EFFECTS OF CULTURE ON THE SPATIAL MEANING OF WORDS

by

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Abstract

In what ways do action, language comprehension, and visual perception interact with one another? Previous research has shown how language comprehension may interfere with mental imagery and actual visual perception (Barsalou, 1999; Richardson, Spivey, Barsalou, & McRae, 2003; Spivey & Geng; 2001, Glenberg & Kaschak, 2002; Zwaan, Madden, Yaxley, & Aveyard, 2004). Furthermore, spatial language that insinuates action in one direction may interfere with our ability to perform physical actions of the opposite direction (Glenberg & Kashack, 2002). However, meanings associated with a particular action or gesture can be different across different cultures. The present paper is a grant proposal Project Plan designed to test whether activating spatial representations primes meaning in ways that are specific to the culture of the participant. In a task where people are incidentally asked to move their heads in a particular way, (i.e., either in an up and down nod, or a side-to-side shake), does that action that is irrelevant to the task affect language and spatial processing, and vice versa? And do we find different patterns of effects for English speakers (for whom nodding the head means *yes* and shaking the head means *no*) and Greek speakers (for whom nodding the head means *no* and shaking the head means *yes*)?

Aim: The proposed study aims to determine whether action and language processing interfere with each other in culturally specific ways. The study also aims to examine whether the timing of action relative to language processing affects the direction of the effects.

Effects of Culture on the Spatial Meanings of Words

Most everyday tasks in life involving language comprehension require some level of multi-tasking. While eating, we have conversations with others at the table. While driving a car, we listen to the radio. Whenever we process language while doing other things, to what extent do the words that we hear influence those other tasks? For example, do the lyrics of songs on the radio influence what we see when we drive? Likewise, do the actions we take while understanding language affect how we process the meaning of the words we hear? For example, does changing gears while driving affect how we understand the lyrics of songs on the radio? The proposed study examines the nature of these kinds of interactions among language, perception, and action.

Traditionally, researchers have treated language and other high-level cognitive abilities as separate from perception and action. Perception and action have been seen as the systems that allow us to interact with the environment, but the dominant view is that you need a separate "thought" system to allow us to do all the complex reasoning we are capable of. The theory that conceptual representations are symbolic and abstract and not represented from sensory and motor systems is known as disembodied cognition (Mahon & Caramazza, 2008). The researchers elaborate on how one's motor system may be activated by symbolic and abstract representations (e.g., the concept of a hammer), but this does not require any motor aspect to the representation. Simply knowing what the hammer can do or what it is used for without using any motor representations is enough. Embodied cognition is the theory that the brain is not the only resource that influences problem solving but also the motor system or perceptual systems help humans achieve the required goal (Mahon & Caramazza, 2008; Wilson & Golonka, 2013).

More recently, researchers have shown that you can explain a lot of complex human behavior just in terms of perception and action, suggesting that there might not be separate systems. Wilson and Golonka (2013) developed a four-step task analysis for future research of embodied cognition. The first step is to identify the task that needs to be solved; the second step is to identify what resources (e.g., mind, body, and environment) the individual has access to in order to solve the task; the third step is how can the resources previously detected help create a dynamic interaction or system between the mind, body and environment; and lastly researchers must identify whether the dynamic system that the individual created helped solve the task. Taking these four analogy steps into consideration can help explain complex behavior based on perception, action, and external resources in the environment, not just static representations in the mind.

One possible consequence of having a language system built on perception and action could be that words end up having perceptual meanings, even when those words refer to something abstract. Previous research has shown that concrete and abstract words do have spatial meaning that is automatically activated when people simply hear the words (Richardson et al, 2003; Spivey & Geng, 2001). For example, concrete words such as *push* and *pull* would be associated on the horizontal axis, whereas words such as *fly* and *plummet* would be associated on the vertical access. The researchers showed that even abstract words such as respect and hope would associate on the vertical axis, whereas words such as *argue* and *tempt* would associate on the horizontal axis. If the meanings of these words are truly perceptual in format, then performing action and viewing actual visual stimuli in the world should interfere with language processing, and language processing should interfere with visual and motor processing. The proposed study examines these possibilities, aiming to find similar effects as have been seen before, now extending them to look at culture. It will be focusing on how simultaneous action modulates the effects of language on perception.

