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Observational Learning of Complex Motor Skills: Dance

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Synonyms

Observational learning

Definition

The ability to learn new actions through observation is a ubiquitous feature of human behavior. Whether one is attempting to learn how to put a saddle on a horse or to dance the Irish Jig, observation, along with physical practice, is key for effective task learning. Decades of behavioral research have provided clues that observational learning shares common cognitive and neurophysiological underpinnings with physical learning. Recent advances in human neuroimaging techniques are enabling scientists to directly quantify the brain systems underlying skill learning. Research paradigms investigating dance learning via physical practice or observation reveal common neural processes underlying both types of learning.

Theoretical Background

When we learn to walk, use a fork, or drive a car, we learn by first observing others do the task, and then practicing it ourselves. A wealth of research has demonstrated that not only is observation helpful for learning, but that physical practice is more beneficial when paired with observation of new movements (Hodges et al. 2007). Behavioral research on action learning suggests simultaneously observing and reproducing the correct pattern of movements, results in the quickest and most accurate learning (e.g., Bandura 1977). Nevertheless, the ability to learn or improve task performance by observation alone, without concurrent physical practice, is a powerful capacity of humans.

Early behavioral investigations of observational learning by Sheffield (1961) led to the proposal that observation of a motor sequence improved learning by means of providing a "perceptual blueprint," or a standard of reference for how the task should be performed. Behavioral studies comparing observational and physical learning support the value of a perceptual blueprint. While the bulk of observational learning research has focused on learning from an expert human model, the use of a human actor performing the target behavior is not a requirement for forming a perceptual blueprint (Hodges et al. 2007). A more inclusive conceptualization of observational learning encompasses encoding any instruction, whether physical or symbolic, that can provide a sufficient model of the to-be-performed actions. The key distinction of what defines observational learning is not the *type* of instruction, per se. Rather, pure observational learning is defined as the subject not concurrently performing physical practice at the time the observational instructions are provided.

One of the primary theories why observational and physical learning have so much overlap is that they both engage similar cognitive processes (Bandura 1977; Hodges et al. 2007). However, as researchers in this field are quick to point out, such findings do not mean that physical and observational learning are *identical* cognitive processes; particular features remain unique to each kind of learning, but the common ground shared by these two types of learning might provide insights into how we are able to learn from both kinds of instruction. Contemporary research on observational learning thus attempts to more fully characterize points of overlap and divergence between physical and observational learning.

While the wealth of behavioral research on observational learning provides a foundation for exploring the comparative effectiveness and mechanisms underlying this kind of learning, it is difficult to determine from behavioral procedures alone the degree of correspondence between cognitive and neural processes serving these two types of learning. With the advent of functional neuroimaging techniques, including functional magnetic resonance imaging (fMRI), scientists are making significant advances in understanding how both types of learning imprint the brain and behavior by determining whether observational and physical learning modify similar or

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distinct neural regions. If both types of learning engage the same areas of the brain, then it seems plausible that both observational and physical learning engage comparable cognitive processes. Conversely, the emergence of different areas of neural activity based on learning would be more indicative of distinct cognitive processes underlie these two types of learning.

Important Scientific Research and Open Questions

Recently, several research laboratories have endeavored to evaluate and compare brain and behavioral responses during observational and physical learning of complex motor skills, such as those required to dance. These experiments identify a distinct set of brain regions that are active both when observing and when performing actions, including bilateral premotor and parietal cortices, collectively referred to as the "mirror neuron system" (MNS). The MNS encompasses a network of neural regions involved in visual analysis of action as well as areas involved in visuo-motor and action sequence performance. As such, this system is thought to be a plausible mechanism supporting new action learning, as it is responsive to physical and observational experience for a broad range of actions, spanning from simple keypress sequences to far more complex skills such as playing basketball, juggling, and dancing (Rizzolatti and Craighero 2004).

Two studies in particular have demonstrated the feasibility of using dance learning and observation as a paradigm for investigating observational compared to physical learning of complex action sequences. In one such study, the authors evaluated the influence of observational compared to physical experience on neural processing during dance observation (Calvo-Merino et al. 2006). In order to parse visual familiarity from physical experience, expert men and women ballet dancers observed videos of movements learned only by their sex, only by the opposite sex, or moves that are performed by all dancers. The motivation behind this procedure was to determine whether equally robust action resonance processes may be elicited by observation of movements that are equally visually familiar (because men and women dancers train together), but unequal in terms of physical experience. The authors reported that when effects of visual familiarity were controlled for, evidence for action resonance based on pure motor experience was found in MNS regions (inferior parietal and premotor cortices), as well as cerebellar cortices. This study provided initial evidence that observational and physical experience can imprint the brain differently, but this evidence is tempered by the fact that dancers' observational experience was not precisely controlled, and no measures of physical competence for observed movements were recorded.

A subsequent study addressed some of these issues by investigating whether, under certain situations, observational learning alone can lead to changes within the MNS, thus broadening the capacity of this particular brain system to include learning from pure observation (Cross et al. 2009). In this study, novice dancers physically rehearsed one group of simple dance sequences in a video game context, and passively observed a distinct set of simple dance sequences in between blocks of physical rehearsal. fMRI measures taken immediately before and after a week of training revealed that a subset of MNS regions showed comparable neural responses after physical and observational experience. The neural responses to physical and observational experience were more robust than responses measured while novice dancers observed comparable untrained dance sequences whilst being scanned. Moreover, participants performed physically practiced and observed dance sequences more accurately than untrained sequences. Considered together, the imaging analyses from this study suggest that among this sample of novice dancers, physical and observational learning share more commonalities than differences at a neural level. The converging evidence from the behavioral and neural measures serves to link the rich history of behavioral research on observational learning with the burgeoning field of neuroimaging inquiry into action cognition.

A tentative conclusion that can be drawn from this experiment on observational learning of dance is that we can learn to dance through observation using the same brain systems that are involved when physically practicing dance. In this study, it is noteworthy that such clear evidence emerged for observational learning in light of the fact that participants were never explicitly told to try and learn the sequences they watched each training day. Evidence from other studies suggests that the amount of observational learning can be markedly increased if participants are explicitly instructed to try and learn the information they observe during the training procedures (e.g., Hodges et al. 2007). At present, a great need exists for future research to explore the different parameters that might influence observational learning at a brain and behavioral level, including motivation to learn, which part of the model provides the most information for learning a new skill, and how different kinds of instructions might influence observational learning. Such research should shed light on how educators and those involved in rehabilitating individuals recovering from neurological or physical injury might be able to capitalize upon the brain and body's inbuilt mechanisms for learning effectively from observation.

Cross-References

► Implicit Learning
► Neurophysiological Correlates of Learning to Dance (Dance Learning- Neurological Correlation of Complex Action)
► Robot Learning from Demonstration

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