frontiers in
PSYCHOLOGY

OPINION ARTICLE
published: 23 August 2010
doi: 10.3389/fpsyg.2010.00042

Grand challenge for movement science and sport psychology: embracing the social-cognitive–affective–motor nature of motor behavior

Rebecca Lewthwaite[1] and Gabriele Wulf[2]*

[1] *Rancho Los Amigos National Rehabilitation Center, University of Southern California, Downey, CA, USA*
[2] *University of Nevada, Las Vegas, NV, USA*
**Correspondence: gabriele.wulf@unlv.edu*

Movement is critical to surviving and thriving, to expression, to thought. It is a foundational capability, enabling many other human activities, and sometimes the vehicle for extraordinary human achievement. Movement is a product of the events and processes of the mind, brain, and body, as well as a reflection of diverse influences, from the physical, social, and cultural environment to the body's structure and function. Movement has often been a subject of philosophical discourse, part of the triumvirate of mind, brain, and body. Despite this history, in many ways, movement may never have been so integral in psychological thought as it is today, as reflected in the burgeoning research related to the concept of embodiment, as well as the revelations regarding the mirror neuron system. In embodiment, motor actions precede and sometimes influence thought, language, and emotions (see Glenberg, 2010, for a review). Embodiment highlights the shared architecture and interconnectedness of motor, emotional, cognitive, and social aspects of behavior – a principal theme in this essay.

THE SOCIAL-COGNITIVE–AFFECTIVE–MOTOR NATURE OF "MOTOR" BEHAVIOR

A major challenge for movement scientists is to recognize that the "motor" behavior they examine in their studies is actually some amalgam of *social-cognitive–affective–motor behavior*. The intertwined nature of movement, cognition, emotion, and the influence of the social and cultural context in which performance takes place, has become increasingly obvious in recent years. Numerous studies point to various linkages between the motor, social-cognitive, and affective components of behavior. Certainly, the idea that movements affect emotions goes back to Darwin (1872/1998) and James (1890). Darwin argued that facial expressions are not just a sign of emotions, but that they contribute to those emotions: "The free expression by outward signs of an emotion intensifies it. On the other hand, the repression, as far as this is possible, of all outward signs softens our emotions" (pp. 360–361). Likewise, the facilitation of movement performance (e.g., Triplett, 1898) and the modulation of motor learning by motivation has been recognized (Mogenson et al., 1980; Brooks, 1986).

Research findings support the idea that facial expressions can induce the mood they portray (e.g., Duclos et al., 1989). Reading verbs connoting emotions (e.g., laugh, smile, cry, frown) has been shown to elicit activation of the muscles used in smiling or frowning (Foroni and Semin, 2009). Moreover, the bodily reactions to emotional content affect people's judgment (i.e., cognition). For example, when body (i.e., lip) movements were inhibited by asking participants to hold a pen with their lips, thus preventing them from smiling, cartoons were rated as being less funny, compared to when facial expression was not inhibited, or facilitated by having them hold a pen between their teeth (Strack et al., 1988). These findings suggest that emotional experiences are mediated by the activation of muscles that are typically used for the expressing those emotions. Furthermore, the inhibition of body movements can impact comprehension. In a recent study (Havas et al., 2010), after Botox injections into muscles used in frowning, the reading of sentences with emotional content (i.e., anger) was slowed.

Relevant to our focus on human movement, studies have also demonstrated the obverse relationships: the influences of thoughts and emotions on movements. For instance, thoughts about the future or past have observable movement correlates; imagining future events leads to forward sway, while thinking of the past has the opposite effect (Miles et al., 2010). Furthermore, invoking stereotypes about older people can cause people to walk more slowly (Bargh et al., 1996). Many of us can imagine motivational effects on movement, resulting in such concepts as hesitant gait, nervous talk, and short-armed release of basketballs in high-stakes situations. Consistent with the embodiment idea – and highlighting some possible practice implications – engaging the motor system (e.g., touching dental floss) while watching health-related videos (e.g., on the importance of flossing) can change individuals' intentions and even health behavior (Sherman et al., 2010).

