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Self-controlled KR schedules: Does repetition order matter?

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ABSTRACT

The impact of an experimenter-defined repetition schedule on the utility of a self-controlled KR context during motor skill acquisition was examined. Participants were required to learn three novel spatial-temporal tasks in either a random or blocked repetition schedule with or without the opportunity to control their KR. Results from the retention period showed that participants provided control over their KR schedule in a random repetition schedule demonstrated superior learning. However, performance measures from the transfer test showed that, independent of repetition schedule, learners provided the opportunity to control their KR schedule demonstrated superior transfer performance compared to their yoked counterparts. The dissociated impact of repetition schedule and self-controlled KR schedules on retention and transfer is discussed.

1. Introduction

Practice contexts organized to challenge the information processing capabilities of the learner are believed to be an important factor facilitating motor skill acquisition (Guadagnoli & Lee, 2004; Lee, Swinnen, & Serrien, 1994; Schmidt & Bjork, 1992). Such practice contexts are referred to as *cognitively effortful* because the processing demands required by the learner to plan, execute, and interpret the outcome of their motor action are heightened (Guadagnoli & Lee, 2004; Lee et al., 1994). Understanding the cognitive mechanisms responsible for the learning advantages associated with cognitively

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effortful practice continues to be a topic of interest in understanding the practice factors facilitating motor skill learning (for reviews see Guadagnoli & Lee, 2004; Lee et al., 1994; Schmidt & Bjork, 1992).

During motor skill learning, the predictability of the repetition schedule (i.e., blocked versus random repetitions) as well as the availability of augmented feedback (frequent vs. infrequent) are two practice variables shown to differentially modulate the cognitive demands imposed on the performer (for reviews see Guadagnoli & Lee, 2004; Wulf & Shea, 2002). Repetition schedules requiring the performer to actively engage in the cognitive processes that are required to *plan* a motor action on each repetition (i.e., random or serial repetition schedule are considered cognitively effortful) have proven superior for learning compared to repetition schedules considered to place predictably lower amounts of motor planning demands on the learner's cognitive processes (i.e., a blocked repetition schedule requires low cognitive effort; see Lee & Simon, 2004 for a review). The learning advantages of cognitively effortful repetition schedules have been attributed to the heightened demands placed on the learner's working memory required for such motor planning processes as inter-task comparisons; (e.g., Shea & Morgan, 1979; Shea & Zimny, 1983, 1988) and construction of motor plans (e.g., Lee & Magill, 1983, 1985). Likewise, providing the learner augmented feedback (i.e., knowledge of results (KR)) on less than 100% of the acquisition trials has been shown to facilitate greater learning compared to providing KR on all trials (see Salmoni, Schmidt, & Walter, 1984; Wulf & Shea, 2004 for reviews). The heightened cognitive processing required by the leaner during the no-KR trials to consciously interpret their intrinsic sources of task related information subsequently strengthens their independence in error detection and correction.

Combining a random repetition schedule with increased no-KR trials (e.g., response interpretation phase) offers a novel method of cognitively challenging the learner in both the *motor planning* and *response interpretation* phases of a motor trial. In fact, the learning benefits associated with both the manipulation of the repetition schedule and provisions of KR have independently proven to be robust. Until recently, the potential *additive* learning advantages of combining these practice contexts has received minimal attention. For example, Wu et al. (2011) examined whether practicing in a random practice schedule combined with a faded-KR schedule (e.g., high cognitive effort) would prove more advantageous to learning compared to receiving faded-KR under a blocked schedule, KR on all trials in a random schedule, and KR on all trials in a blocked schedule (i.e., low cognitive effort). The results showed the characteristics of the repetition schedule (i.e., random repetition schedule) was the practice factor facilitating motor learning, irrespective of the KR schedule. Thus, an additive learning advantage of challenging both the motor planning (i.e., random repetition schedule) and response interpretation (i.e., faded KR) components of a motor trial was not supported. However, an earlier study showed an additive learning advantage when a random repetition schedule was combined with providing KR in a summary format (e.g., Del Rey & Shewokis, 1993). Collectively, the aforementioned results suggest the potential learning advantages of challenging the cognitive processes required to plan a motor action, and those processes required for error detection and correction remains inconclusive.

Understanding the cognitive mechanisms underlying the learning advantages of practice contexts considered cognitively effortful have until recently been attributed to practice contexts defined by the researcher (i.e., externally defined; Guadagnoli & Lee, 2004; Lee et al., 1994; Schmidt & Bjork, 1992). However, an increasing body of literature suggests that providing the learner control over their *repetition schedule* (e.g., Keetch & Lee, 2007; Wu & Magill, 2011) or *KR schedule* (e.g., Chiviacowsky & Wulf, 2002; Hansen, Pfeiffer, & Patterson, 2011; Patterson & Carter, 2010) has a positive impact on skill acquisition. In fact, during multi-task learning, learners have shown a preference for a blocked repetition schedule early in the acquisition period, followed by a preference for a random repetition schedule later in practice, to the advantage of learning (Hodges, Edwards, Luttin, & Bowcock, 2011; Wu & Magill, 2011). Commensurately, learners demonstrate frequent requests for KR early in practice, followed by less-frequent requests for KR as a function of practice trials completed (Chiviacowsky & Wulf, 2002). The learning advantages of a self-controlled practice context are suggested to be the results of a practice context that is individualized to systematically challenge the information processing capabilities of the learner, to the benefit of learning (Chiviacowsky & Wulf, 2002; Patterson & Carter, 2010; Patterson, Carter, & Sanli, 2011; see Wulf, 2007 for review).