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The Role of Sensorimotor Representation in Social Interaction

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Abstract

Emerging grounded cognition contended that the representation and processing of knowledge involved perceptual, somatosensory, and motoric re-experiencing information. In this view, social interaction was grounded in the physical context. For example, temperature changed people's social feelings and social feelings were understood by temperature. Hence, the representation of social interaction was based on the sensorimotor representation. However, it is still unclear whether and how humans use grounded cognition theory to explain social interaction. In this review, we first introduced some basic viewpoints of grounded cognition and how this theory can be applied in social interaction. Then it explained the universality of grounded cognition theory by comparing some related theories of grounded cognition. Next, by speculating on the causes of the phenomena of grounded cognition in social interaction, it was proved that grounded cognition theory can be well applied to social interaction. In the last part, the advantages and disadvantages of grounded theory in interpreting social interaction are further discussed by comparing conceptual metaphor theory with grounded cognition theory.

Keywords

Grounded Cognition, Social Interaction, Physical Sensation

1. Introduction

Traditional theories about human cognition used the computing metaphor to describe cognition. Feature lists, semantic networks, frames, and so on, were used to represent knowledge in human minds, which were all abstract and unrelated to perceptual and sensory knowledge (Fodor, 1975; Pylyshyn, 1984). But perceptual and sensory information were also joined in different cognitive processing (Barsalou, Niedenthal, Barbey, & Ruppert, 2003). Thereby, grounded

cognition pointed out that cognitive processing includes perceptual and sensory information.

2. Grounded Cognition

Grounded cognition held that cognition is fundamentally grounded in sensorimotor representations, which referred to actual bodily states, simulations of experience, and situated actions in modality-specific systems (Barsalou, 2008; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Wilson & Golonka, 2013). The sensorimotor representation could be online and offline. Online representation referred that cognitive processing was grounded in current bodily states. Offline representation referred that cognitive processing was also grounded in simulations of experience and bodily states (Niedenthal et al., 2005; Wilson, 2002). The representation and processing of knowledge always involve perceptual, somatosensory, and motoric re-experiencing information (Niedenthal, 2007).

Another opinion of grounded cognition was that human cognition was nonstationary. Everyone had different bodily states and simulations of experience in different stages, making their cognition different and dynamic. The nonstationary derived from that dynamic systems used dynamic methods to couple with the outside information. As cognition was grounded in the physical context that changed by itself, cognitive system must act to use the circumstances (Smith, 2005).

Sensorimotor representation also existed throughout development and adulthood. Action experiences shaped infants' thinking and reasoning. Then people used these actions to scaffold learning in the life span (Kontra, Goldin-Meadow, & Beilock, 2012). Human intelligence is aroused from the interaction between body and environment by sensory-motor activity (Smith, 2005). Hence, grounded cognition has extensive applications in daily life.

Findings in the neuroimaging studies also supported grounded cognition. Body, brain, and environment interacted with each other and supported cognition (Anderson, Richardson, & Chemero, 2012). Functional neural circuits were connected with physical experiences and made people's thought meaningful (Lakoff, 2012). Activations of a distributed circuit across other modality-specific areas in macaque's brain, while they processed social signals, suggested grounded cognition might exist in different species (Barsalou, 2005).

Although findings of grounded cognition could be explained by traditional theories while traditional theories added complex assumptions in their model, traditional theories could not easily predict these findings of grounded cognition priori (Barsalou, 1999). Besides, grounded cognition sometimes were a little difficult to be replaced (Doyen, Klein, Pichon, & Cleeremans, 2012). One of the probable reasons is that sensorimotor representations are moderately stable due to the individual differences in sensation, which may reduce the grounded cognition effect (Myachykov, Scheepers, Fischer, & Kessler, 2013).

For years, grounded cognition has been applied to social interaction. The bodily states and simulations of experience influenced people's social interaction and vice versa. These two kinds of grounded cognition effects were observed in different sensory modalities at the behavioral and neural levels (Barsalou, Niedenthal et al., 2003). Such findings provide fresh ideas to social psychology and have a good application prospect. But there are still controversial problems, such as the order, the stability, and the power of the effects. More importantly, two issues have not been dealt with so far. First, other theories like conceptual metaphor theory could also interpret these findings. What's the relation between the conceptual metaphor theory and grounded cognition? Second, the role of language has been found in social interaction. How did the role of language play in grounded cognition?

3. Conceptual Metaphor Theory, Perceptual Symbol Systems, and Situated Cognition

Conceptual metaphor theory stated that humans used conceptual metaphors to think. Conceptual metaphor referred that using sources concepts (usually concrete concepts) to elaborate target concepts (usually abstract concepts) (Lakoff & Johnson, 1980). This theory has many similar opinions with grounded cognition. Both theories emphasize that bodies, situations, and simulations were important, while conceptual metaphor theory mainly believed the metaphor related to the language.

