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Embodied Cognition and Evidence from Neuroscience

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Abstract
Modern social and cognitive psychology research has emphasized towards embodied cognition. It makes an effort to comprehend a variety of cognitive processes, including decision-making and social interpretation. According to current psychological theories, the brain alone is entirely responsible for creating our behaviour; perception serves as the input to a communicative, representational system that mentally transforms data into motor orders. This essay attempts to summarize and evaluate the current literature on the subject of embodied cognition that utilizes neuroscience-based evidence. Human beings integrate elements of their surroundings to aid in their cognitive function. We, thus, also see an incorporation of three dimensions of embodied cognition discussed in the literature.
While several studies still take a reductionist approach in pursuit of the neurobiological basis for cognitive phenomena, recent work shows that there is a fascinating interplay between neuroscientific results and philosophical science, searching out and combining both viewpoints. Theories and limitations pertaining to said constructs are also mentioned in the paper; with added emphasis on the need for scrutinized refinement.
The concluding section draws attention to neuroimaging studies, highlighting neural patterns and activity, in sync with brain areas, of cognition. It also gives a direction for future research to build on.

Understanding Embodied Cognition& Neuroscience

Embodied cognition has been a contemporary focus of research in social and cognitive psychology. It attempts to understand a range of cognitive processes from social interpretation to decision-making. This perspective postulates a reductionist argument that states that the motor system influences our cognition, in a bilateral paradigm. Current theories of psychology place all responsibility for generating our behavior within the brain; perception is the input into an interactive, representational system that mentally converts information into motor commands; Many researchers interpret embodied cognition as believing that the condition of our bodies will influence the essence of these mental states and representations. There are some problems with these studies; however, the primary problem is that the mental condition is assumed to be the same in both cases as if you were doing unembodied cognitions (Thompson,2012).This research remains business as usual, with a few embodied bells and whistles — all the hard work is done in the brain to generate behavior, it's just that this experiment can be distorted by what the body is up to. However, the suggestion that the body could play a part in thought is probably much more extreme than that. Through extending the resources available to solve a problem from simply the brain to include the body (with its perceptual and motor systems), we have opened the possibility that we can solve a problem in a very different way than a brain can solve the challenge by itself (Thompson,2012). This approach extensively uses neuroscience as a source of evidence to support this theory. This

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essay will attempt to summarize and evaluate the current literature on the subject of embodied cognition that utilizes neuroscience-based evidence.

Embodied cognitive science differs in that it rejects the input-output method from the traditionalist approach. It is partly due to the problems raised by the Homunculus argument, which suggested that without any kind of inner definition, semantic meaning could not be extracted from symbols. If any little man interpreted incoming symbols in a person's head so who will interpret the inputs of the little man? The traditionalist paradigm has begun to appear less feasible because of the specter of an infinite regress. Incorporated cognitive science thus aims at preventing this issue by describing attention in three ways.Neuroscience has been utilized to solidify the physical basis for the claims made by this school of thought. The use of this kind of evidence has established three main elements of embodied cognition that use physical evidence collected by neuroscience to support these claims.The first element of embodied cognition looks at the physical body's function, in particular how its properties influence its ability to think(Lakoff,2012). The second dimension draws heavily on design research by George Lakoff and Mark Johnson. They argued that human beings use metaphors to help describe their outside world whenever possible. Even humans have a simple stock of concepts from which to derive other concepts (Lakoff, 2012).A third aspect of the embodied approach looks at how the agents use their immediate cognitive processing environment. In other words, the local environment is seen as an actual extension of the cognitive process in the body. Human beings, therefore, integrate elements of their surroundings to aid in their cognitive function.

Neuroscience explores the structure and function of the nervous system and the human brain. To map the brain at a mechanistic stage, neuroscientists use cellular and molecular biology, anatomy and physiology, human behavior and cognition and other disciplines.Cognitive neuroscience addresses the issue of how neural processing generates psychological functions. The advent of powerful new measuring techniques such as neuroimaging (e.g., fMRI, PET, SPECT), EEG, MEG, electrophysiology, optogenetics, and human genetic analysis coupled with advanced cognitive science experimental techniques enables neuroscientists and psychologists to answer theoretical questions such as how perception and emotion are mapped to different neural substrates.While several studies still take a reductionist approach in pursuit of the neurobiological basis for cognitive phenomena, recent work shows that there is an fascinating interplay between neuroscientific results and philosophical science, searching out and combining both viewpoints. The neuroscience empathy work, for example, explored an fascinating interdisciplinary discussion involving theory, psychology, and psychopathology. In addition, the neuroscientific identification of multiple memory systems linked to different brain areas has challenged the concept of memory as a functional replication of the past, promoting a view of memory as a generative, positive, and dynamic mechanism.Although some researchers tend to follow a reductionist approach in search of the neurobiological basis for cognitive phenomena, recent research reveals that there is a fascinating interplay between neuroscientific findings and philosophical study, searching out and integrating both points of view. For example, the neuroscience empathy study presented a fascinating interdisciplinary discussion that included theory, psychology and psychopathology. In addition, the neuroscientific discovery of multiple memory systems linked to various brain areas challenged the

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idea of memory as a functional reproduction of the past, cultivating a perception of memory as a generative, constructive, and complex process.

