non-words. All filler blocks included two words and two non-words whose order was randomized. There were five types of filler blocks: all words; all non-words; one word and three non-words; one non-word and three words, and two words and non-words.

The text font was 24-point bold Arial, white on a dark grey background. Each item was preceded by a 17 ms “++” sign appearing in the middle of the screen and serving as a fixation point, followed by a 17 ms blank screen. The timeout was 2500 ms, and feedback was given on each response. The order of presentation of the blocks containing critical items was counterbalanced across participants and across item blocks.

## Procedure

The experiment was carried out in a quiet room of 6 m in width and 30 m in length, computers were

10 m apart from each other. The experiment was run on one (sitting down condition) or three (walking condition) personal laptop computers. Participants were tested individually. In the walking condition, three computers were placed along a straight line in which participants walked forward, facing the computer screens (see figure 1). They had to stop to perform the task at each of the stands supporting the computers, maintaining a standing position. In contrast, in the sitting down condition, participants had to complete their tasks on a single computer on a stand, and they had to sit down and then to stand up again in between completing their tasks. In the walking condition, participants completed 22 circuits, with each circuit comprising the displacement from Computer 1 to Computer 2, from Computer 2 to Computer 3, and from Computer 3 back to Computer 1. The first circuit was completed as follows. Participants started at Computer 1, where the following instruction was shown: “When pressing X on Computer 2, four items will appear on the screen, one at a time. You will have to respond as quickly as possible whether the item is a word or not. To enter your responses, you will use a joystick with buttons for “yes” and “no”, and you will receive feedback on each response. After reading four items on Computer 2 and four more items on Computer 3, you have to go back to Computer 1. To begin, please press X on Computer 2”. When participants completed the block shown on Computer 2, the instruction “Press X on Computer 3” appeared on the screen. Participants then walked to Computer 3 and completed another block of items. Once the block shown on Computer 3 was completed, participants were required to proceed to Computer 1. The remaining 21 circuits were identical to the first, except for the fact that the general instructions presented on Computer 1 were removed. The procedure was the same for the sitting down condition, except that instead of walking from one computer to the next, participants were asked to sit down and then stand up in between blocks. Before the experiment, participants of both conditions

completed six practice blocks, following the same procedure as in the main one.

## Results

Lexical decision times obtained in the control study revealed a priming effect for the critical sensory-motor word “acercábamos” (approaching),  $t(43.812) = 3.676, p = .001$ . Therefore, the ME from the initial pool that contained this word—“Nos acercábamos a fin de año” (We were approaching the New Year)—was not included in the main experiment.

## Experiment

Two groups of participants read MES, corresponding to the *Ego Moving* perspective. As in the pilot study, while one of the groups read the MES after having performed a physical activity that was consistent with the *Ego Moving* perspective (walking), the other group received such expressions after having performed a physical activity that was unrelated to the *Ego Moving* perspective (sitting down and standing up). The dependent variable was the time taken by participants to comprehend the expressions.

## Participants

Sixty undergraduate psychology students at the University of Comahue participated in exchange for course credit (22 male and 38 female,  $M = 22.6$  years,  $SD = 2.8$  years). All participants were native speakers of Spanish and had either normal or corrected to normal sight. Participants gave informed consent to take part in the study, which was conducted in accordance with the revised declaration of Helsinki.

## Materials

As a result of the pilot study, we included 14 MES derived from the *Ego Moving* perspective (e.g., “Ya