Barsalou (1999) proposed perceptual symbol systems to represent knowledge and concepts. According to this theory, knowledge was represented in mind as the form of perceptual symbols, which contained some physical input and conscious experiences. This theory was one branch of grounded cognition theories and focused on the representation of knowledge and concepts (Niedenthal et al., 2005).

Simliarly but differently, situated cognition emphasized that the role of situation in cognition, indicating that the simulation was typically situated in background, events, and introspections. Compared with grounded cognition, situated cognition paid more attention to the environment but not bodily states or simulation.

4. Grounded Social Interaction

4.1. Temperature and Social Interaction

Social feelings could be changed by current body temperature. Children with safe attachment personal traits in the warm room were more generous toward their peers (IJzerman, Karremans, Thomsen, & Schubert, 2013). Physical temperature could also change people's social perception. After participants hold a cup of hot or cold coffee, they received an impression questionnaire to evaluate the target person.

On the contrary, recalling social interaction changed people's feelings toward

ambient temperature and body temperature. Recalling previous social exclusive memory made participants' underestimated the temperature of the experimental room (Zhong & Leonardelli, 2008). Social exclusion also reduced participants' finger temperature while they were excluded in an online football game (IJzerman et al., 2012).

Besides, there are two questions worth to be discussed. First, why temperature could affect social interaction or vice versa? Second, how do the two domains (temperature and social feeling) interact with each other?

Social interaction grounded in temperature may arise from peoples' early experiences and this relationship may be instinctive. Researchers found neonatal monkeys spent more time on the warm mother surrogates than cold ones (Harlow, 1958). Vess (2012) further found attachment anxiety was a valid factor to predict participants' sensitivity to temperature cues, indicating there was a relationship between temperature and attachment. Mothers' warm body temperature may be the cue for safety and acceptance. In people's development, such temperature cues gradually became a more general cue for social interaction. Hence, attachment may be the bridge that connected temperature and social interaction.

IJzerman et al. (2012) found holding a warm cup could also alleviate social exclusive pain. Similarly, IJzerman and Semin (2009) found holding a warm beverage could lead to more social proximity. Fay and Maner (2012) found warmth led participants to underestimate the distance. Under warm conditions, participants preferred spatial proximity. From these findings, warmth may help participants reduce their distance from the outside world. Therefore, physical temperature and social relationship share, at least partially, some similar elements. However, another interesting finding was a shorter distance produced experiences of proximity and higher temperature (IJzerman & Semin, 2010), which made the relationship between temperature and distance vague.

4.2. Vision and Social Interaction

Emotional experiences in social interaction could moderate attention shifting. Wapner, Werner, and Krus (1957) found participants who acquired a higher grade in the test did more upward behaviors and participants who acquired a lower grade in the test did more downward behaviors. People's personality may also have relationships with space. Meier and Robinson (2006) found participants with higher neuroticism or depressive symptoms detected lower spatial attention targets faster compared with higher targets.

Understanding power in social interaction also needs the help of visual cues. Moeller, Robinson, and Zabelina (2008) found dominant participants were good at vertical spatial probes which indicated that they represented power in vertical vector, that was, powerful was up, and powerless was down. Schubert (2005) further found judging a group's power was based on its vertical location. Further studies also repeated this link. These findings may indicate that power and personality are grounded in space.

Moral judgment was related to the level of cleanness. Zhong and Liljenquist (2006) tested the relationship between cleanness and moral, showing that participants preferred to select cleansing products after they copied an unethical act story. Recalling unethical act increased participants' desire for cleansing products. If unethical act information was delivered by mouth but not hand, participants also preferred to select mouthwash (Lee & Schwarz, 2010). From these findings, washing hands or other parts of the body may reduce people's negative desires.

Moral judgment was also related to the light of the environment. Zhong, Bohns, and Gino (2010) indicated darkness had a strong relationship with cheating. Participants in a dark room cheated more to earn undeserved money. Participants showed more selfishness while they wore sunglasses which incurred darkness. Banerjee, Chatterjee, and Sinha (2012) found recalling an unethical deed made participants felt the room was darker than recalling an ethical deed. Participants who recalled an unethical deed preferred to select light products.

Other visual cues also affected social interaction. First, importance was grounded in size. Important stimuli were perceived as larger than less important stimuli. Emotional valence could not modify this effect (Bruner & Postman, 1948). Second, clothes help people keep warm and show people's fashion. In the view of grounded cognition, it also influenced people's attention. Third, the shape of ambient environments shaped people's personalities. Hess, Gryc, and Hareli (2013) found participants who were exposed to a sharp environment felt others more aggressive than a round environment.

