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When Repetition Isn't the Best Practice Strategy: Examining Differing Levels of Contextual Interference during Practice

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When repetition isn't the best practice strategy: Examining differing levels of contextual interference during practice

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Two experiments examined the effects of blocked and random practice schedules on the performance accuracy, speed, and temporal evenness of performance by wind players. Blocked schedules used repetitive practice orders, while random schedules constantly changed the order of tasks practiced. Beginning clarinet students completed three days of practice on three short technical tasks, in either a blocked or random order. Twenty-four hours after practice, beginning students who had practiced in the random order were able to play significantly faster than students who had practiced in the blocked order ($F_{1,38}$=24.95, $p<0.001$, η^2=0.92). Students in the blocked group performed significantly slower at 24-hour delayed retention than immediately after practice ($p<0.001$). Contrary to non-musical motor learning investigations, there was no speed-accuracy trade-off: students maintained high accuracy scores while speed gradually improved. In Experiment II, university wind students practiced three short technical tasks in either a blocked or random order for two days. Retention testing occurred 24-hours and one week following practice. Preliminary results were presented in the conference session.

Keywords: practice; contextual interference; blocked; speed-accuracy trade-off; speed

Musicians and music educators are always seeking to better understand factors contributing to efficient and effective practice. Motor learning research, which studies how people acquire and refine movements over time, offers a potentially valuable framework for exploring the challenges of instrumental performance. To the extent that playing a musical instrument is a motor task, motor learning theories and methods may be relevant to the study of music practice.

A series of two studies applied the motor learning principle of contextual interference, the amount of cognitive disruption present when practicing multiple tasks within a practice session, to instrumental practice. The purpose of these studies was to examine the effects of differing levels of contextual interference on performance speed, accuracy, and temporal evenness by beginning and university-level instrumentalists. Low levels of contextual interference were defined as blocked practice orders (AAA BBB CCC), while high levels of contextual interference were defined as random practice orders (ABC BAC ACB). The contextual interference hypothesis (Shea and Morgan 1979, Battig 1966) predicted the blocked condition would exhibit superior performance immediately following practice (acquisition) but the random condition would perform better at delayed retention testing. This hypothesis is generally consistent in laboratory motor learning studies (e.g. Lee and Magill 1983, Brady 2004), but less consistent in applied studies of sports skills (e.g. Landin and Hebert 1997, Hall *et al.* 1994) and fine-motor skills (Ollis *et al.* 2005, Ste-Marie *et al.* 2004).

In a music context, university non-percussion majors practiced right hand lead snare drum sticking for one practice session in either a blocked or varied (random) order or an unstructured free condition (Rose 2006). After retention delays of 30 minutes to 24 hours, no significant differences were found between blocked and random groups for accuracy. Likewise, Stambaugh and Demorest (under review) found second and third year clarinet and saxophone students learned 8-measure method book songs equally well in either 6-minute blocked, 1-minute serial (ABC ABC), or hybrid (2-minute serial) orders.

The current investigations expanded on previous research by using designs more similar to traditional motor learning experiments and musicians with different levels of expertise.

METHOD: EXPERIMENT I

Participants

Participants (n=41) were beginning clarinet players recruited from 16 elementary schools in the northwest USA. Students were enrolled in the first year of their school band program, which started in either fifth or sixth grade (age 11 or 12 years).

Materials

The stimuli (e.g. see Figure 1) were composed by the researcher to meet the following constraints: limited performance range, task brevity, transposable

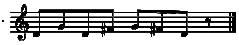

Figure 1. Practice task for Experiment I.

to two other keys to control for any aural confounds, inclusion of a novel pitch to prevent ceiling effects, and majority tonality. There were two screening tasks, three practice/retention tasks, and two transfer tasks.

Procedure

Students began by playing the screening tasks, and this accuracy score was used as a covariate. The practice sessions occurred in group settings led by the researcher. Microphones were attached to students' clarinets during all playing. Cubase multi-track software enabled individual recordings to be made of each student's playing while in the group setting.

Students within schools were randomly assigned to either the blocked or random practice condition, attending three practice days and one delayed testing day. Students were instructed to play as "accurately and quickly as possible." In the blocked group, students played 18 trials of one task on each day. Random group students played 6 trials of each of the 3 tasks in a random order. At retention testing, students within groups were further divided for testing in either a blocked or random order (blocked practice-blocked retention, blocked practice-random retention…). After performing 3 retention trials of each task and 3 trials of the transfer tasks, students completed a brief questionnaire about their attitude toward their practice condition.