Background and Significance

Many studies have established links between language processing and visual and motor processing. For example hearing a story (Spivey and Geng, 2001) or spatial language (Richardson et al, 2003) can induce and activate mental imagery, and while processing language it may have effects of congruency or incongruency (Kashack, Madden, Therriault, Yaxley, Aveyard, Blanchard, & Zwaan, 2004; Zwaan et al. 2004). Likewise, the language can be concrete or abstract and it has been found that language is grounded in motor action (Glenberg & Kaschak, 2002). Spatial language can induce or activate mental simulations. Previous work on the relationships among language, mental imagery, and perception have shown that during language comprehension people perform the same types of eye movements that are used during actual visual perception of the type of scene described by the language (Spivey and Geng, 2001). Spivey and Geng (2001) had participants sit down and face a blank white projector screen while listening to stories that consisted of upward, downward, leftward and rightward scenes. They also exhibited a control story that avoided explicit directional terms. Participants were unaware that their eye movements were being recorded throughout the experiment. It was shown that while listening to a story with spatial direction, participants made eye movements that were consistent with the direction of the story. When participants heard the story of a fishing line off a boat to the right, it caused them to move their eyes rightward even though they were staring at a blank monitor screen. As to when they heard the control story that had a non-spatial description of a dining couple through a telescope, it did not produce any directional eye movements. These results show that language in the absence of visual input causes people to engage in acts of visual perception, even though they are not looking at anything. This may be a result of how language comprehension and visual perception are linked to low-levels of visual processing (Meteyard, Bahrami, & Vigliocco, 2007) and exposure to a spatial story long enough can influence mental imagery (Dils & Boroditsky, 2010).

Spivey and Geng (2001) suggested that understanding language causes people to imagine what they hear and engage in acts of visual perception. Could that imagery interfere with actual visual information on the screen? Previous research has shown that that concrete verbs can activate spatial representations, which can then interfere with visuospatial processing (Richardson et al, 2003). Participants heard a series of concrete or abstract verbs while having to judge whether objects appearing on the screen were either a circle or square. Half of the verbs were vertical and half were horizontal, based on previous norming studies by Richardson, Spivey, Edelman, and Naples (2001). Examples of concrete horizontal verbs are “pull” and “hunt,” and concrete vertical verbs are “bomb” and “perch”. While fixating, subjects had to report whether an object that appeared in the periphery was a circle or a square as quickly as possible. It was concluded that subjects identified the visual stimuli quicker in the vertical position when a horizontal verb was presented instead of a vertical verb. Likewise, they were quicker when the visual stimulus was in a horizontal position when a vertical verb was presented instead of a horizontal. Richardson et al. (2003) concluded that language processing and visual perception must compete for the same resources in order for this interference effect to occur.

Hearing spatial words appears to activate mental imagery that interferes with visual processing in the same part of space as the word. This is true for concrete verbs like “perch” and “fly.” Is it also true for abstract verbs that people rate to have vertical meanings? For example, abstract verbs like “respect” and “hope” don’t actually describe objects physically moving in space. Nonetheless, Richardson et al. (2003), found that they also interfere with visual processing in congruent parts of space. For vertical abstract words like respect and hope, subjects were faster when the visual stimulus was in a horizontal position but slower when the visual stimulus was presented in the vertical position. These effects for concrete words were replicated by the Bergen, Lindsay, Matlock & Narayanan (2007), but they did not find evidence of abstract language affecting perception.

