2011

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Recommended Citation
Stambaugh, Laura A.. 2011. "Repetition and Judgment of Learning in Wind Instrument Practice." *Proceedings of the International Symposium on Performance Science, Toronto, Canada*, Aaron Williamon, Darryl Edwards, and Lee Bartel (Ed.) Utrecht, The Netherlands: European Association of Conservatoires (AEC). source: http://performancescience.org/conference/isps2011/ isbn: 978-2-9601-3780-4
https://digitalcommons.georgiasouthern.edu/music-facpubs/5

International Symposium on Performance Science
ISBN 978-94-90306-02-1

Repetition and judgment of learning in wind instrument practice

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This study draws on two existing lines of research: blocked and random practice orders and judgment of learning. University wind and brass students practiced three short technical tasks in either a repetitive order or a random order during two practice sessions. Retention testing occurred 24 hours and 1 week after the second practice session. Performances were evaluated for accuracy, speed, and evenness. Woodwind players benefited from a random practice order. A secondary research question was drawn from judgment of learning research in motor learning and metacognition. At the end of the second practice session, participants predicted the metronome marking at which they would play each music task. Predictions were compared with the actual tempos performed at 24-hour retention. All instruments had low to moderate correlations between predicted and performed tempos.

Keywords: practice; contextual interference; judgment of learning; music cognition; learning

While repetition is a common practice strategy in wind instrument practice, previous research suggests blocked practice orders (AAA BBB CCC) are not always as effective as random practice orders (ABC CBA BAC) (Shea and Morgan 1979) for learning brief technical tasks (Rose 2006, Stambaugh 2011). This phenomenon has not been studied with university-level wind players, only at the beginning level. Because this effect is related to cognition, it is possible that more experienced and older musicians may not be affected by practice orders in the same way as young musicians. In addition, it is possible that brass instruments require a higher cognitive load than woodwind instruments, and this could interact with practice orders.

A secondary research question was drawn from "judgment of learning" research in motor learning and metacognition (Simon and Bjork 2001). The judgment of learning construct represents how well an individual believes he has learned a task. This is highly relevant to self-regulated practice. When judgment of learning interacts with blocked and random practice orders, this construct reveals repetitive practice orders lead a learner to be overconfident in how well they have learned a task. Conversely, learners who have practiced in a random order underestimate their level of learning. The purpose of this study is to examine the following research questions:

- Will blocked and random practice orders affect university woodwind and brass players' learning in a similar manner?
- Will blocked and random practice orders affect university woodwind players in the same way as beginning woodwind players?
- How accurately can university wind players predict their level of learning?

METHOD

Participants

Undergraduate participants (N=46; mean age=19.9 years) were members of concert bands at two universities in the USA. Instruments were represented as follows: flute n=10, oboe n=2, clarinet n=9, saxophone n=4, trumpet n=14, French horn n=5, and tuba n=2. Twenty-three students were randomly assigned to a blocked practice group (n=12 woodwind, n=11 brass), and 23 students were randomly assigned to a random practice group (n=13 woodwind, n=10 brass). At retention testing, the practice groups were divided into blocked and random retention testing orders.

Materials

One practice task was composed and then transposed into two additional keys (see Figure 1). With seven pitches, the tasks were designed to represent one motor unit. The transfer tasks were composed to present some of the same intervals as the practice tasks, but in different contexts.

Procedure

All sessions took place in a small room with the researcher present. Participants were recorded at 16 bit 44.1 kHz sampling rate with a Nady CM-60 miniature condenser lavalier microphone. This was connected to a PreSonus FireStudio interface into a MacBook Pro laptop running Cubase LE4 software.

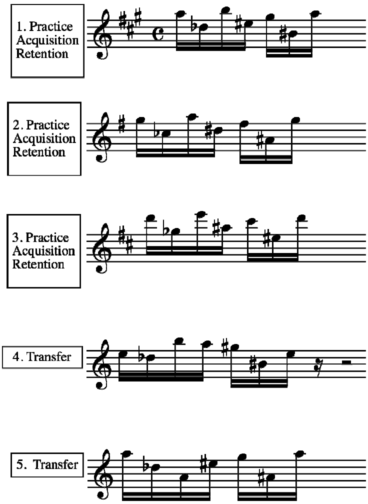

Figure 1. Musical tasks as presented to the flutists.

Each practice task was printed on a separate piece of paper. The music stand had a sheet of paper that listed the order of the practice trials. Participants were told to check off each practice trial as they completed it, to ensure they practiced the tasks in their assigned blocked or random practice order. In the blocked (repetitive) order, participants played nine trials of one task, then nine trials of another task, and finally nine trials of the third task. In the random order, participants played nine trials of each task but in a mixed up order (2 3 1 3 1 2 1 2 3...). A pencil and metronome were also available for use on the music stand.

The second practice trial occurred approximately 24 hours after the first practice session. After completing the practice trials on day 2, participants were told to write down the metronome marking they expected to play each of the three practice tasks when they started the research session on day 3.