The basis for many psychological processes – including the imitation of movements performed by others, action simulation to understand others, and the experience of empathy – can be seen in the mirror neuron system (e.g., Grafton, 2009; Iacoboni, 2009). Distributed mirror neurons in the premotor and posterior parietal cortex are activated not only during the execution of actions but also when observing somebody else performing the same or similar actions. Moreover, links between the mirror neuron system, insula, and limbic system constitute larger neural networks that allow people to experience empathy, and thus play a role in facilitating social behavior (Carr et al., 2003). Though excitement about the action-observation aspects of the mirror neuron system has been most prominent within movement science circles to date, evidence that the mirror neuron system is modulated by the motivational context or social significance of observed action (Kilner et al., 2006; Cheng et al., 2007) should also be of relevance to those interested in the foundations of movement.

Thus, "motor" behavior cannot be seen anymore as being simply a function of a pure "motor system." This is an important insight for both traditional (information processing) motor learning and social-cognitive researchers alike, not to mention scientists who don't study movement *per se*. For those who study motor control and learning, the interconnectedness of social-cognitive, affective, and motor influences on performance (and learning) makes it necessary to consider and address those influences in their investigations. While motor learning researchers have long considered cognitive influences on learning, most have largely ignored – or not yet realized – the motivational (e.g., social-cognitive and affective) impact of the practice variables under investigation. Some recent studies have shown, for instance, that feedback not only provides the learner with (neutral) information about the task to be learned, but that its influence on the learner's motivation appears to have a direct and powerful impact on the learning and control of movements as well (e.g., Lewthwaite and Wulf, 2010). Similarly, the effects of other variables, such as contextual interference, observational practice, or self-controlled-practice, have been examined and interpreted mainly from an information-processing perspective. Yet, it is very likely that their functioning has motivational underpinnings as well. In fact, several variables that impact motor learning have recently been identified whose effects on performance and learning are clearly motivational, not informational, in nature. This includes social-comparative information, fear, performance pressure, learners' conceptions of ability, and self-efficacy, among others. All of these variables appear to have ties to the self, that is, they affect the extent to which individuals become self-evaluative or self-conscious (see Wulf and Lewthwaite, 2010). The result of a focus on the self is often the use of more conscious control processes, widespread, inefficient, activation of the muscular system, and disruption of automaticity. In addition, a self-evaluative focus presumably increases learners' need to control self-related thoughts and affective responses. Worries about task performance, for example, could direct attention to attempts at negative thought and emotion suppression. Efforts to manage self-related thoughts and emotions, in turn, can tax the available self-control or attentional capacity to a degree that performance suffers. Thus, motor learning is not merely the acquisition of specific movement patterns, but it encompasses the self-regulation of cognitive processes and affective reactions. Therefore, in addition to measuring performance, scientists need to assess the affective and motivational correlates of the variables under investigation – using methods that have traditionally been utilized by (sport) psychologists such as questionnaire ratings or introspective self-reports – to assess the impact of those variables on learning. Further, scholars must better account for the implicit as well as explicit, and non-conscious as well as conscious processes that affect behavior, and presumably movement behavior.

Recognition of the sociocultural influences on movement will perhaps be more difficult than that of the sociocultural influences on cognition. Partly, this will be due to the more obvious biological and physical contributors among the multiple determinants of movement. Likely, this kind of insight will also be influenced by the current "culture" or state of sub-specialization within the larger field of human movement. The fragmentation of movement science into its physiological, biomechanical, psychological, and sociological aspects has led to limited integration of perspectives and levels of analysis in recent years. It certainly provides a challenge to further insights into the social-cognitive–affective–motor nature of "motor" behavior. It might even be argued that some researchers of human movement would not want or hope to see such a broad-ranging notion as social-cognitive–affective influences become pertinent to the machine-like processes they purport to study.