estaba apoyando mis plantas en el nuevo milenio” [I was already setting the soles of my feet on the new millennium]) and 28 filler MES derived from other conceptual metaphors referred to time (e.g., “Invirtió varios años en entrenarse para los exámenes finales” [He spent many years training for his final exams], from *Time Is Money*, see complete list in Appendix C). Each block of MES comprised a critical ME (i.e., from the *Ego Moving*) and two filler MES (e.g., one from *Time Is Money* and the other one from *Time Is A Substance*). The critical expression of each triplet was always presented first, in order to ensure that it was processed right after experimental participants had carried out the *Ego Moving* sensory-motor activity. The inclusion of fillers was intended to prevent participants from becoming aware of the centrality of *Ego Moving* MES throughout the experiment, as well as to prevent participants from carrying-over activation of the *Ego Moving* conceptual metaphor from one computer to the next as an effect of having applied it to interpret MES. Each sentence was followed by a simple yes/no question (e.g., after the sentence: “We felt that we were stuck in 2012”, the question was “did they feel they were not making progress?”). While for half of the questions, the correct answer was yes, for the other half, it was no (see Appendices A and C). These questions were included both to enforce participants to read the expressions carefully, as well as to eliminate participants who did not show evidence of paying adequate attention to the experimental materials. The order of the blocks was randomized across participants. Metaphorical expressions and questions were displayed in the center of the screen and did not exceed a complete line of text. The text font was 22-point bold Arial, white on a dark grey background. Timeout for each ME and for its corresponding question was 10 s. Participants used a joystick to complete their tasks. There were three response buttons: X, to indicate that the ME was understood, and yes and no, to answer the question about the ME.

## Procedure

The experiment was carried out in a quiet room of 6 m in width and 30 m in length, computers were 10 m apart from each other. The experiment was written in DmDX code (Forster & Forster, 2003) and run on one (sitting down condition) or three (walking condition) personal laptop computers of 1,024 x 768 pixels.

Participants were tested individually and told that they would take part in an experiment on language comprehension. The experiment lasted approximately 20 minutes. In both conditions, participants had to read MES and then to press a button as soon as they understood their meaning. Right after a response was emitted, a question about the ME presented appeared on screen, together with yes/no options. Upon responding at each of these questions, a sign stating either “your response is correct” or “your response is incorrect” was displayed. As in the pilot study, three computers were placed along a straight line in which participants in the walking condition walked frontward, facing the computer screens. They had to stop to perform the task at each of the stands supporting the computers, maintaining a standing position. In contrast, participants in the sitting down condition had to read the MES from a single computer on a stand, and they had to sit down and then to stand up again upon completing each block.

In the walking condition, participants completed seven circuits, with each circuit comprising the displacement from Computer 1 to Computer 2, from Computer 2 to Computer 3, and from Computer 3 back to Computer 1. The first circuit was completed as follows. Participants started at Computer 1, where the following instruction was shown: “When pressing X on Computer 2, three sentences will appear on the screen, one at a time. You will have to read each of them carefully and press X as soon as you comprehend it. After reading each of the sentences, a simple yes/no question about that sentence will appear. You will receive feedback about the correctness of your answer. After reading three

sentences on Computer 2 and three more sentences at Computer 3, you have to go back to Computer 1. To begin, please press X on Computer 2". When participants completed the triplet of MES shown on Computer 2, the instruction "Press X on Computer 3" appeared on the screen. Participants then walked to Computer 3 and completed another triplet of MES. Once the triplet of MES shown on Computer 3 was completed, participants were required to proceed to Computer 1. The remaining six circuits were identical to the first, except for the fact that the general instructions presented on Computer 1 were removed. The procedure was the same for the sitting down condition, except that instead of walking from one computer to the next, participants were asked to sit down and then stand up in between triplets. Before the experiment, participants of both conditions completed six practice triplets, following the same procedure as in the main experiment.

## Results and Discussion

Given that all participants gave correct answers to more than 80% of the comprehension questions, no participants were withdrawn from the data analysis. For each of the critical and filler expressions, all reading times two standard deviations above or below the mean (4.09% of the data set) were excluded from the data set and replaced by the average of all participants reading such expression under the same experimental condition. A subject analysis of the time taken to understand *Ego Moving* MES revealed no differences in reading times between the walking condition ( $M = 3.448$  s,  $SD = 0.452$ ) and the sitting down condition ( $M = 3.461$  s,  $SD = 0.723$ ),  $t(48.665) = -0.082$ ,  $p = .935$ . An item analysis of the same data set also failed to find a difference in comprehension times between the walking condition ( $M = 3.448$  s,  $SD = 0.714$ ) and the sitting down condition ( $M = 3.461$  s,  $SD = 0.901$ ),  $t(26) = -0.041$ ,  $p = .967$ . Thus, results show no evidence that the activity of

walking affects the comprehension times of *Ego Moving* MES.

