ARE ABSTRACT WORDS GROUNDED IN VERTICAL SPACE?

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A thesis submitted to the Graduate School-Camden Rutgers,

The State University of New Jersey

In partial fulfillment of the requirements

For the degree of Master of Arts

Graduate Program in

Psychology

Written under the direction of

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and approved by

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Camden, New Jersey

October 2015

THESIS ABSTRACT

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The literature on embodied cognition poses as a formidable contender to the amodal view of the mind. The last ten years have resulted in a plethora of support for the embodiment/grounding of concrete language processing. However, the issue of abstract concepts has not been resolved. If it is true that abstract concepts are embodied or grounded, how does this coincide with the fact that abstract concepts refer to specific things in space like bodies. Therefore, this issue must be addressed to investigate the extent of the grounding of language processing. The present paper features two studies where participants view a word associated with either upward or downward space, followed by an identification task of a target letter which either matched the associated location of the word or not. It was predicted that spatial targets which match a presented word's spatial association would result in reaction time interference. The results were found to be inconclusive. Methodological problems and future directions are presented and suggested.

Introduction

The ability of language to describe features of the world is a fundamental cognitive ability required in a variety of everyday tasks. The power of this ability rests on the assumption that words elicit mental imagery (mental content) which correspond to what they signify in the world. There are, however, two opposing views concerning the nature of the relation (if any) between perception and imagery: Embodied cognition (also known as perceptual symbol systems) and amodal mental imagery. As mentioned before, the view that mental imagery or content uses the same facilities as perception is novel and counter to the prevailing paradigm in cognitive science, which assumes cognitive processes are separate from those of the sensorimotor system. .

The prevailing view of the last forty to fifty years deals with the idea of amodal representation (e.g. Fodor, 1975) where perception and mental imagery (content) are processed in different mental domains. This view affirms that sensory data is taken into the brain and translated into detached, distilled, and abstracted conceptual nodes to signify understanding (Glaser, 1992). That is, raw experience becomes abstracted in the mind into arbitrary content not dependent on the environment or bodily shape. Therefore mental images should not interfere with perception.

Amodal representations are themselves problematic. The issue lies in their inability to account for the relation between a symbol and their referent. That is, a grounded problem is present with amodal approaches because there is no sufficient answer as to how a symbol can refer to anything in the world, as the symbol is arbitrary (e.g. different languages develop for the similar referents). Another approach which predicts the hypotheses of this proposal and acknowledges this problem is called embodied cognition (EC). It proposes that instead of arbitrary mental representations, mental content consists of perceptual/motor simulations, which interfere with perception. It is useful to go over some of the relevant literature within this new approach to the study of cognition (EC) - and how the current study fits in with this thread of research activity.

EC has during the last decade seen a wealth of studies uncover how the traditional view of mind as based on arbitrary and amodal mental symbols may be misguided. During the last fifteen years, these studies have shown how many mental processes and structures are contingent upon bodily form and environment. Wilson (2002) has outlined six points of convergence amongst the EC literature: (1) Cognition is situated; (2) Cognition is time pressured; (3) Cognition is off-loaded onto the environment; (4) The environment is a part of the cognitive system; (5) Cognition is for action; (6) Offline cognition is body based. Most relevant for the current study are points one and six. As point one claims, cognition is situated in the environment and (importantly) within perception and action. The current study hypnotizes that mental imagery, a cognitive process, is grounded or situated in the perceptual system. Point six, like the current study, posits that cognition is body based. The other four points are exemplars of EC broadly, but beyond the scope of the present study. The implications of these six points are so profound for cognitive psychology and science as a whole, it has garnered novel methodological and theoretical approaches (Wilson & Golonka, 2013). More radically, these implications have called into question the traditional boundaries of the acting and sensing body, in favor of perhaps a more fluid and encompassing definition based on linguistic and social conventions (Borghi & Cimatti, 2010).