Evaluation of Neuroscience-based Evidence for Embodied Cognition

Embodied accounts of cognition are considered especially appropriate for inquiries into neuroscience. The main neurobiological evidence for embodied cognition accounts can be found in the multi-regional theory of time-locked activation and the hypothesis of the mirror neurons (Damasio,1989). Two suggestions are based on these proposals. (Chatterjee,2010. The first is that fragments of sensory and motor attributes are reported in early sensory and motor cortices of unimodal origin. Secondly, there is convergence. Manuscript areas, which are mostly amodal neural systems, organize certain fragments' combinatorial activations time-locked to be connected into entities or events. Such regions (cortices of association and convergence zones) have reciprocal interconnections that feedback and forth. The key argument is, the sense is not contained in one location. The neural instantiations of this term are central to early sensory and motor activations. Neuroscience data in favor of social cognition typically comes from “imagery, electrical (ERP and MEG), transcranial magnetic stimulation (TMS), and acquired studies of lesions”(Chatterjee,2010). As stated by Chatterjee (2010) "The general argument is that the proof for neuroscience is not as strong as is often argued." The results do not seem to be adequately scrutinized.

A pervasive issue in this field has been the extensive specificity of the researches undertaken. This is justified as research that depends on neuroscience has to limit themselves to a particular function and the biological underpinning they believe motivates the agent's actions. This would be understandable, if not for many research papers extrapolating the evidence collected in their research as a sufficient basis to claim the holistic applicability to this model in other areas. The proof of this functioning in one specificity does not mean it will function the same in other fields. Most definitions are so unspecific and over-inclusive that they are useless on a scientific basis. As the concepts are increasingly focussed on neuroscience studies, it is important to clearly define it. Furthermore, this field specifically requires both cognitive neurology and psychological understanding to interpret and understand the results and limitations correctly. The extensive use of jargon in these papers makes it exceedingly difficult for people who do not have the necessary background information to understand the conclusions drawn upon. Naturally, the limitations that affect neuroscience-based evidence will also be limited within studies of embodied cognition, therefore those have not been elaborated upon.

Arguments in embodied cognition attempt to establish evidence using a developmental model based on mirror neuron system functioning as evidence. Brain structures like the mirror neuron network, however, can hardly be regarded as an adequate basis for shared understanding A mirror on the wall represents nothing but a subject that can take its reflections like a mirror image. And, in the process of reciprocal communication and interaction, the child has to know itself that others are "like me." Besides, given an embodied and developmental view of the mirror neurons, infants are not supposed to grasp the aims of other people's behavior through the mirror mechanism until they can execute the behavior themselves (Fogassi et al. 2005). The mirror neuron hypothesis was derived from observations that neurons were then identified in the lower parietal lobule in the F5 sector of the prefrontal macaque cortex which discharges when the monkey acted also discharge when

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similar actions were observed by the monkey (Fogassi, 2005). Such neurons encode behavioral objectives differently, such as grasping for food versus grasping to place an object (Fogassi, 2005). The general principle is that recognizing actions of others requires discharging mirror neuron ensembles, whether by observation of actions or by terms relating to behavior.

Tettamanti and colleagues cite a standard fMRI analysis for the identification of mirror neurons in the embodied accounts (Tettamantil, 2005). Tettamanti found that participants listened to action sentences as opposed to abstract ones phrases stimulated various areas of the brain such as the posterior temporal intermediate gyrus (pMTG). The writers describe in the title of the paper the concept of action-related sentences triggering 'frontoparietal motor circuits,' and the debate addresses frontal and parietal activations as being compatible with the theory of mirror neurons (Chatterjee,2010).Minimizing the value of activations with pMTG. The explanation for that bias is to ensure that the proof is consistent with the theory of mirror neurons. Under the alternative theory, the model will maybe work better than attempting to work it into an existing one. Likewise, Kemmerer (2008) also looked at "neural patterns of behavior when participants made semantic similarity decisions about five different types of verbs. These included running, talking, punching, trimming verbs and changing situations. For these types of verbs, we have found numerous topographic activations in the motor and premotor cortex(Chatterjee,2010).They also looked at non-motor factors that could have influenced their results, something other studies have not done. Importantly, also provided a detailed study of the abstract properties of verbs.