Vision is a powerful modality in sensation. Various visual stimuli could change people's social cognition according to the grounded view. However, does the human mind drift along easily and automatically? Maglio and Trope (2012) found while participants use abstract thinking, the grounded factor (i.e., weight) could not affect people's judgment on visual length estimate and importance rating task. Grounded cognitive effects might be reduced by abstract construal. But there are some other cognitive processing that may control or affect these effects. Further follow-up studies need to pay attention to these factors.

4.3. Proprioception, Somatosensory, and Social Interaction

Proprioception refers to information about position and movement derived from muscular, tendon, and articular sensors (Sherrington, 1923). It is a multidimensional concept including identification with one's body (i.e. body-ownership), self-location of body and body parts in space, and the first-person perspective (Blanke, 2012; Park & Blanke, 2019). Social interaction is an exchange between individuals and is a building block of society.

People's thinking in social interaction could be reflected by their actions and gesture. Schneider et al. (2013) found while participants experienced ambivalence, their side-to-side movement became more than people who did not experience ambivalence. Meanwhile, participants' experiences of ambivalence would be increased if they have more side-to-side movement. Further, actions also built

infancy's perception, thinking, and reasoning of the word. Infants' ability in grasping positively correlated with their ability to attribute other agents' grasping behavior (Woodward, 2009).

Weight was an important cue for social judgment. Jostmann, Lakens, and Schubert (2009) found participants holding heavy clipboards estimated the value of foreign currencies more valuable than participants who hold a light clipboard. Similar effects were also found in estimating the importance of having a voice in decision making and estimating the mayor and attitudes toward the city. Further holding heavy clipboards made participants polarize toward strong judgment. As a result, participants who hold heavy clipboards showed more confidence than those who hold light clipboards. Weight also changed participants' social perception. People who hold heavy things felt other people were important and would think others have a better performance.

Internal experiences could influence people's understanding of others and even the perception of the world. O'Brien and Ellsworth (2012) found visceral states make participants prefer to think that other people also have the same bodily states as their own. However, this effect was moderated by the in group effect. Nordgren, van der Pligt, and van Harreveld (2006) found severely fatigued participants more attributed other people's failure as fatigue than moderate fatigued participants and not at all fatigued participants. While participants were told not to use their states to estimate characters states, this effect was also found. This indicated that visceral states' influence could not be controlled by people's consciousness. This finding may shed light on the issue of the stability of sensorimotor representation.

4.4. Gustation, Olfaction, and Social Interaction

Gustation could affect people's social interaction. Troisi and Gabriel (2011) indicated comfort foods reduced people's belongingness threat whose attachment styles were secure. Meier, Moeller, Riemer-Peltz, and Robinson (2012) pointed out people preferred to believe strangers were higher in agreeableness if these strangers liked sweet. If participants liked sweet food, they would have more prosocial personalities, prosocial intentions, and prosocial behaviors. While momentarily proving some sweet foods to participants, they reported higher agreeableness and prosocial behaviors. Hence, the proverb, you are what you eat, was right from the grounded view.

Olfaction also has a significant effect on social moral judgment. Wheatley and Haidt (2005) found when participants felt disgusted in a hypnotic state, they became more severe after they were brought out of the hypnotic state. This finding proved disgust has a strong effect on moral judgment even participants did not know they have experienced them. Besides, Eskine, Kacinik, and Prinz (2011) found drinking bitter beverages also induced physical disgust and made participants feel more disgusted.

Although disgust could induce severe moral judgment, cleanness could reduce the effect of disgust. Schnall, Benton et al. (2008) let some participants wash

their hands to keep the room clean after they watched a disgusting film. These participants had less severe moral judgment compared to other participants who did not wash their hands. From this, it seems that some grounded factors could eliminate the effects of others. For example, cleanness eliminated the effect of disgust on moral judgment.

Hence, there is a question about the order of these grounded effects. From previous parts, amounts of sensations have been discussed. It is clear that grounded factors are important in social cognition. However, the question is which one is more important? Is there an order in these factors?

5. Grounded Cognition and Conceptual Metaphor Theory

From the previous parts, it was clear that bodily states and simulation affected social interaction. But these findings could also be explained by the conceptual metaphor theory. For example, people preferred to use the metaphor, a cold-blooded man, to describe people. Hence, both theories could explain these grounded findings. But the contents of the two theories are different.

Metaphor is a way that people use concrete concepts to understand abstract concepts. Lakoff and Johnson (1980) indicated metaphors were conceptual mapping between source concepts and target concepts. Source concepts were concrete concepts that raised from people's interaction with the physical and social world. Target concepts were more abstract and difficult to understand. People used source concepts to understand target concepts. For example, his ideas have finally come to fruition. The source concept (fruition) helps people understand the target concept (ideas) (Lakoff & Johnson, 1980).