In order to fully grasp the present problem, it will be useful to briefly present the history of embodied cognition. Over a hundred years ago, it was shown that mental images may interfere with the visual perception of stimuli (Perky, 1910). That is, perception of a picture is affected by thinking of a mental image related to the picture- such as thinking of a banana and attempting to perceive a yellow rectangle on the threshold of visible perception. This has been labeled the “Perky effect”. More recently, it has been shown that mental imagery of motor movements in one direction can cause a perceptual illusion called the motion after effect (Winawer, Huk, & Boroditsky, 2010) in which, for example, after watching a waterfall, the rocks nearby will seem to be slightly moving in the direction opposite to the flow of the water. .

More interestingly, concerning the current study, is the effect on visual perception and perceptual behavior from the mental imagery evoked by language comprehension. The rationale is that when one hears language, content is simulated or imagined. It has been shown that language describing motion can cause motion aftereffects (a visual illusion) like perceptual stimuli (Dils & Boroditsky, 2010). Language denoting or suggesting physical space can affect perceptual behavior; a study found that words were quicker to process when in spatial locations matching their spatial associations (Thornton, Loetscher, Yates, & Nicholls, 2013; Dudschig, Souman, Lachmair, Vega, & Kaup, 2013). There is also fMRI evidence showing that language processing is done in the brain within different perceptual modalities as opposed to one amodal system (Simmons, Harmann, Harenski, Hu, & Barsalou, 2008). In line with the preceding studies, language has been shown to be both action oriented and related to motor and perceptual processes (Fischer & Zwaan, 2008).

Acknowledging that language, mental imagery (i.e. simulation), and visual perception are closely related, one may wonder that if the spatial meaning of an lexical item can interfere with the perception of visual stimuli, in a space congruent with the word's spatial meaning. That is exactly what has been found. Visual perception may use the same cognitive resources as language, thereby allowing for a bidirectional relationship between the two (Kaschak, Madden, Therriault, Yaxley, Aveyard, Blanchard, & Zwaan, 2005). Imagery, like language, has also been shown to interfere with perception on a visual detection task, when the visual target's place is congruent with the spatial meaning of the mental image (Craver-Lemley & Arterberry, 2001). The comprehension of verbs has been shown to interfere with the identification of visual markers in spaces congruent with the verbs spatial meaning (Richardson, Spivey, Barsalou, & Mcrae, 2003). Visual imagery from sentence comprehension of both noun and verbs has been shown to interfere with visual perception of markers congruent with the spatial meaning of the mental imagery evoked from the sentence comprehension (Bergen, Lindsay, Matlock, & Narayanan, 2007).

Mental imagery or simulations from sensory modalities like sound can also interfere with visual perception- music can elicit a motion after effect (Hedger, Nusbaum, Lescop, Wallisch, & Hoeckner, 2013). This shows that mental imagery can be utilized by multimodal perceptual processes. That is, mental imagery is not confined to only the visual modality or to an amodal system. Others (Vermeulen, Chang, Mermillod, Pleyers, & Corneille, 2013) have found that perceptual load from other modalities (light, sound) affects cognition- demonstrating that cognition and multimodal perception share the same resources.

A more nuanced explanation of how language or mental imagery/simulation interferes with perception may be valence. That is, the relation between mental imagery and perception may be mediated by valence. Schubert (2005) has investigated the relation between valence and space as a function of power. Others have shown that affect influences perception (Meier & Robinson, 2004). Lakens (2012) shows that although valence and EC (or modal mental imagery) are related, they are nevertheless separate processes. Others contend valence may have no relation to embodied cognition (Dantzig, Zeelenberg, & Petcher, 2009)

One paper (Estes, Verges, & Barsalou, 2008) investigates how single lexical items (a word) interfere with the perception of a marker (X or O) shown after it. Both an X and O were used to mislead participants about the hypothesis of the study by having them think the task was to see a difference between the marker, rather than its location. Across three conditions, they found that words that denoted objects high in physical space, such as head or cloud, interfered with the perception of the marker- by slowing down the time to identify it- than words that were had a low spatial orientation, such as foot or floor; the opposite is true for words oriented toward objects low in physical space. This study demonstrated that single word processing involves sensorimotor behavior (i.e. embodied cognition). The study, however, did not make a distinction between concrete and abstract words. The present study aims to explore this distinction.