Indeed, both concrete and abstract verbs have spatial meanings that interfere with visuospatial processing. Can the effect go the other way? Can activating spatial representations either facilitate or interfere with language comprehension? Previous research has shown that language comprehension may affect our ability to perform a congruent action, which is also known as action-sentence compatibility effect (ACE; Glenberg & Kaschak, 2002). In this study, participants made sensibility judgments on sentences. Their job was to indicate whether sentences were sensible (e.g., "Close the drawer") or nonsense sentences (e.g., "Grab the air") by making a response that required moving towards or away from their bodies. Half of the sensible sentences were sentences that implied actions towards the body, and the other half of the sensible sentences implied action away from the body. They only cared about processing time of sensible sentences. Participants used a constructed button box that had three response buttons: one button was towards the body, the middle button was to present the sentence on the monitor, and the third button was away from the body. When a sentence insinuated action in one direction (e.g., "Close the drawer") participants found it difficult judging the sensibility of the sentence if they had to physically move their hands towards themselves as opposed to away from themselves, and vice versa. Therefore, Glenberg and Kaschak (2002) claimed that language comprehension is grounded in human action.

Further evidence suggests that spatial meaning in language can interact with spatial meaning in a subsequent visual stimulus (Kashack et al, 2004; Zwaan et al, 2004). In this study, participants listened to sentences that described motion in a particular direction (e.g., towards, away, up or down) and were instructed to make sensibility judgements while they watched a visual stimulus of motion. Kashack et al. (2004) found that when participants listened to sentences that implied action in one direction (e.g., "The car approached you."), participants were slower when they made a sensibility judgment about the sentences when the visual stimulus was congruent with the sentence. They responded faster when the visual stimulus was incongruent or opposite of the direction of the sentence. In contrast, in a previous study by Zwaan et al. (2004), participants responded more quickly when the implied motion of the sentence matched the movement from the visual stimulus. Participants saw sentences presented one word at a time and then made judgments about whether a pair of serially presented pictures of a ball were the same size or different size. Seeing a picture of a large ball before a small ball implied motion away from the participant, whereas seeing a picture of a small ball before a large ball implied motion toward the participant. Participants were faster when the direction of motion implied by the sentence matched the direction of motion implied by the set of pictures. Kashack et al. (2004) claimed that the reason why they found an incongruency effect when Zwaan et al. (2004) found a congruency effect was due to the format of the linguistic stimulus (auditory versus visual). When the language and the perceptual judgment are both visual, the processing has to be more serial. When they are in different modalities, neurons are activated and engaged at the same time, therefore, it is more difficult to construct a simulation during language comprehension when participants heard the sentence at the exact same time, producing an interference effect.

We have seen how spatial language can induce perceptual mental simulations. How much do these simulations vary from person to person or from culture to culture? Body gestures certainly appear to be distinctive cross-culturally. Between English and Greek speakers, for example, the very same head movement can have opposite meanings. For English speakers, nodding the head up and down means “yes” and shaking the head left and right means “no,” but to Greek speakers the pattern is opposite: shaking the head left and right means yes, but nodding the head up and down means no. Therefore, it may be that concepts that are *true* may have a vertical metaphorical meaning for English speakers but a horizontal metaphorical meaning for Greek speakers, and concepts that are *false* may have metaphorically horizontal meanings for English speakers but metaphorically vertical spatial meanings for Greek speakers. This proposed study aims to examine whether nodding or shaking the head may interact or interfere with semantically true and false sentences (e.g., “Elephants are bigger than birds” vs “Birds are bigger than elephants”) in culturally specific ways between English and Greek speakers. In addition, it will examine whether motor actions of head moments may interact or interfere with understanding sentences that have vertical or horizontal meanings (e.g, “Elephants are bigger than birds” or “A mile is longer than an inch”) in the same way for all people, because, regardless of culture, nodding is a vertical action and shaking is a horizontal action. Finally, the study will test whether the timing of language and action affects whether there is a congruency effect versus an incongruency effect. Having multiple timing conditions can help predict when there should be a congruency effect and when there should be an incongruency effect. In one condition, participants will make incidental head movements by following a dot on a screen *while* language is being presented, and in another condition participants will make a response using an upward or downward head motion *after* the language has been fully presented.