Compared with grounded cognition, conceptual metaphor theory usually treats metaphors were asymmetric or unidirectional. Lakoff and Johnson (1980) pointed out that "the less clearly delineated (and usually less concrete) concepts are partially understood in terms of the more clearly delineated (and usually more concrete) concepts, which are directly grounded in our experience". Source concepts were the bases of target concepts but not the vice visa. For example, people would say: "job is jail." However, it is seldom to say: "jail is job" (Landau et al., 2010). Hence, using conceptual metaphor theory to explain previous findings seems not suitable, as studies have found bodily states affected social interaction which seems could not be explained by a metaphor. On the contrary, grounded cognition indicated the relationship between bodily states and social interaction was symmetric. Social interaction was based on the sensorimotor representation and sensorimotor representation could also be activated during social interaction. Hence, it seems that grounded cognition have a bigger power to explain these findings in social interaction.

The statement about the asymmetricity or unidirectionality of conceptual metaphor is not exact and could not be used in social interaction. First, the asymmetricity of conceptual metaphor is reflected in the language usage. People do not usually reverse metaphors in language. This may be attributed that the source concepts in metaphors are used for highlighting some features. Hence,

the function of source concepts is similar to adjectives. However, target concepts do not always contain suitable features for source concepts. Hence, reversed metaphor becomes meaningless. For example, "job is jail" is easy to understand, and "jail" highlights the discomfort and bother of "job". However, "jail is job" is nonsense because "job" did not highlight proper features of "jail." However, reversed metaphors are sometimes meaningful while source concepts and target concepts share similar features. For example, people could say "she sings like a bird" or "a bird is singing a song". In social interaction, social warmth-physical warmth, social rejection-physical cool, social significance-physical large, and so on, shared similar features. Second, if words in metaphors are always presented together, processing one of them may also activate the other one because of their association. Hence, asymmetricity or directionality may not be a good index to distinguish metaphor and grounded cognition. In some situations, metaphor may be bidirectional. However, when, how, and why metaphors are bidirectional needed further studies to investigate in cognitive linguistics (Landau et al., 2010).

Representations of metaphor and grounded cognition are also different. Grounded cognition contents that representations are perceptual symbols, which contain sensation, action, and situation information (Barsalou, 1999). Conceptual metaphor theory emerged from the cognitive linguistics area. And metaphor indicated that source concepts were the basis of target concepts (Hellmann, Echterhoff, & Thoben, 2013).

From the difference between metaphor and grounded cognition, previous findings could be better explained by grounded cognition. Some researchers preferred to use metaphor to interpret the relationships between bodily states and social metaphor because metaphor links in language could easily be found to describe these relationships. For example, good is up/bad is down, powerful is up/ powerless is down, past is backward (or left)/future is forward (or right), and interpersonal intimacy is spatial distance (IJzerman & Semin, 2009; Landau et al., 2010; Meier, Moeller et al., 2012; Weger & Pratt, 2008). However, other findings in social interaction could not find metaphorical descriptions in language. For example, wearing a lab coat increased people's selective attention (Adam & Galinsky, 2012). Participants who felt thirsty also thought other people were thirsty (O'Brien & Ellsworth, 2012). Comfort foods reduced people's belongingness threat (Troisi & Gabriel, 2011). These findings are difficult to be interpreted by metaphors in language.

The relationship between metaphor and grounded cognition might be that metaphor arises from bodily states. Lakoff (2012) pointed out that primary metaphors were motivated by bodily experiences. Metaphors help people quickly understand concepts by highlighting specific aspects of concepts. Hence, metaphors are the shortcuts of conceptual processing. However, bodily states still plays an important role. On one hand, using metaphors might activate bodily states. On the other hand, some new emerging concepts did not have metaphors to support their processing, which needed the support of sensorimotor representation. In a word, conceptual processing may have two paths: 1) through me-

taphor; 2) through bodily states. If this hypothesis is true, using grounded cognition to understand previous findings in social interaction may be better as bodily states are the foundation of both social interaction and metaphor.

6. Conclusion

Compared with conceptual metaphor theory, using grounded theory to explain social interaction could bridge the gap between social interaction and physical context. Grounded cognition not only provided a new view for social interaction but also a better explanation of the influences of physical context on social cognition. People used their bodily states and simulations to understand social interaction. Social interaction was grounded in bodily states and simulations. According to grounded cognition, social cognition was grounded in physical contexts. The development has emerged under the interaction of bodily states and the environment. Nevertheless, grounded cognition still faced some challenges, such as the relationship between grounded cognition and language. Evidence from linguistic relativity proved language built on cognition as well as effects of grounded cognition. Further studies were needed to deal with these challenges.

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Conflicts of Interest

The author declares no competing financial or nonfinancial interests.

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