There is good reason to expect abstract concepts, and the mental imagery/simulation that accompany them, are embodied. Abstract emotional concepts have been shown to be embodied in facial expressions, so that blocking facial muscles interferes with abstract emotion evaluation (Niedenthal, Winkielman, Mondillon, & Vermeulen, 2009). It has been demonstrated that mathematical thought, which is thought to be a standard of abstract concepts, is also embodied (Landy & Goldstone, 2007). Moreover, abstract concepts themselves have been shown to be embodied as well (Cassanto, 2009). The explanation of how abstract mental content is embodied is vital for the development and trajectory of EC in giving a full account of cogntive phenomenon.

The potential of EC in shaping the future of cognitive psychology and science is evident. Some think that EC can unify the many diverse parts of psychology like action, perception, and cognition (Barsalou, 2010). Others think EC will restructure how we see the individual- allowing for aspects of coupling with the environment (McGann, Jaegher, & Di Paolo, 2013). Overall, there is good reason to think that EC will be successful in explain cognition, considering its achievement within social cognition (Goldman & Vignemont, 2009) in addition to what has been presented above. However, EC will have much less of a fruitful future if the embodiment of abstract notions cannot be accounted for.

Returning to the specifics of the alternative hypothesis to amodal mental imagery, the view suggested in this paper is that of perceptual symbols systems. This is where the mental domains of perception and imagery are drawing from the same resources, or maybe the same domain. (e.g. Barsalou, 1999). That is, perceptual symbol systems acknowledges that mental symbols embody, reenact, or simulate their referents (Barsalou, 2008). This means that the symbols humans use to represent the world are not detached from the world and juxtaposed on it. Rather, they are directly grounded in the world. Here, raw experience serves as a model or simulation of the world one inhabits.

Therefore if imagery is a perceptual simulation of what it refers to in the real world, then mental images should be able to interfere with perception of external stimuli. This is because the imagery, using the same facilities as perception, gets in the way of the presented stimuli, as if the mental image was an external image itself. Thus this view is in support of the current proposal's hypothesis. Notice, this view may also be called grounded or embodied cognition.

Again, it has been shown that single lexical items (words) describing motion may elicit corresponding mental imagery (Verges & Duffy, 2009). With regard to this, it follows that language may interfere with spatial imagery and perception. That is, a word can disrupt the time it takes to view a marker on a screen, if presented before. This is because the mental imagery elicited by spatially associated words obstructs the perception associated with that spatial location referred to by the word.

What is less known, however, is if there are any differences in the elicitation of mental imagery interfering with perception between abstract and concrete words. Verges and Duffy (2009) studied if the spatial association of words interfered with the perception of marker (X or O) on a screen. They found that spatially associated words interfere with perception similarly to pictures. For example, the word hat interferes with the perception of a top marker (on a screen) if shown before, as much as a picture of a hat shown before the marker. The words presented though were all categorized as concrete.

Meier and Robinson (2004) have shown associations between affect and vertical position. That is, words which are positively associated are quicker to identify at the top of a screen then the bottom or middle. The opposite is true with negative words- being quicker to identify if at the bottom of a screen. However their study did not investigate if these positive valence or negative valence words had any perceptual interference effects. It would be useful to see if valence interferes with perception differently then mental imagery. Doing so can help elucidate the role of affect in mental imagery and perceptual simulation/interference, investigating whether or not they are independent of each other or if valence is mediating the relation between mental imagery/simulation and perception. Understanding this will lead to a more accurate account of the potential embodiment of abstract concepts.

As discussed before, there is a growing need for research in grounded and embodied cognition to explain high level cognition (e.g. Di Paolo, Rohde, & Jaegher, 2010). This is because this view has mostly culminated support from the domains of low level cognitions such as motor perception. Therefore, the present study will add to the embodied/grounded literature a necessary look at the effects of abstract words on perceptual interference. As abstract words require high-level cognitive processing, it will be interesting to see if it has an effect on perception. If it does, it will give much needed support to the notion that high level cognitive processes are embodied much like low level cognitive processes are.

