ENHANCING PRACTICE THROUGH GRADUAL INCREASES IN CONTEXTUAL INTERFERENCE

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Letter to the Editor

Dear Editor-in-Chief,

In a recent study, Porter and Beckerman (2016) investigated the influence of an "increasing schedule" of contextual interference on the learning of a continuous motor skill. Contextual interference (CI) refers to the phenomenon whereby the order in which skills or variations of skills are practiced has the potential to interfere with cognitive processes, and thereby influences both short-term performance and longer-term learning. Practicing the same skill for a block of trials or time, before switching to the next skill, induces low CI (also known as blocked practice). Continually switching between different skills or skill variations (random practice) induces high CI. In the typical "increasing contextual interference" schedule reported in the literature (Porter & Magill, 2010; Porter & Saemi, 2010; Saemi, Porter, Ghotbi-Varzaneh, Zarghami, & Shafinia, 2012), the first third of practice is completed under low CI, the middle third under moderate CI, and the final third under high CI. Consistent with these previous studies, Porter and Beckerman (2016) found that an increasing schedule of CI led to learning superior to that induced by constant schedules of either low or high CI. In this critical reflection, I do not question the findings of this line of research, which are consistent across the studies listed earlier. Instead, I firstly wish to highlight, from the theoretical and empirical positions, a misunderstanding in the design of the increasing CI schedule which may enhance the quality of future studies. Secondly, I will highlight a limitation in existing experiments, and a method which may be applied to address this limitation.

To generate moderate levels of CI, Porter and colleagues have utilised a serial practice structure whereby participants complete tasks in a repeating sequence. That is, participants performed a different movement on every trial following a predictable sequence (e.g., ABCABCABC). However, according to theoretical explanations of CI, the use of a serial pattern consisting of three or fewer movements, in which no movement is ever immediately repeated, is predicted to result in high CI. The central premise of the Elaboration hypothesis (Shea & Morgan, 1979; Shea & Zimney, 1983) is that switching from performing one movement pattern to performing another allows the two movement patterns to be compared, leading to the development of more detailed (or elaborate) memory representations. A more elaborate memory representation is proposed to have greater storage and retrieval strength. In the case of a sequence of three or fewer patterns, each movement is compared to all other variations. As such, it is the number of times that a performer switches between movement patterns that is critical to the generation of high CI, and not the predictability of the sequence.

An alternative but complimentary explanation of CI was proposed by Lee and Magill (1985). According to Action Plan Reconstruction, when a performer attempts a motor skill, an action plan is generated based upon the integration of long-term memory and relevant sensory information. When the performer repeats the motor skill, relatively little cognitive processing may be required in order to update the action plan. In contrast, if the performer switches to a new motor skill, considerably more cognitive effort must be expended in the retrieval of relevant information from long-term memory and the construction of a new action plan. Lee and Magill (1985) argued that it is this increased cognitive processing which accompanies switching between movement patterns that contributes to enhanced learning (see also Bjork & Bjork, 2014). Thus, according to both primary theoretical explanations of CI, whether the changes between movement patterns occur in a predictable sequence or not is irrelevant; it is simply the number of changes that matters.

Experimental studies support the conclusion that the serial practice schedule utilised by Porter and colleagues in fact produces high CI. Lee and Magill (1983) specifically contrasted groups learning complex motor sequences while following blocked (low CI), random (high CI) or serial practice schedules. In two experiments, performances of the serial practice group mirrored those of the random practice group. Within a sporting context, Bortoli, Robazza, Durigon, and Carra (1992) similarly found that a group practicing in a predictable sequence mirrored the acquisition, retention and transfer test performances of a group which practiced in a random sequence (see also Kalkhoran

& Shariati, 2012). While Goode and Magill (1986) did present contradictory results, in which a serial group's transfer test performance was intermediate to those of groups which practiced in blocked and random schedules, it is important to note that performance of the serial group in acquisition was unexpectedly below that of the random group. Within their discussion, Goode and Magill were not able to offer any explanation for either of these findings. In summary, the available research largely supports the theory-derived proposition that a serial practice schedule, in which there is no immediate repetition of movements, is equivalent to a random schedule in producing high contextual interference. Consequently, the increasing schedule which has been utilised in the research to date (Porter & Beckerman, 2016; Porter & Magill, 2010; Porter & Saemi, 2010; Saemi, et al., 2012) may be more accurately described as progressing from low to high to high CI, rather than from low to moderate to high CI, as intended.

Moderate CI may be introduced through manipulating the size of a block of trials (i.e., by varying the number of times a learner switches between movements) (Landin & Hebert, 1997). As such, instructors have considerable flexibility to control the amount of CI to which a learner is exposed in response to an athlete's progress. To date, however, a second methodological shortcoming in experiments investigating increasing schedules of CI has been the loose coupling of increases in CI to changes in a learner's performance. Specifically, predetermined increases in CI have been introduced for all participants on completion of one third of the allocated practice trials (Porter & Beckerman, 2016; Porter & Magill, 2010; Porter & Saemi, 2010; Saemi, et al., 2012). Simon, Lee, and Cullen (2008) provided an example of how a more individual-specific approach to CI scheduling might be employed within applied or experimental contexts with their Win-Shift/Lose-Stay concept. As the name suggests, after a successful attempt (win), a performer shifts to practicing an alternative skill. After an unsuccessful attempt (lose), a performer repeats the same skill. Consequently, by applying Win-Shift/Lose-Stay, a generally successful performer will switch between skills frequently, experiencing a high level of CI. A generally unsuccessful performer will switch between skills less frequently, experiencing a low level of CI. As such, Win-Shift/Lose-Stay offers an efficient method by which the level of CI performers experience can be tightly coupled to their success rate. Further research is warranted into the efficacy of Win-Shift/Lose-Stay, particularly in contrast with the predetermined schedules of increasing CI.

In conclusion, by investigating increasing CI schedules, Porter and colleagues have made a valuable contribution to the motor learning literature. However, future research designs relating to this question would benefit from utilising small blocks of practice to generate moderate contextual interference, as would applied practitioners. In addition, future research should address how levels of CI could be more tightly coupled to individual learners' performance levels. Simon et al.'s Win-Shift/Lose-Stay strategy (2008) is a promising method by which such individual-specific prescription of CI could be achieved within either an experimental or applied context.

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