Our mental frameworks determine what is recognized from all the events that are present, so we must "know" to look in order to see. In the case of movement, we must know to look for the influence of culture, of other social factors, of various cognitions, of affect, and of biological and physical constraints. In some sense, the study of movement is mired in the metaphor of the computer and its neutral, machine-like, processing operations – a metaphor with little room for "hot" (non-neutral) social-cognitive and affective influences. Likewise, research paradigm shifts from experimental to quasi-experimental to qualitative methods, consistent both with a concern for ecological validity and a focus on the pathways linking thoughts and feelings have led social-cognitive movement scientists in directions away from the study of movement behavior, even as they have enriched other insights.

RE-CENTERING MOVEMENT SCIENCE AND SPORT PSYCHOLOGY IN MOVEMENT BEHAVIOR

Movement scientists collectively are charged with understanding the manner in which skilled movement emerges, is acquired and produced at will, and can be maintained in the face of challenges. What are the fundamental mechanisms and underpinnings of skilled human movement? And how can insights regarding these mechanisms be used to optimize the development of fundamental motor capabilities, as well as specialized movement skill learning, and motor control in the many realms in which the application of movement expertise is important?

Baumeister et al. (2007) have argued that psychology as a whole has lost its calling in recent decades as the science of behavior, substituting self-reports of behavior or limited finger movements for the richness of behavioral expression itself. Recent work in the social psychology of human movement has likewise tended to investigate interrelations among inner thoughts and feelings surrounding the movement experience, often without the more difficult measurement of movement quality or quantity per se. Like Baumeister and colleagues, as the previous discussion exemplifies, we would not argue against the value of studying the influence of cognitions and affective experiences, but suggest that their relation to dimensions of movement control and performance deserves particular attention.

It can be suggested that motor behavior provides a particularly rich opportunity to study behavior as a dependent variable. Episodes of motor behavior are often public, extend over considerable time (e.g., a cricket match), involve ballistic displays coupled with fine motor control within the same game (e.g., golf), constitute tests of physical endurance (e.g., marathon racing), demand exquisite motor control (e.g., musical performance, biathlon shooting), and generate speed-accuracy tradeoffs galore. This behavior can be captured in multiple ways, from energy expenditure, accelerometry, electromyography, and many metrics of time, distance, accuracy, and control, as well as competitive outcome.

Psychological movement science, as it moves to take fuller advantage of insights into the neural underpinnings of human movement, including those on motor learning and control, as well as the contributions of social-cognitive–affective neuroscience, must not lose sight of its primary dependent variable, overt movement behavior. Current neural imaging methods often constrain the types of movements that can be studied to those which can be performed in the small space of scanners or that involve limited extraneous movements. As brain imaging technologies continue to evolve, the kinds of movement behavior that can be observed from the neural perspective will be expanded as well. In the meantime, scientists must be circumspect in basing assumptions about the neural processing subsuming available movements into those pertaining to other forms.

The use of relatively simple laboratory tasks has already been predominant in motor learning research, sans neuroscience, for some time. There are presumably different reasons for the utilization of simple skills, both theoretical and pragmatic. Fundamental research using simple skills has without doubt contributed to our understanding of the learning process and the discovery of learning principles. However, there are also reasons to believe that the inclusion of more complex and ecologically valid skills in motor learning research would be more effective in determining meaningful principles that have application to more complex and real-life skills. For instance, principles developed on the basis of simple skills do not always generalize to more complex skills, and vice versa. Finally, tasks of increased difficulty and complexity – that pose a true challenge to the performer – may reveal changes in coordination as a function of different self-regulation strategies.

CONCLUSIONS

Conceptualizations regarding the integrative cultural, social, cognitive, and motor nature of human movement promise to broaden and advance movement science, providing new opportunities to explain and influence movement behavior. The ability to develop and take advantage of an integrative perspective will demand collaboration across sub-fields of movement science, not to mention full-brain neuroscience.

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Received: 07 July 2010; accepted: 13 July 2010; published online: 23 August 2010.

Citation: Lewthwaite R and Wulf G (2010) Grand challenge for movement science and sport psychology: embracing the social-cognitive–affective–motor nature of motor behavior. Front. Psychology ***1****:42. doi: 10.3389/fpsyg.2010.00042*

This article was submitted to Frontiers in Movement Science and Sport Psychology, a specialty of Frontiers in Psychology.