A possible concern with respect to the validity of the obtained results might be that not all MES employed in the experiment correspond, as we supposed, to the *Ego Moving* conceptual metaphor. In order to determine this, we presented the MES to two independent judges who classified them as instances of the *Ego Moving* conceptual metaphor, the *Time Moving* conceptual metaphor, or none of them. Both judges were cognitive psychologists at the National University of Comahue and were oblivious to the objective of the study. They received explanations of each conceptual metaphor accompanied by an animation displaying the basic events involved in them. In the animation for the *Ego Moving* metaphor, a person walked towards a still circle representing an event on a point in the timeline, passing it by and leaving it behind. In the animation for the *Time Moving* metaphor, a person remained still while the circle moved towards him, passing him by and, as a result, being left behind. After the explanation of each conceptual metaphor, judges were presented with three examples of MES derived from it. Subsequently, they were presented with the 14 MES employed in the study. They had to mark their choice with a cross (*Ego Moving*, *Time Moving*, or none of them). We considered a ME as a case of the *Ego Moving* conceptual metaphor, the *Time Moving* conceptual metaphor, or none of them only when they were categorized as such by both judges. They agreed on all but four MES (71.43% of the cases). Specifically, "Todavía tenía cerca de mi nuca el mes de Abril" (April was still close to my neck) was categorized as *Time Moving* and as "none of them", "Ya no podíamos retornar a los tiempos pasados" (We were unable to return to past times) was considered as *Ego Moving* and "none of them", "Había dejado a mis espaldas buena parte del siglo" [I had already left a good part of this century behind my back] was regarded as *Time Moving* and as *Ego Moving*, and "Sentíamos que estábamos

varados en el 2012” (We felt that we were stuck in 2012) was considered as *Ego Moving* and “none of them”. On the other hand, judges agreed on considering “Detenidos en la juventud, la vejez nos parecía muy distante” (Stopped at youth, senescence felt very distant), as “none of them”. An analysis was performed, excluding the mentioned MES. The reading times of MES in the consistent condition ( $M = 3397.81\text{ms}$ ,  $SD = 461.61\text{ms}$ ) did not differ from those of the inconsistent condition ( $M = 3299.08\text{ms}$ ,  $SD = 684.67\text{ms}$ ),  $t(50.85) = 0.655$ ,  $p = .516$ , showing that there was no incidence of the activity of walking on the reading time of *Ego Moving* MES. In this way, even when the analysis was circumscribed to MES, independently controlled to pertain to the *Ego Moving* conceptual metaphor, results were the same as when all MES were included.

## General Discussion

As Casasanto (2009) pointed out, the *Time Is Space* conceptual metaphor constitutes a sort of “fruit fly” for metaphor theorists, as it is the most explored conceptual metaphor in the field. According to conceptual metaphor theory, comprehending MES in which time is understood in terms of space implies simulating the sensory-motor involved in the spatial movement. In the *Ego Moving* version of this conceptual metaphor, it implies simulating the action of moving forward towards an object that corresponds to a future moment in time (Lakoff & Johnson, 1980, 1999). There is extensive evidence for the thesis that both the *Ego Moving* and *Time Moving* variants are used in the interpretation of MEs (e.g., Boroditsky, 2000; 2001; Gentner, Imai, & Boroditsky, 2002; McGlone & Harding, 1998). However, Boroditsky, and Ramscar (2002) is the only study that has investigated their representational modality.

The present experiment was aimed at assessing whether the *Ego Moving* conceptual metaphor is bodily grounded, by a procedure that circumvents

the described shortcomings of the one followed by Boroditsky and Ramscar (2002). While participants in the experimental group read *Ego Moving* MES after performing the sensory-motor activity referred to by the base domain (i.e., walking forward), those in the control group read such expressions after having performed an irrelevant physical activity (i.e., sitting down and standing up). No differences in reading times were found between both conditions.

