



A systematic review of observational practice for adaptation of reaching movements



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Observational practice is discussed as a substitute for physical practice for motor learning and adaptation. We systematically reviewed the literature on observational practice in reaching and aiming tasks. Our objectives were to identify (i) performance differences between observational and physical practice; (ii) factors that contribute to adaptation following observational practice; and (iii) the neural correlates of observational practice. We found 18 studies, all investigated adaptation of reaching in visuomotor rotations or force-field perturbations. Results of the studies showed that observational practice led to adaptation in both, visuomotor rotation and force-field paradigms ($d' = -2.16$ as compared to no practice). However, direct effects were considerably smaller as compared to physical practice ($d' = 4.38$) and aftereffects were absent, suggesting that observational practice informed inverse, but not forward modes. Contrarily, neurophysiological evidence in this review showed that observational and physical practice involved similar brain regions.

Motor learning—as it is defined in this paper—encompasses the acquisition of new unknown skills or tasks as well as the improvement or adaptation of skills acquired in the past. While movement skills are typically learned through repeated task execution (i.e., physical practice), observation of a model or another actor executing the task (i.e., observational practice), can have beneficial effects for the acquisition of new skills and adaptation of previously learned skills. Some evidence exists about the benefits, modalities, and potential underlying brain mechanisms when learning motor skills from observational practice (i.e., observational learning) in upper extremity tasks, such as reaching¹. Reaching, aiming, and grasping are involved in many (instrumental) activities of daily living and frequently targeted following motor impairments such as stroke. Further, reaching plays a prominent role in the interaction with technical devices and human-like robots (or robotic arms) might learn reaching actions in a similar fashion to humans. Observational practice can supplement or enhance the learning of reaching skills through physical practice². In the context of sports sciences research, observational learning of more complex upper extremity skills, such as juggling, or a tennis serve has been intensively investigated in the past³. However, to date, no systematic review of the literature on observational learning of relatively simple reaching, aiming, and grasping tasks that are relevant for activities of daily living has been conducted. In this study, we

therefore systematically reviewed studies on observational practice in reaching, aiming, and grasping tasks. Our aim was to investigate whether observational practice of upper extremity reaching movements leads to similar learning rates and involves similar neural (brain) mechanisms as compared to physical practice and whether there are factors that determine learning success.

It has been well established that we do not only learn and adapt motor skills through physical, but also through mental practice. This includes the imagination of oneself performing the action (i.e., motor imagery) as well as the observation of another person (i.e., action observation) performing the same action. The potential of learning from observing a demonstrator (i.e., observational practice) as a substitute or complementary mode of practice is discussed to be particularly useful in situations where novel complex movements are learned, e.g., for sports or playing musical instruments⁴, when movement execution is restricted, e.g., in rehabilitation⁵ or when unskilled practice may have severe consequences and prior development of expertise is crucial, e.g., when performing surgery⁶. Whether learning from observing others can complement or even replace physical practice depends on different factors, such as the complexity of the task, the current skill level as well as its attentional and motivational state of the learner⁷.

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R Sandford



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