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Self-control over combined video feedback and modeling facilitates motor learning

Phillip G. Post [a,*], Christopher A. Aiken [b], David D. Laughlin [c], Jeffrey T. Fairbrother [d]

[a] Department of Kinesiology and Dance, New Mexico State University, United States
[b] Integrative Physiology and Health Science Department, Alma College, United States
[c] Department of Movement Science, Grand Valley State University, United States
[d] Department of Kinesiology, Recreation, and Sport Studies, University of Tennessee, Knoxville, United States

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ABSTRACT

Allowing learners to control the video presentation of knowledge of performance (KP) or an expert model during practice has been shown to facilitate motor learning (Aiken, Fairbrother, & Post, 2012; Wulf, Raupach, & Pfeiffer, 2005). Split-screen replay features now allow for the simultaneous presentation of these modes of instructional support. It is uncertain, however, if such a combination incorporated into a self-control protocol would yield similar benefits seen in earlier self-control studies. Therefore, the purpose of the present study was to examine the effects of self-controlled split-screen replay on the learning of a golf chip shot. Participants completed 60 practice trials, three administrations of the Intrinsic Motivation Inventory, and a questionnaire on day one. Retention and transfer tests and a final motivation inventory were completed on day two. Results revealed significantly higher form and accuracy scores for the self-control group during transfer. The self-control group also had significantly higher scores on the perceived competence subscale, reported requesting feedback mostly after perceived *poor* trials, and recalled a greater number of critical task features compared to the yoked group. The findings for the performance measures were consistent with previous self-control research.

Movement practitioners must decide when to provide instructional support such as feedback or demonstrations during practice to facilitate learners' skill acquisition. Typically, learners rely on the instructor to provide such instructional support during practice. Recent motor learning research, however, indicates that learners benefit from controlling when instructional support is delivered during skill acquisition (Wulf, 2007). For instance, research has shown that motor learning on a variety of tasks can be facilitated when learners control the delivery of augmented feedback (Aiken, Fairbrother, & Post, 2012; Chiviacowsky, de Medeiros, Kaefer, Wally, & Wulf, 2008; Chiviacowsky & Wulf, 2002; Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997) and video demonstration (Wulf, Raupach, & Pfeiffer, 2005). The benefit of self-control has traditionally been revealed through comparisons to yoked control groups that do not control feedback or demonstration delivery. Matching the frequency and schedule of feedback via yoking has allowed group differences to be attributed to the provision of self-control rather than the effects of reduced frequency of feedback.

Although the mechanisms underlying self-control effects are not well understood, several plausible explanations have been forwarded. These include more deeper information processing (Janelle, Kim, & Singer, 1995), increased cognitive effort

* Corresponding author at: Department of Kinesiology and Dance, New Mexico State University, Las Cruces, NM 88003, United States.
E-mail address: ppost@nmsu.edu (P.G. Post).

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(Bund & Wiemeyer, 2004; Patterson & Carter, 2010), enhanced motivation (McNevin, Wulf, & Carlson, 2000), and tailoring of practice to meet individual needs and preferences (Chiviacowsky & Wulf, 2002). Evidence consistent with the latter notion – tailoring the instructional setting – has been identified by the fact that self-control participants appear to request feedback strategically during practice. For example, the majority of self-control feedback studies have revealed decreases in request frequency as practice progressed (e.g., Aiken et al., 2012; Janelle et al., 1997; Laughlin et al., 2015). These behaviors have been interpreted as indicating that learners understand the need to reduce their dependency on instructional support. More direct evidence has been found in explicit reports from self-control participants about the strategic use of different types of instructional support (Laughlin et al., 2015).