The embodied hypothesis posits that the interpretation of MES involves a sensory-motor simulation of the base domain of a conceptual metaphor. We reasoned that if a mental simulation of a base domain can on occasions facilitate the comprehension of MES (Wilson & Gibbs, 2007), the physical realization of the base sensory-motor activity should yield even stronger facilitation. An alternative to the embodied hypothesis would posit that comprehending MES does not require sensory-motor simulations of the base domain, but rather computing an analogy in an amodal, or abstract format. Given that our manipulation did not affect comprehension times, the most plausible conclusion is that participants made sense of MES by means of an amodal representation of the conceptual metaphor. Our results are consistent with Cacciari and Pesciarelli’s (2013) findings that MES, including verbs that refer to the spatial movement (e.g., “The student jumps from a book to another one”), do not engage sensory-motor simulations. They are also compatible with experiments involving patients with lesions in the left perisylvian cortex (Kemmerer, 2005). In his study, participants with impaired knowledge of the spatial meanings of prepositions (e.g., *at the corner*) did not show any deficits in understanding the temporal meanings of the same prepositions (e.g., *at 1:30*), which led the author to conclude, contrary to the embodiment hypothesis, that the comprehension of MES referring to time does not require spatial representations. In turn, the neurological evidence reviewed by Kranjec and Chatterjee (2010) indicated that spatial representations are stored either as amodal, left-hemisphere representations closely

linked to language or as embodied, right-hemisphere representations more closely related to perception. Regarding this distinction, the results of the present study suggest that the reading of MES derived from the *Ego Moving* perspective engages the former kind of representations, rather than the latter. Similar conclusions have been derived regarding other conceptual metaphors. For example, Minervino, Martín, Tavernini, and Trench (2018) obtained evidence that the comprehension of MES derived from the *Understanding Is Seeing* conceptual metaphor does not necessitate carrying out sensory-motor simulations of the experience of seeing. In that experiment, congenitally blind individuals' comprehension of such expressions was equal to that of sighted participants, suggesting that their interpretation did not involve sensory motor simulations of the base domain of seeing. However, the results of neuroscientific studies lead to mixed conclusions. Some fMRI studies have found that portions of the somatosensory cortex were activated during the comprehension of MES (e.g., Boulenger, Hauk, & Pulvermüller, 2009; Chen, Widick, & Chatterjee, 2008; Lacey, Stilla, & Sathian, 2012). For instance, Lacey et al. (2012) found that while the parietal operculum, a region of the brain for sensing texture through touch, was activated when participants listened to textural MES (e.g., *A rough day*), the same region was not activated when listening to literal expressions of equivalent meaning (e.g., *A difficult day*). Desai, Binder, Conant, Mano, and Seidenberg (2011) found that while both literal and MES referring to different kinds of sensory-motor activities activated the left anterior parietal lobule, an area involved in action planning, activation in primary motor and biological motion perception regions was inversely correlated with sentence conventionality. In contrast, other fMRI studies have found that brain areas involved in somatosensory processing were activated for literal expressions, but not metaphorical ones (e.g., Aziz-Zadeh, Wilson, Rizzolatti, & Iacoboni, 2006; Raposo, Moss, Stamatakis, & Tyler, 2008). As an example, Raposo et al. (2008) found

activation of motor and premotor areas only when participants listened to leg and arm related literal sentences (e.g., “The muddy children trampled over Sarah’s clean floor” and “The fruit cake was the last one so Claire grabbed it”, respectively), but not when presented with MES including the same leg and arm related verbs (e.g., “The spiteful critic trampled over Sarah’s feelings” and “The job offer was a great chance so Claire grabbed it”, respectively), which in turn engaged front-temporal areas associated with language processing.

It does not seem easy to put forward a plausible explanation for the inconsistent results obtained in psychological and neuroscientific studies. It might be useful to discuss the possibility that conceptual metaphors require sensory-motor simulations that vary as a function of the tasks being performed and the specific conceptual metaphors at stake. This would imply adopting a more pluralist perspective with respect to the representational format of concepts, as advocated by authors like Dove (2010) and Zwaan (2014). In any case, the study of the sensory-motor basis of conceptual metaphors requires a multidisciplinary approach, as well as taking into account studies that show positive results as well as those presenting negative results.