Specific Aim: The proposed study aims to determine whether action and language processing interfere with each other in culturally specific ways. The study also aims to examine whether the timing of action relative to language processing affects the direction of the effects.

Approach

Participants

Approximately sixty monolingual adult participants will be recruited for this research. Thirty participants will be English speakers, and thirty participants will be Greek speakers. These participants will be recruited from the Purchase College Psychology Participant Pool, Amazon Mechanical Turk, and advertisement on social media platforms of Facebook and Instagram. The study will require travel to remote areas where monolingual speakers of Greek can be found. Greek speakers will be recruited using flyers and by word of mouth. Those who are recruited from the Psychology Participant Pool will receive one credit and people recruited from other populations will be paid the national minimum wage for their time.

Design

The main experiment is broken down into 2 head movement conditions (shaking and nodding) x 2 spatial directions in language (vertical and horizontal) x 2 truth value levels (true and false) x 2 timing conditions (simultaneous and serial), all within-subjects. The language of the participants (Greek versus English) is a between-subjects variable. Accuracy and reaction time to the linguistic stimuli are the dependent measures in this study.

Materials

All participants will complete a demographic questionnaire and language use questionnaire to ensure participants are speakers of the languages being tested, and not speakers of other languages that might interfere with their spatial meaning systems. Some questions that the language use questionnaire consists of include the age the participant (1) acquired the language, (2) became fluent in language, (3) began to read in the language, and (4) became fluent in reading in the language (Marian, Blumenfeld, & Kaushanskaya, 2007).

In the present study, participants will listen to sentences presented in sequence. Half the sentences will be true and half will be false. Half the sentences will be vertical and half will be horizontal as considered in the English language. An example vertical true sentence is: “Elephants are taller than birds,” and a vertical false sentences is: “Elephants are shorter than birds.” An example horizontal true sentence is: “A mile is longer than an inch,” and an example horizontal false sentence is: “An inch is longer than a mile.” Some of these sentences will be taken out of the Richardson et. al (2003) study. The sentences will be submitted to a norming study before data collection begins to ensure that they have the spatial qualities they were designed to have.

Procedure

Before the main experimental task begins, each participant will complete a set of practice trials. Once the practice trial tasks are done, they will move forward to the main experimental tasks.

The experimental task consists of two blocks. Each block has a sequence of 30 sentence trials. In the simultaneous condition, participants will move their heads in a single direction for the entire block *while* the sentences are presented, either vertical or horizontal. While listening to the sentences participants will track a dot on the screen that alternates between either the top and bottom (vertical) or left and right (horizontal). Incidentally, this task will cause their heads to move in a nodding fashion or shaking fashion synchronized with the dot. The dot will change colors six times and at the end participants will be asked how many times it changed colors. The point of this task is to make sure participants are following the dot. In the sequential condition, participants will use a head movement to actually make a response about the truth value of the sentence, so they will be moving their heads after the sentence has been presented and not during.

On a given trial, participants will hear a sentence and judge whether it is true or false. Participants will be instructed to respond quickly and accurately when they hear the set of sentences. Participants in the simultaneous condition will respond by pressing the "L" key labeled true and the "A" key labeled false. Participants in the sequential condition will respond by lifting their heads up or down to indicate true or false (counterbalanced across participants) on half the trials, and left or right to indicate true or false (counterbalanced across participants on the other half of trials. Head responses will be video recording during the study, and blind raters will code those responses after all data have been collected.

To conduct the study, I will be using Psychopy software for presenting audio-visual stimuli and recording a variety of responses on laptops in the field.