The present study aims to expand upon previous findings (i.e. Estes, Verges, & Barsalou, 2008; Verges & Duffy, 2009) whether abstract and concrete words function in a similar fashion. The present study also aims to expand on what Meier and Robinson found by investigating the influence of valence of words on perceptual interference. By doing so, and exploring the effects of the delay and the type of word, we can come to a better understanding of the processes underlying mental imagery/simulation, valance, and perceptual symbol systems. It has been demonstrated that mental imagery elicited by words interferes with perception, but it is not certain that single abstract words would also do so. Therefore as the hypothesis that these words (including abstract ones) may interfere with perception is both plausible (because of previous research showing words causing perpetual interference) and uncertain (because of the gaps in the literature) it is worth testing. The testing of this hypothesis will prove necessary to the future of EC- specifically the embodiment of abstract mental content.

If the hypothesis is supported, then the conclusions gathered from this study can contribute to the lacking literature on embodied/grounded high-level (abstract) cognitions by showing high-level mental processes are embodied. This understanding is essential for the development of EC- without it EC will suffer. However, if the null hypothesis is suggested, then this study will give support to the amodal perception view in cognitive science, by suggesting that abstract notions have little interaction with perceptual systems and faculties. Thus, whether or not the present study affirms the hypothesis, the conclusions gathered therein will demonstrate importance for the cognitive science literature.

My central research question is: are there differences between how spatially associated mental imagery- also known as simulation- elicited from concrete vs. abstract linguistic stimuli, interferes with vertical spatial perception. In a second experiment, I also investigate the effect of the valence of linguistic stimuli on facilitating perception, as a way to address some of the conceptual issues in the literature. The first experiment will have three independent variables. The first independent variable for the first experiment will be word type; this variable has two levels: abstract words or concrete words. Concrete words are those which directly denote physical things in the word such as car or pencil. Abstract words on the other hand, are those which do not directly denote physical things in the world such as time or honor (for the word list, please refer to the appendix). The second variable of the first study will be spatial direction of the word; this variable has three levels: upward spatial association, downward spatial association, or neutral association. The third variable of the first study will be spatial congruence between word and a target/marker shown after the word; this variable has two levels: congruent or not congruent with a word's associated meaning. There are three independent variables in the second study. The first is word valence; this variable has three levels: words with positive valence, words with negative valence, and words with neutral valence. The second independent variable of this second study will be spatial direction like the first study; this variable has once again three levels: they are upward, downward, and neutral spatial direction. The last independent variable is spatial congruence; this variable has two levels. The first study's dependent variable will be reaction time to spot a marker on the screen, following the presentation of the independent variable. The second study's dependent variable will be reaction time, again, to spot a marker following the presentation of the independent variable.

The main hypothesis is that because of perceptual interference, participants will take more time to spot the marker if it matches the spatial association of the linguistic stimuli presented before. The second hypothesis, concerning the second experiment, is that positive valence will facilitate the perception of markers placed upward, while negative valence will facilitate with the perception markers placed downward, and words with neutral valence will not facilitate the perception of the markers.

Methods

Concerning the independent variable of word type in the first study, they will be words which will either be concrete or abstract, such as pillow, bird (concrete) or hate, justice (abstract). The second independent variable will be the spatial association/direction of the words. This independent variable has three levels: an upward association will be a word which is commonly related to things that are high in physical space, such as plane, sun (upward concrete) or above, heaven (upward abstract). The opposite is the case for downward associations, with the words like floor or fall (downward concrete) being usually associated with objects low in physical space. Neutrally associated words are not associated with anything in physical space, such as newspaper and lamp (spatially neutral concrete) or habit and intention (spatially neutral abstract). As for the first independent variable in the second experiment (word valence) there are three possible levels. Words with positive valence like joy usually elicit pleasant feelings. While words with negative valence usually elicit undesirable feelings, like illness or death. Finally words with neutral valence do not elicit emotionally associated feelings, like sound or number. The third independent variable of both studies (congruence) has two levels: congruent- meaning that the spatial association of the word matches the placement of the marker, and non-congruent- meaning the marker does not match the spatial association of the word present before it. The dependent variables for both studies will be the reaction time to spot a marker as quickly and as accurately as possible. This will be measured in milliseconds as the time to complete the task of identifying the marker is expected be brief.

