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The learning of two similar complex movement sequences: Does practice insulate a sequence from interference? ☆

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ABSTRACT

Panzer et al. [Panzer, S., Wilde, H., & Shea, C. H. (2006). The learning of two similar complex movement sequences: Proactive and retroactive effects on learning. *Journal of Motor Behavior, 38*, 60–70] found evidence to indicate that the memory state(s) underpinning the production of a movement sequence that was practiced for one day was essentially "overwritten" when another similar sequence was subsequently practiced on the next day. An interference paradigm was used to determine if additional practice on the first sequence would insulate it from retroactive interference arising from learning a new similar sequence. Participants produced the sequences by moving a lever with their right arm/hand to sequentially presented target locations. The experimental group practiced one 16-element movement sequence (S1) for two consecutive days. A second 16-element sequence (S2) was practiced on Day 3. The sequence practiced on Day 3 was created by switching the positions of 2 of 16 elements in the sequence practiced on the first day. Control groups received either two days of practice on S1 or one day of practice on S2. Contrary to our earlier findings (Panzer, Wilde, & Shea, 2006) of strong retroactive interference when S1 was only practiced for one day, we found no evidence of retroactive interference when S1 was practiced for two days prior to the switch to S2 practice. Interestingly, but also contrary to our earlier findings, we found the learning of S2 was facilitated by the prior

☆ For purposes of clarity we have chosen to use the term interference to refer to the negative influences of one sequence on another sequence, and positive transfer to refer to the positive influences. Of course we could have used positive and negative transfer or positive or negative interference as has been done in some literatures.

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practice of S1. This proactive facilitation was observed in S2 acquisition and on the S2 retention test.

1. Introduction

Numerous movement sequences are learned and later modified as circumstances dictate throughout one's lifetime. We learn sequences to shift gears in a standard transmission car, sign our name on a piece of paper, swing a golf club, or play a musical score on the piano. After initially learning to perform these types of sequences we may be required to perform a slightly different but related sequence. For example, after learning to shift gears in a standard transmission car, we may be required to drive a farm tractor where the gears are aligned in slightly different positions. Likewise, after learning to play a musical score on a standard piano, we may be required to play the same score on an electronic keyboard where the spacing between keys is slightly different than on the standard piano. The major question we are addressing is: How are these subtle changes accommodated by the motor system? Obviously, the more that is known about how sequences are structured, learned, and adapted to new demands, the better the guidance that can be provided to practitioners attempting to design training and retraining programs. In addition, an understanding of the processes involved in the performance, learning, and modification of motor sequences is important to theories of motor learning in general because movement sequences comprise a large proportion of our learned motor behaviors.

In a recent paper (Panzer et al., 2006) we determined the effect of making a subtle change in a previously learned movement sequence. Two competing hypotheses were initially proposed. First, because the two sequences were so similar, proactive and retroactive interference could degrade the performance of both sequences. The notion that similarity plays a role in increasing interference effects is well documented in the verbal (e.g., Lustig & Hasher, 2001; Melton & von Lackum, 1941; Underwood, 1951) and motor learning (e.g., Bock, Schneider, & Bloomberg, 2001; Holding, 1976; Muehlbauer & Krug, 2007; Panzer, Naundorf, & Krug, 2002; Schmidt & Young, 1987; Walter & Swinnen, 1994) literatures. On the other hand, because the two sequences were so similar, it seemed logical that a previously learned movement sequence could be modified to produce a slightly different movement sequence (e.g., Schmidt & Young, 1987, see also Malfait, Shiller, & Ostry, 2002). If this were true, proactive facilitation would be evident in the performance of the new sequence. Indeed, the latter notion is consistent with the belief that lead-up games and practice activities form the building blocks for the later skilled performance even though the specific movement sequences used in the training activities may be subtly different from that used by the skilled performer.

It should be noted that the subtle changes we are most interested in investigating are not those that could be accommodated by simply rescaling the movement sequence (metrical change) but rather those that result in a change in the movement pattern (structural change) (Braden, Panzer, & Shea, in press; Wilde & Shea, 2006). A large literature on movement sequences (e.g., Povel & Collard, 1982; Restle, 1970; Rosenbaum, Kenny, & Derr, 1983) indicates that when the sequence is composed of a relatively large number of elements that participants essentially chunk elements (termed motor chunks by Verwey (1999)) together into relatively independent subsequences. These subsequences are often observed in the data as a comparatively long duration for one element (beginning of the subsequence) followed by relatively short durations for the remaining elements in the subsequence. Shea and colleagues (e.g., Park & Shea, 2005; Wilde & Shea, 2006) have also noted that the beginning of the subsequence also tends to be more variable than the element in the subsequence and zero crossings on the acceleration trace tend to cluster around these elements indicating brief hesitations in an otherwise smooth movement production. When a new movement sequence is introduced interference or facilitation may arise depending on the degree to which the new sequence requires the modification of the original sequence structure.

In an attempt to begin the process of systematically studying the interference patterns involved in learning two similar sequences, Panzer et al. (2006) had participants practice a 16-element movement sequence (S1) on one day and then practice a similar sequence (S2) on a second day. The second