Predictions

A mixed designs ANOVA will be used to measure the response time and accuracy of the sentences. It is predicted that the veracity of the sentence will show a congruency effect in the sequential condition but an incongruency effect in the simultaneous condition. However, this effect should look different in Greek and English speakers. Moving their head up and down should cause interference with true statements for English speakers in the simultaneous condition, but facilitation in the sequential condition. Moving their head up and down should cause facilitation with true statements for Greek speakers in the simultaneous condition, but interference in the sequential condition. The opposite pattern is predicted for false statements.

Everybody should look the same when considering the spatial aspect of the sentences. For all people, nodding is vertical and shaking is horizontal, so all speakers should show an incongruency effect in the simultaneous condition when the direction of the sentence matches the direction of the head movement, and they should show a congruency effect in the sequential condition when the sentence direction matches the head movement. The opposite pattern is predicted when the sentence direction mismatches the direction of the head movement. In addition, it will be interesting to see how it would interact with one another, whether the veracity of the sentence, language and motor actions affects is stronger or dominates the other.

Intellectual Merit

The purpose of this study is to advance knowledge and understanding of the relationships between language comprehension and visual and motor processing. Traditionally, language is studied as a separate system from the mechanisms that allow us to perceive and act on the world. Recent research in language comprehension talks about the spatial meanings (e.g., up, down, left, right) that are inherent to some words, including abstract words, and how this spatial meaning from language has the power to affect visual mental imagery and actual visual perception (Barsalou, 1999; Richardson et al. 2003; Spivey & Geng; 2001, Glenberg & Kaschak, 2002; Zwaan et al. 2004). Embodied cognition theorists argue that this relationship between physical space and abstract meaning is best explained by the fact that all the information we humans have is obtained through the senses and is structured by sensory mechanisms. In support of this theory, Gallese and Lakoff (2005) pointed to evidence of the activation of common sensory-motor brain mechanisms during both language comprehension and motor action, and proposed that while imagining, performing, and perceiving an action we use the same neural mechanisms.

Motor actions such as head movements have culturally specific meanings. In English speakers, nodding is “yes” (vertical) and shaking is “no” (horizontal), but to Greek speakers it is the opposite; nodding is “no” and shaking is “yes”. This study will add to the growing body of work showing a relationship between action and perception by asking whether these types of culturally specific actions and gestures lead to different patterns of meanings in language. If this type of relationship exists, then the same motor action should *interfere* with language comprehension in culturally specific ways. Finally, these findings will help to tease apart different explanations for why some studies demonstrate congruency effects and other studies demonstration incongruency effects. These findings can further help research in cognitive theories and language comprehension. A limitation about this study would be accessing monolingual speakers of Greek. Most Greek people have studied English at some point in life and that might affect their spatial meanings. Comparatively, it will be easier to recruit monolingual English speakers compared to Greek speakers.

Broader Impacts

Most cognitive psychology studies are conducted on samples consisting of largely White, college-aged, high SES participants, with the assumption that the effects will generalize to other populations. This study identifies important potential differences in cognition across cultures and uses a diverse sample with respect to age and culture. Therefore, learning about how people from different cultures represent the world differently is interesting and enlightening. In addition to head movements, there are a variety of distinctive gestures across cultures that these findings might apply to. When you greet someone in the U.S. (when there is no global pandemic) you would usually use your right hand to shake their right hand, in some European cultures you would you give a kiss on either one or both cheeks, and in some Asian cultures you would bow your head. Gaining knowledge on distinctive cultural gestures might help people to better understand each other's perspectives and expand their horizons on how the meaning of these gestures affects language processing.

If language has spatial meaning that can affect visual perception, then the language we hear on a daily basis can either interfere or influence the way we perceive things. While driving a car and listening to the radio or music, we may start to imagine the words we hear, which might affect what we see on the road. At the same time, the actions we take while driving (like changing gears or checking our mirrors with a left-to-right head movement) might moderate the effects of language.

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