It is proposed here that because mental imagery (simulation) uses the same faculties as perception (a novel point in cognitive science which will be discussed shortly) the spatial imagery elicited by the word (the linguistic stimuli) will delay the accuracy and response time to a marker, if presented in the same associated space as the word (lexical item). That is, it is expected that the mental image or simulation will directly cause the delay in reaction time to spot the marker, if the spatial associations match. This means that the independent variable in the first study will precisely cause the delay in reaction time if the conditions are as described above. Therefore a causative relationship is hypothesized between the independent and dependent variables of the first study. As for the second study, it is proposed that words (linguistic stimuli/lexical items) with positive valence will affect reaction time of upwardly placed markers, negative valence words will affect the reaction time of downwardly placed markers, and words with neutral valence will have no effect on accuracy and reaction time to identify the marker. Therefore, for the second experiment, a direct causative relationship between word valence and reaction time is proposed. Figure 1 demonstrates the anticipated graphed results. Notice how A (abstract) and C (concrete) have less interference time than B (valence).

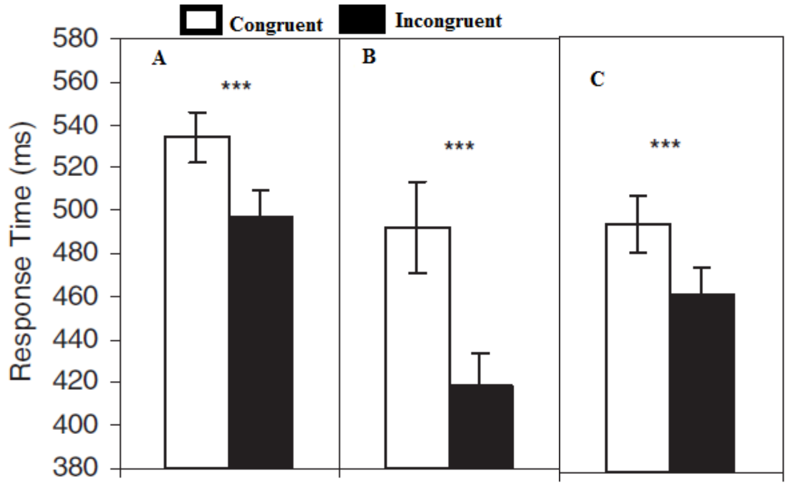

Figure 1

The anticipated results for groups A-Abstract, B-Concrete, and C-Valence. Note, concrete shows more interference than the abstract group, while valence is similar to the abstract condition.

Experiment 1

Participants

38 undergraduate students from Rutgers University- Camden.

Procedure and Materials

The present study used an experimental design by controlling for all other variables across conditions except for the independent variables. The study was conducted in a controlled space within a psychology laboratory in the basement of a building. There are no windows in the lab room. The study had randomized trials for participants. The current study utilized a within subjects design.

Upon entering the lab for the assigned session, participants were brought to a closed off room and seated in front of a computer using E-prime, which is turned on with the experiment on screen ready to run. They then were required to view a single word, for a short period of time (250ms) on a computer screen. After a short delay (50ms) participants were asked to identify a marker (X or O) as quickly and accurately as possible on a screen by using a keyboard button. They then were asked to complete 190 of such trials sequentially. After completing a selected number of trials, participants were told the experiment was over, and escorted out the room.

Results and Discussion

Data were labeled according to whether the target appeared in the same space as the association of the word. The typical condition occurred when the target location matched the word's association prime. On the other hand, the atypical condition occurred when the target location mismatched with the word's association prime. Data was analyzed using an ANOVA and linear general model across participants and items.