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## Appendix A

EGO MOVING metaphorical expressions employed in the main experiment

1. *Apenas habíamos despegado los talones y ya era el nuevo siglo* [We had just detached our heels from the ground and it was already the new century].  
¿Sentimos que transcurrió rápido el tiempo? [Did we feel that time had elapsed quickly]
2. *Ya estaba apoyando mis plantas en el nuevo milenio* [I was already setting the soles of my feet on the new millennium].  
¿Estábamos en el mismo milenio? [Were we still in the same millennium?]
3. *Todavía tenía cerca de mi nuca el mes de Abril* [April was still close to my neck].  
¿Sentía que el mes de abril realmente pertenecía al pasado? [Did she really feel that April belonged to the past]
4. *Ya casi ponían sus pies en Diciembre* [They were almost putting their feet on December].  
¿Estábamos a fin de año? [Were we at the end of the year?]
5. *Sentíamos que estábamos varados en el 2012* [We felt that we were stuck in 2012].  
¿Nos era fácil superar 2012? [Was it easy for us to get over 2012?]
6. *Habíamos dado una zancada nada más y ya era viernes* [We had strided and it was already Friday].  
¿Nos sorprendía que fuera viernes? [Were we surprised that we were already on Friday?]
7. *Apenas me había puesto en marcha y ya estaba viviendo mi adolescencia* [I was just getting going and I was already living my adolescence].  
¿Tuve la sensación de que duró mucho la infancia? [Did I have the feeling that my childhood had lasted too long?]
8. *Había dejado a mis espaldas buena parte del siglo* [I had already left a good part of this century behind my back].  
¿Había transcurrido mucho del siglo? [Had a significant proportion of the century elapsed?]

9. *Detenidos en la juventud, la vejez nos parecía muy distante* [Stopped at youth, senescence felt very distant].  
¿Sentíamos que transcurría la juventud? [Did we feel that youth was vanishing too quickly]
10. *Nos habíamos alejado ya de la primera década.* [We were already far away from the first decade].  
¿Había transcurrido bastante desde la primera década? [had a significant amount of time elapsed after our first decade?]
11. *Nos desplazábamos hacia la Navidad* [We were moving towards Christmas].  
¿Había ocurrido la Navidad? [Had Christmas taken place?]
12. *Ya no podíamos retornar a los tiempos pasados* [We were not able to return to past times].  
¿Querían revivir cosas? [Did they want to re-live stuff?]
13. *Transitamos rápido el 2012* [We travelled quickly through the year 2012].  
¿Se hacía interminable el 2012? [Did it feel as of 2012 was never ending?]
14. *Atravesamos el invierno muy lentamente* [We went through the winter very slowly].  
¿Parecía que duraba mucho el invierno? [Did the winter appear to last long?]

## Appendix B

### Non-critical words included in the pilot study

lámpara	similar	dominar
escuchar	intuir	recurso
ratón	detalle	obrar
toldo	lodo	bote
pintar	agallas	revivir
gaviota	dictar	rubí
mentir	retrato	disecar
probar	nivel	mantel
disco	idear	aprender
revisar	racimo	difícil
adentro	ofuscar	ovillo
atril	peor	roedor
desatar	teñir	temer
marea	araña	cuchara
imitar	moderar	crear
agenda		