Accuracy and speed scores were determined for each of the 3,554 performance trials. Accuracy was scored through repeated listening by the researcher using a point-deduction system, and speed was measured in Cubase as the time lapsed from the onset of the first pitch to the onset of the last pitch in each trial. Temporal evenness was scored for the final three practice trials (acquisition), retention, and transfer trials (1,286) using an equation determining the average interonset interval in relation to trial duration: $|IOI_x\text{-}IOI_m|=IOI\Delta$, $\sum IOI_\Delta/\sum IOI$.

RESULTS: EXPERIMENT I

Figure 2 presents means and standard deviations of speed and accuracy averaged for every 3 practice trials. After 18 practice trials, there were no significant differences between groups for accuracy, speed, or temporal evenness ($p>0.02$). A repeated measures ANCOVA for speed found a main effect for trial ($F_{5,34}=5.05$, $p=0.001$, $\eta^2=0.11$), indicating both groups did improve speed

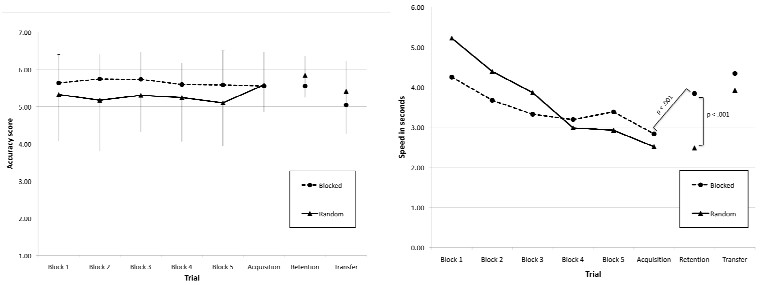

Figure 2. Accuracy and speed mean scores averaged across every three trials.

during the practice trials. At 24-hour delayed retention, the random group performed significantly faster than the blocked group ($F_{1,38}$=24.95, p<0.001, η^2=0.92), and pairwise comparisons indicated the blocked group played significantly slower at retention than at acquisition (p<0.001). There were no significant differences for accuracy or evenness at retention, and no significant differences between groups on transfer tasks. When students within practice groups were tested in blocked or random orders at retention, there were no significant within-practice group differences for accuracy, speed, or evenness. Regarding attitude toward practice, both groups exhibited a similar (t_{40}=-1.10, p>0.28) positive response.

METHOD: EXPERIMENT II

Participants

Participants (n=40) were members of university bands, playing woodwind or valved brass instruments.

Materials

The researcher composed the stimuli (e.g. see Figure 3) to be a major tonality, short task, and difficult enough to prevent a ceiling effect.

Procedure

Procedures were similar to Experiment I, with three notable differences. First, participants completed practice sessions individually, without the re searcher present. Second, the 18 practice trials occurred over two, rather than three, days and a one-week delayed retention test was added. Third, the

Figure 3. Example task for Experiment II.

blocked practice order was 9 trials of each task on both days in a blocked order, to control for consolidation effects.

RESULTS: EXPERIMENT II

Preliminary results were presented in the conference session.

DISCUSSION

Like many applied studies, results of Experiment I were partially consistent with the contextual interference hypothesis: although group scores were similar at acquisition, the random group performed faster at retention. A possible explanation for the similarity between group performances at acquisition is differences between the single-day practice design and the three day practice design used here. In single-day designs and in the blocked group in Experiment I, block 6/acquisition occurred on the same day as all practice trials: there was no sleep-based consolidation interval (Duke and Davis 2006, Duke *et al.* 2006). However, the random group in Experiment I distributed their practice across three days, allowing some consolidation to occur before playing block 6/acquisition. This potential confound was addressed in Experiment II.

Notably, these results are also inconsistent with the snare drum task practiced in Rose (2006), perhaps due to the nature of the musical task. The clarinet stimuli were specifically designed to begin and end on tonic pitch. During the 18 trials, students cultivated an aural imprint of the task, and as automaticity progressed, it is possible this melodic component facilitated a pitch-to-finger mapping that was not possible in the non-melodic task.

The learning advantage exhibited by the random group suggests this practice strategy is beneficial for beginning clarinet students practicing short technical tasks, contrary to the drill-type strategies promoted in many beginning method books, practice software, and lessons.

Acknowledgments

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