There was no significant difference across abstract, concrete, and valance conditions $F(2,74)=.980$ $p=.38$ eta squared=.026. There was a minimally significant difference between downward/upward Abstract and upward/downward condtions $F(3,111)=2.683$ $p=.053$ eta squared= .067. There was no significant difference between abstract downward typical and atypical trials $F(1,37)=1.029$ p.317 eta squared=.067. There was a significant difference between abstract upward conditions $F(1,37)=8.179$ $p=.007$ eta squared=.181. For concrete downward typical and atypical trials, there was a marginal significant difference between them $F(1,37)=3.278$ $p=.078$ eta squared= .081. Concrete upward typical and atypical conditions were not significantly different $F(1,37)=.823$ $p=.370$ eta squared= .022. Negative valence typical and atypical conditions were not significantly different $F(1,37)=.033$ $p=.858$ eta squared=.001. Finally positive valence typical and atypical conditions were not significantly different $F(1,37)=.055$ $p=.816$ eta squared=.001. As for accuracy, there was no difference in proportion of correct responses between abstract downward and upward, concrete downward and upward, and positive and negative valence typical and atypical conditions $F(1,37)=.012$ $p=.914$, $F(1,37)=.201$ $p=.657$, $F(1,37)=2.056$ $p=.160$, $F(1,37)=3.289$ p.078, $F(1,37)=3.116$ $p=.086$, $F(1,37)=1.740$ $p=.195$, respectively. These results prove to be inconclusive. Figure 2 displays the results as a bar graph. Note, the reaction times of all three groups are not significantly different from each other (group 1- abstract, group 2- concrete, and group 3- valence).

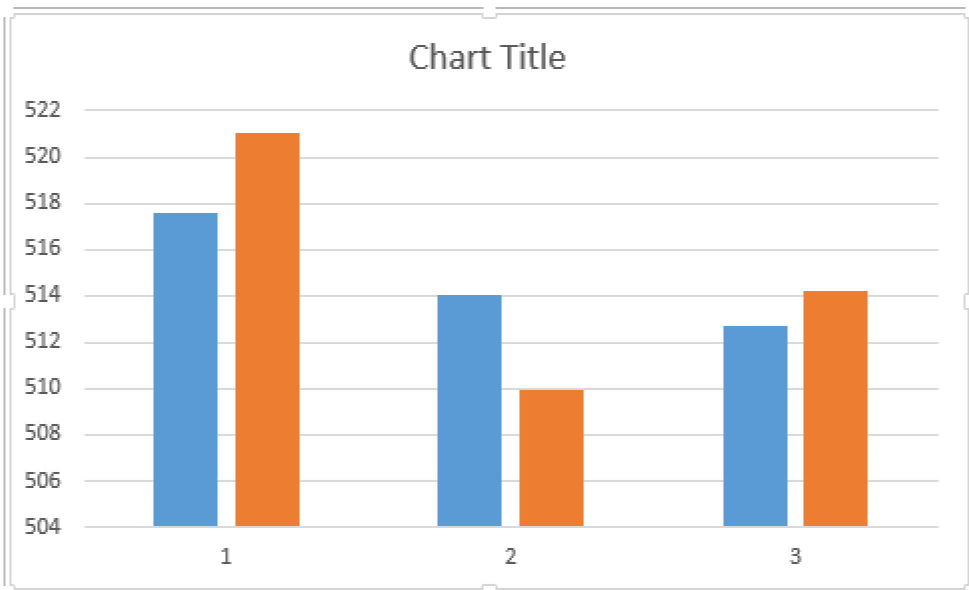

Figure 2

This bar graph displays the results for experiment 1 for abstract (1) concrete (2) and valence (3) conditions. Notice the lack of a difference between groups.

Experiment 2

Method

Participants

77 undergraduate students from Rutgers University- Camden.

Procedure and Materials

The procedure of the experiment was identical to the first one, with the exception of an additional word identification task at the end of the letter identification tasks. Participants were shown a word in red and asked to identify it as the previously seen word.

Results and Discussion

The data were analyzed in the same manner as the first experiment. 16 percent of the data were excluded- the responses over 1000ms. There was no significant difference between abstract up, abstract down, concrete up, and concrete down conditions F(3,237)=1.601 p=.190 eta squared=.067. There was also no difference between positive and negative valence conditions T(79)=.832 p=.408. These results, like the first experiment, prove to be inconclusive. See table 1 for a table of experiment's 2 results.