## Appendix C

Filler metaphorical expressions, main experiment

1. *Invirtió varios años en entrenarse para los exámenes finales* [He spent many years training for his final exams].  
¿Fue a los exámenes sin estudiar? [Did he sit for the exam without having studied?]
2. *Había que salir como fuera de ese año nefasto* [It was imperative to exit that year by whatever means]  
¿Fue malo aquel año? [was that a bad year?]
3. *Se metían dentro de una década en la que quedarían atrapados* [they were getting into a decade in which they were to get trapped]  
¿Sería una década de poca importancia? [would that be a decade without importance?]
4. *Llenábamos el tiempo con las actividades más tontas* [we were filling time with the silliest activities]  
¿Estaban faltos de tareas importantes? [were they lacking important activities?]
5. *Se reservó los últimos minutos para pensar en ella* [He saved the last minutes to think of her]  
¿Dedicó los últimos minutos a cosas espirituales? [Did he save his last minutes to spiritual matters?]
6. *Al fin pude recuperar el tiempo perdido de mi juventud* [At last I could make up the misspent time of my youth]  
¿Sintió que no había aprovechado del todo su juventud? [Did she feel that she hadn't made the most of her youth?]
7. *Se creaba tiempo para sus momentos privados* [He made time for her private moments]  
¿Generaba tiempo para compartir con otros? [Did she make time for social gatherings?]
8. *No te regala un minuto de su tiempo* [He won't give you a minute of his time]  
¿Administra cuidadosamente su tiempo? SI [Does he administer his time carefully?]
9. *Escapó de aquel día con un cansancio descomunal* [I escaped from that day with a tremendous tiredness]  
¿Terminó el día relajado? [Was he revitalized at the end of the day?]
10. *Puso sus horas a disposición de su jefe* [She placed her time hours at her boss's disposal]  
¿Mostró predisposición para el trabajo? [Did she show predisposition for work?]
11. *Era difícil robarle un minuto a aquel profesor* [It was hard to borrow a minute from that professor]  
¿Estaba el profesor ampliamente disponible? [Was the professor fully available?]
12. *En aquel pueblo no había cómo matar el tiempo* [In that town there were no ways of killing time]  
¿Se trataba de un pueblo aburrido? [Was the town boring?]
13. *Exprimíamos los días como si fueran los últimos* [We seized the days as if they were the last].  
¿Queríamos que transcurrieran rápido los días? [Did we want those days to elapse quickly?]
14. *Malgastaba el tiempo en discusiones inútiles* [He misspent time in pointless discussions]  
¿Hacía un uso tonto de su tiempo? [Did she make a silly use of her time?]
15. *Entregó sus últimas horas a Dios* [He offered his last hours to God]  
¿Se dedicó al placer en el tramo final de su vida? [Did he devote his last hours to leisure?]
16. *Acumulaba días para sus vacaciones* [He was accruing days for his vacations]  
¿Buscaba tener unas vacaciones largas? [Was he planning to have long holidays?]
17. *Se nos esfumaba el tiempo y no lográbamos dominar los contenidos* [Time vanished and we were not mastering the learning materials]  
¿Estaban progresando rápidamente? [Were they making rapid progress?]

18. *Había que meter todas las actividades en una semana* [All activities had to be packed within one week].  
¿Estábamos faltos de tiempo? [Were we short of time?]
19. *Se propuso ganarle la carrera al tiempo y terminar la tarea* [He set the objective of defeating time and finishing his task]  
¿Postergaría la tarea? [Would he postpone the completion of the task?]
20. *Dilapidaba sus días en nada* [She was dilapidating her days for nothing]  
¿Hacía mal uso del tiempo? [Was she employing her time inadequately?]
21. *Ella le ganaría la batalla al tiempo* [She was decided to win the battle against time]  
¿Había desistido de intentarlo? [Had she withdrawn from her intentions?]
22. *Ganaba tiempo con su nuevo método* [He saved time with his new method]  
¿Su método le resultaba útil? [Was the new method useful?]
23. *El tiempo se estiraba a la espera de que ella llegara* [Time stretched while waiting her to arrive]  
¿Llegó ella antes que él? [Did she arrive earlier than him?]
24. *El tiempo había dejado sus huellas en nosotros* [Time had left traces on us]  
¿Se advertían los años transcurridos? [Had we changed noticeably over the years?]
25. *Buscaba resucitar los tiempos pasados* [He wanted to revive past times]  
¿Quería olvidar el pasado? [Was he willing to forget the past?]
26. *Pudimos encajar todo lo programado en un día* [We managed to fit all the programmed activities within one single day]  
¿Fue finalmente suficiente el tiempo? [Was time finally sufficient?]
27. *No podíamos derrochar más nuestras tardes* [We could not waste our afternoons any longer]  
¿Podíamos seguir relajados? [Could we keep being so relaxed?]
28. *Supo invertir bien años más productivos* [He managed to capitalize on his most productive years]  
¿Sacó provecho de sus años más productivos? [Did he take advantage of his most productive years?]

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