On day 3, participants played three trials of each practice task in either a blocked or random order. Then they played the two transfer tasks in an alternating order. One week later participants again performed the retention and transfer trials. The research design was fully counterbalanced.

The trials of interest were each participant's final practice trials, termed "acquisition," the retention trials, and the transfer trials (1,863 trials). The trials were prepared for scoring by first creating master audio files with all the trials of each task placed in a random order. To score for accuracy, I listened to each trial repeatedly and employed a point-deduction system used in previous research (Stambaugh 2011; Stambaugh and Demorest 2009). To score the speed of each trial, the trials were imported into Audacity. I highlighted the onset of the first pitch to the onset of the last pitch and recorded the time generated by Audacity, to the hundredth of a second. To determine evenness for each trial, the average interonset interval (IOI) of the six intervals was determined (IOI_m) and subtracted from the IOI of each individual interval (IOI_x) in the trial. This produced six scores for the differences between individual IOIs and the mean within the trial. The sum of all difference scores ($\sum IOI\Delta$) was divided by the sum of the IOIs for the trial ($\sum IOI$).

RESULTS

The preliminary analysis examined retention order: within the blocked woodwinds, for example, did it matter if they played their retention trials in a blocked or random order? Four sets of t-tests for independent groups compared the retention order within blocked woodwinds, random woodwinds, blocked brass, and random brass for speed and accuracy. The *a priori* alpha level was set at 0.025 for each t-test. Only one within-group comparison was significant: woodwind blocked practice/blocked retention ($M=2.24$, $SD=0.33$) versus blocked practice/random retention ($M=1.42$, $SD=0.22$), $t_{10}=2.07$, $p=0.019$, for speed. Therefore, the practice-retention groups were collapsed to just practice groups for the remaining analyses.

Blocked versus random practice

Two covariate scores were used to control for individual abilities in playing: the accuracy and speed scores for the first practice trials. Analyses of covariance (ANCOVAs) examined within-practice group changes from acquisition to 24-hour retention and 1-week retention, as well as 24-hour transfer to 1-week transfer, for accuracy, speed, and evenness. The *a priori* alpha level was set at 0.016 per comparison. Table 1 presents the means and standard deviations for these comparisons. No main effects or interactions were found for accuracy for woodwinds, but a significant practice group by speed interaction was found, $F_{4,17}=4.232$, $p=0.015$. Woodwinds who used random practice were able to play significantly faster than woodwinds who used blocked practice. For accuracy by brass players, ANCOVAs indicated no significant differences for accuracy, but the blocked group approached a significant learning advantage for speed, $F_{4,13}=3.663$, $p=0.03$.

Table 1. Means (and standard deviations) for groups (woodwind [WW] and brass) at acquisition, 24-hour retention, and 1-week retention.

	Acquisition		*24-hour retention*		*1-week retention*	
	Accuracy	*Speed*	*Accuracy*	*Speed*	*Accuracy*	*Speed*
Blocked WW	6.06 (0.77)	1.52 (0.67)	5.62 (1.01)	1.94 (0.83)	5.94 (0.86)	1.87 (0.82)
Random WW	6.32 (0.52)	1.41 (0.43)	6.29 (0.72)	1.44 (0.33)	6.09 (0.64)	1.50 (0.44)
Blocked Brass	5.50 (0.65)	1.61 (0.32)	5.04 (0.68)	1.95 (0.35)	5.40 (0.72)	2.06 (0.55)
Random Brass	4.36 (1.22)	2.28 (0.96)	4.16 (1.26)	2.35 (0.76)	4.68 (1.44)	2.02 (0.56)

Table 2. Difference between predicted tempo and performed tempo (in beats per minute). Positive numbers indicate having predicted a faster tempo than having played. Negative numbers indicate having predicted a slower tempo than having played.

	Song 1	*Song 2*	*Song3*
Blocked WW	0.56	-2.47	5.87
Random WW	3.70	4.61	7.61
Blocked Brass	25.54	25.64	27.81
Random Brass	25.20	24.00	27.70

Judgment of learning

Pearson correlations were examined between musicians' predicted tempos and their actual performed tempos. Table 2 shows the mean difference between the predicted tempos and the actual tempos. Brass players consistently predicted faster tempos than they actually played, regardless of practice condition.

DISCUSSION

Previous research found that for beginning clarinet students learning short technical tasks, random practice was more effective than repetitive practice. These results were replicated with university-level clarinet players. However, blocked practice may be more effective for university brass players. This may be related to the greater cognitive demands already present in playing a brass instrument. Often, practice strategies are generalized for use with all instruments. Evidence from this research suggests it is important to validate the use of specific practice strategies with a variety of instruments. In addition, it is clear that brass students were highly inaccurate when assessing their own learning. Future research should investigate how brass students can become more reliable in assessing their learning.

Acknowledgments

This research was supported in part by a grant from Western Washington University.

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