	NEUTRAL	CONGRUOUS	INCONGRUOUS
Abstract-Down		711.48	694.38
Abstract-Neutral	706.32		
Abstract-Up		698.825	703.06
Concrete-Down		700.54	689.09
Concrete-Neutral	699.8		
Concrete- Up		689.73	705.62
Valence- Negative		708.71	687.8
Valence- Neutral	700.14		
Valence- Positive		688.3	714.05

Table 1

This table displays the reaction time averages for each word condition (row) and congruency condition (column). Notice the interference in reaction time for upward but not downward words.

General Discussion

With the embodiment/grounded cognition evidence accumulating over the last ten years (Barsalou, 2010), it is imperative to study abstract concepts and their relation to embodied language simulations. The two experiments resulted in upward related words causing interference in critical trials, where the target was upward as well. On the other hand, downward associated words showed facilitation. The results taken as a whole were inconsistent with the literature. The valence conditions behaved in a similar fashion to the spatial conditions.

There may have been methodological problems. A potential issue regarding the method of the three present experiments is the lack of a baseline for each group. Although there was a neutral condition, there was no baseline measure for the upward, downward, positive valence, and negative valence groups. To include a baseline measure would mean to have some trials present a target in the middle of the screen. This would have given a measure to contrast the other two conditions. In this way, the addition measure could help elucidate the effects of the other conditions, by providing additional information about how middle presented targets are affected.

Another suggestion for future research within this thread is the use of continual, as opposed to discrete, measures. This is suggested by Spivey (2008) who explains that to understand cognition better, one needs to use measures which provide a *dynamic* account of mental activity. This dynamic approach helps model mental activity (like language comprehension) in a way that accurately portrays how these functions behave through time. This method may well be the new method for cognitive scientist in the 21st century.

One explanation for the effect found in the first two experiments may come from how the words were chosen. The first two experiments used words from an online norming survey which asked participants to rank how high or low the word's association was on a scale of 1 to 8. The interference of upward words and the facilitation of downward words may have been confounded with the words opposite spatial association. The survey may have needed more power. Because of this, one can suspect that the words associations were not discrete, with some upward words appearing downward or neutral, and some downward words appearing upward or neutral. That is, because of the lack of sufficient norming data, word choice may not reflect the intended associations. Words in similar studies were chosen via different measures such as imageability and concreteness. These measures go far beyond simple questions of a words spatial association. Thus, one can expect much different results using abstract words derived using such measures. Future research within this thread should take advantage of this method for word selection.

Another explanation for the lack of an intended effect with the abstract words is a missing context. That is, abstract words may be influenced by context because they may embody or simulate complex scenes as opposed to single items (Barsalou & Wiemer-Hastings, 2005). These scenes include interior events like introspection and exterior systems of interaction. Therefore abstract concepts like democracy embody complex scenes of events of items interacting to create a sum greater than its parts, so to speak. In the present study, the task lacked any context for the words. Therefore because no context was provided for the abstract words, the simulation either did not activate, or differed from the intended content.

Lebols, Wilson-Mendenhall, and Barsalou (2014) found that grounded congruency effects rely dynamically on context. The main features in a grounded concept only become active when a given context gives them salience. They explain this effect resulting from the fact that concepts do not have conceptual cores and vary according to the context which they are within. That is, different aspects of a concept only became salient within certain contexts. One kind of context is the grammar in sentences. Bergen and Wheeler (2010) found that simulations only interfered with motor actions when the sentences demonstrated progressive grammatical structure, as opposed to perfect structures. In this case, the context of the grammar influenced the simulation to be either a motor one or purely sensory.

There is fMRI evidence supporting this idea of context (Wilson-Mendenhall, Simmons, Martin, & Barsalou, 2013). The processing of both concrete and abstract words showed overlap with motor and perceptual areas of the brain. However, abstract words only demonstrated overlap when they were given within a context. Additional evidence comes from Pecher, Dantzig, Boot, Zanolie, and Huber (2010). They found task goals influences performance on tasks requiring to match words in “sky” or “ocean” (upward and downward respectively on the computer screen) positions. Therefore people simulated the sky or the ocean, irrespective of the presented word’s spatial association.