The way self-control participants request feedback seems to depend on the mode of feedback delivery and the nature of the task. Chiviacowsky and Wulf (2002) found that learners requested feedback mostly after perceived *good* trials when learning a simple motor task (i.e., sequential timing task) and being provided with feedback about timing errors. This seeming preference of *good trial feedback* has been replicated a number of times (Badami, VaezMousavi, Wulf, & Namazizadeh, 2012; Chiviacowsky & Wulf, 2005, 2007; Chiviacowsky, Wulf, de Medeiros, Kaefer, & Tani, 2008; Chiviacowsky, Wulf, Wally, & Borges, 2009; Patterson & Carter, 2010; Saemi, Wulf, Varzaneh, & Zarghami, 2011). Aiken et al. (2012), however, did not find such a preference when participants learned a complex motor task (i.e., a set basketball shot) and were provided with a more information-rich source of feedback (i.e., video-KP). Aiken et al. attributed the lack of a *good trial feedback* preference to the fact that complex tasks coupled with video feedback allow participants to identify both good and bad elements in their performance on any given trial. Subsequent research has shown that self-control participants request feedback to both correct errors and confirm correct performance elements (Laughlin et al., 2015). The divergent findings may also be due in part to the different instruments used in the two studies. Chiviacowsky and Wulf (2002) asked participants to make a dichotomous choice between two categories (i.e., asking for feedback mostly after good trials or mostly after bad trials) while Aiken et al. (2012) used Likert scales that allowed participants to simply indicate how often they requested feedback when they thought their form was either good or bad.

Aiken et al. (2012) suggested that when learners are presented with information rich feedback, such as video, they request feedback after both *good* and *poor* trials. One potential explanation for this is that a learner requests feedback to view one aspect of the movement that may be considered a *good* movement quality in an otherwise *poor* trial, or select feedback to view one aspect of the movement that is considered *poor* in an otherwise *good* trial. In either case it suggests that learners are drawing comparisons between the goal of the movement and the movement outcome, which is consistent with Gentile's (1972) model of learning. Specifically, Gentile argued that learners draw comparisons between the goal of the movement and the actual outcome of the movement via knowledge of results (KR) and the plan for the movement and the executed movement through knowledge of performance (KP). These comparisons lead to four possible learning outcomes: (a) both the goal and movement are accomplished; (b) the goal is accomplished but the movement was not executed as planned; (c) the goal is not accomplished but the movement was executed as planned; and (d) the goal is not accomplished and the movement is not executed as planned. In the first case, the learner "gets the idea" of the correct movement. In the second and third cases, the learner discovers that something is wrong with planning and execution. In the fourth case, the learner recognizes that "everything is wrong". From this perspective, the provision of self-control over information rich feedback, such as video, would allow the learner to make comparisons between their plans and movements when they experience one of the four outcomes during practice. Such a use of feedback would also be consistent with the views that feedback provides corrective information to guide future movements (Salmoni, Schmidt, & Walter, 1984) or can be used to confirm success (Aiken et al., 2012). Utilizing Gentile's model, it is possible that yoked participants receive augmented feedback during acquisition at times that does not facilitate a productive comparisons between the goal of the movement, the outcome, and executed movement (e.g., if they do not receive feedback after recognizing that something went wrong).

Video-KP appears to be an effective mode of instructional support in self-controlled learning approaches. Janelle et al. (1997) found that self-control over video-KP coupled with verbal-KP facilitated the learning of overhand throwing technique. Aiken et al. (2012) further demonstrated that self-control over video-KP alone facilitated the learning of a basketball set shot. Authors have argued that video-KP is an effective instructional support because it allows learners to access information about their performance that they would not otherwise receive during skill execution (Winfrey & Weeks, 1993; Wulf & Shea, 2002). For example, a coach could use video replay to assist a novice golfer by providing the learner with information about his or her set up, movement form, and coordination during a chip shot. Innovations in video technology have resulted in widespread availability of relatively inexpensive systems that allow practitioners to use mobile devices (i.e., tablets, laptops, phones) during instruction. Video replay software now makes it possible to provide learners with a split-screen display comprised of a video replay alongside an expert model demonstration. The use of a split-screen replay may further facilitate learning because it provides a comparative basis for identifying key differences between the learner's performance and that of the expert model (Baudry, Leroy, & Chollet, 2006; Laguna, 1996).

It has yet to be determined if self-control over split-screen replay can facilitate motor learning. This is an important question given the ubiquity of split-screen replay technology that is widely and actively promoted to movement practitioners by commercial software vendors. Information about whether or not self-control over split-screen replay facilitates motor learning will provide a basis for recommendations to practitioners about how to best utilize this new technology for skill instruction. On the one hand previous self-control research would suggest that having control over an instructional support such as split-screen replay should facilitate learning. On the other hand, split-screen replay could provide too much information to the learner, which might lead to cognitive overload and degraded learning (Emmen, Wesseling, Bootsma, Whiting, & Van