The key argument for that discussion is that they claim that their findings are consistent with an embodied cognition simulation account. A closer look at the results, however, raises doubts about that conclusion. As stated in Chatterjee (2010) “providing one of the most theoretically sophisticated treatments of verb semantics available in cognitive neuroscience, the authors are willing to agree that the segregated pattern of activations observed for these verb groups along premotor cortices is consistent with the simulation of these acts, although it is unimaginable that the actual use of the legs and hands would generate this behavior.”

These types of data are incredibly insightful and helpful but there are always questions to be answered. These types of studies fail to provide an adequate rationale as to why they chose a particular field, or method to study. It may mean that the experiment could be motivated by some degree of bias or presupposed conclusion.

Most neuroscience experiments seek to look more closely at the role that the motor system plays in mental processing. For example, Buccino and his colleagues (Buccino et al. 2005) showed that listening to action-related sentences modulates the motor system in a somatotopically complex way. Motor evoked potentials (MEPs) were modulated from the hand areas by listening to hand action verbs, and by listening to leg action verbs, MEPs were modulated for the leg areas. In both cases, the modulation was a decline in MEPs (Chatterjee,2010). Researchers explain these results as the result of interference: simulating the meaning of these words activates the motor system in effector-specific ways, which in response to TMS stimulation then decreases MEPs. But again, as argued earlier in the discussion of motor interference behavioral proof, it is not clear how best to interpret

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such data as a simple directionality between variables can not be established (Chatterjee,2010). They are among the best studies from marshaled psychology to support embodied cognition. Nonetheless, taking a closer look poses some questions about those data's power. These results are at best indicative of an embodied understanding of cognition. Additionally, criticisms of this paper seem to suggest that the data does not support such a strong conclusion made in the paper. We require the most optimistic reading of the neuroscience evidence supporting the role of motor systems in conceptualizing behavior, it remains unclear what the sequence of outcomes means.

An alternative theory may be that the role of motor systems contributes to variations in the way people perceive behavior, as opposed to representing a central aspect of the grammar of behavior. The assumption that the degree of motor activation arising from variations in human motor experience is compatible with the evidence reported by Calvo-Merino and colleagues on fMRI (Calvo-Merino, 2005). During their study, ballet dancers and capoeira experts watched video recordings of parts of the ballet or capoeira movement (Calvo-Merino, 2005). The writers suggest descriptions of the actions of others mingle with our movement repertoire (Buccino et al. 2004. If only one contrasts capable participants with actions typically experienced by any capable person, such as running or jumping or waving or wiping, one might easily conclude that simulation is a central function of understanding behavior, although the alternative explanation remains equally viable(Chatterjee,2010). It appears to be a research pattern in this area where a single, best-fitting theory is pursued, perhaps alternative theories are overlooked even though the data provide clear proof of both possibilities.

Recent findings support the theory that personal interactions, in terms of words representing behavior, affect the neural response. Beilock and colleagues (Beilock et al. 2008; Lyons et al) find that in the premotor and caudate regions, ice hockey players have greater responses than non-hockey players when they deliver sentences describing hockey behavior. Similar differences were not seen with everyday actions (Chatterjee,2010). The idea that the degree of motor activation depends on different contextual factors is consistent with the suggestion by researchers Taylor & Zwaan (2009) of a multi-variegated system that instantiates concepts of action.The concept's complexity is measured in part by one's understanding of certain actions. Importantly, the system is tolerant of faults in their opinion, that is, any single aspect, such as the activation of one's motor systems, need not be central to understanding (Chatterjee,2010).

The use of neuroscience in this field has been to establish a modular form of understanding the mechanisms and cause and effect directionality that this specific argument seeks to cement. The issue arises that neuroscience-based evidence can be used to prove directionality, a key facet of this argument. They contribute to creating sufficient evidence for a correlational argument but prove insufficient to prove a causal relationship. Furthermore, the area suffers from a technological lag, where the equipment and processes used in collecting this evidence, logistically, can only measure a fixed range of cognitive operations.

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Summary and Future Direction

To sum up, a wealth of extremely interesting data has been created by the current popularity of embodied cognition accounts. Most of the experiments are sleek. The best interpretation of those results, however, is not always clear. The effectiveness of embodied accounts has also had some unintended side effects. The mirror neuron theory's popularity has emphasized motor effects within neuroscience, at the cost of possible perceptual contributions to mental comprehension (Chatterjee,2010). Contrasting embodied with disembodied diverts of thought typically focuses away from the question of the nature of this representation. Authorities are often permissive to consider details as proof of incarnated records. That permissiveness tends to obscure alternate or more complex hypotheses.

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