Note, a similar study (Goodhew, McGaw, & Kidd, 2014) with a nearly identical task found the opposite of the intended effects- facilitation. This finding gives additional impetus to the importance of word selection and context in designing tasks such as these.

An additional suggestion for future research in embodied/grounded simulations comes from Zwaan and Pecher (2012). They recommend utilizing web surveys like Amazon's Mechanical Turk. It was found that results from the web and the lab are comparable. This comes as an advantage as the internet provides a vital resource for reaching many participants from varying background; this method without a doubt goes beyond the demographic typical of the studies within cognitive science- the college sophomore (e.g. Henrich, Heine & Norenzayan, 2010).

Some have posit research approaches which attempt to reconcile the gap between modal and amodal models of language comprehension. For instance, Louwerse and Jeuniaux (2010) propose that depending on the context which they are brought up in, concepts are both embodied and linguistically stored. They found that participants were quicker to make judgments of word pairs in space (embodiment) and faster to match word pairs in meaning (linguistic). Another researcher (Zwann, 2008) has suggested that simulations (event representations) may be labeled and categorized using situational cues from linguistic systems. Lynott and Connell (2010) have given a name to a model which combines modal and amodal systems called ECCo or embodied conceptual combination. Petcher, Boot, and Van Dantzig (2011) demonstrate that the two competing view of abstract concepts- situation-introspection simulation and image schemas (amodal)- should be combined. Further, Goldman (2012) has suggested a conservative view that embodied simulations should be labeled as b-code or b-form (i.e. based on body representation) representations, because they are based on representations of (internal) bodily states. Finally, Zwann (2014) argues for a pluralistic view involving amodal symbols and grounded simulations in a gradated relationship between both extremes.

Despite such calls for a kind of synthesis between modal and amodal approaches, there is much evidence supporting the embodiment of abstract concepts. For example, the comprehension of language which describes the transfer of abstract or concrete objects activates motor areas of the brain (Glenberg et al., 2008). Note, the transfer of something denotes a context. Yee, Drucker, and Thompson-Schill (2010) demonstrate that when participants think about the a concept's function, the motor areas of the brain are activated. Function is an abstract trait of a concept as it invokes no object, but rather a complex scene through time. Guan, Meng, Yao, and Glenberg (2013) show that the abstract quantifiers of more and less act in accordance with the ACE model of embodiment (e.g. Glenberg & Kaschak, 2002). Interestingly, Marghetis, Nunez, and Bergen (2014) found that hand movements were influenced by the abstract activity of numerical calculations. Moreover, concerning a link between abstract concepts and valence, Kotusa, Vigliocco, Vinson, Andrews, and Campo (2010) found that abstract words carry more valence than concrete words. Further on, researchers (Havas, Glenberg, & Rinck, 2007) have found a congruency effect between emotional facial expressions and sentences matching those emotions, thus showing the embodiment of valence.

Moving on, this thread of research into the dynamics of simulations is important for research into literacy. Yee, Chrysikou, Hoffman, and Thompson-Schill (2013) have demonstrated that the simulations which accompany language comprehension are essential for meaning acquisition. With that said, this research holds promise to help those who have literacy defects. Glenberg (2011) has developed a program to help children with reading difficulties improve their memory and comprehension skills; his technique utilizes the manipulation of simulations, so as to make them more salient to the client. Engelen, Bouwmeester, de Bruin, and Zwann (2011) found that children are faster to match pictures with words just heard or read- demonstrating embodied simulations in young children. Lastly, Samuelson, Smith, Perry, and Spencer (2011) found that children learn object labels via spatial interaction; therefore learning can be facilitated using the embodiment of space. Thus, the embodied view of language comprehension has the potential to help many who suffer from literacy problems.

Although the present study did not find the anticipated results, the data above illustrate the importance of this kind of research. Through following the suggestions listed above, future research can unfold another layer to the onion which is the embodiment of language comprehension.

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