Effects of Early and Late Rest Intervals on Performance and Overnight Consolidation of a Keyboard Sequence

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Abstract
Thirty-six nonmusicians practiced a five-element key-press sequence on a digital piano, repeating the sequence as quickly and accurately as possible during twelve 30-s practice blocks alternating with 30-s pauses. Twelve learners rested for 5 min between Blocks 3 and 4, another 12 learners rested for 5 min between Blocks 9 and 10, and the remaining 12 participants performed 12 blocks without an extended rest interval. All were retested following a night of sleep in six 30-s blocks with a 5-min rest interval between Blocks 3 and 4. Results show that the introduction of extended rest in the early and late stages of practice significantly affected rates of learning within and between sessions. Immediately following the 5-min rest intervals, participants showed large gains in performance, but only following early rest did participants continue to show improvements during training. Participants who rested early in practice also demonstrated the greatest overnight gains. Findings suggest that the temporal placement of rest in practice affected subsequent motor sequence learning and memory consolidation processes.

Keywords
motor skill learning, memory consolidation, practice

A shared goal among musicians is the development of effective and efficient practice techniques. Although research has examined the structure of musicians’ practice (Chaffin, Imreh, Lemieux, & Chen, 2003; Miklaszewski, 1989) and the strategies
used to facilitate memorization (Chaffin & Imreh, 1997, 2002) and develop skills in music (Chaffin et al., 2003; Coffman, 1990; Maynard, 2006; McPherson & Renwick, 2001; Nielsen, 1999a, 1999b; Williamon, Valentine, & Valentine, 2002), a great deal remains unknown about the neurophysical processes that underlie music learning.

Advances in research in psychology, kinesiology, and the neurosciences provide increasingly precise descriptions of the mechanisms involved in skill learning. Applying methods to the study of music practice that have shown to be reliable in the study of motor skill learning generally seems an advantageous approach to understanding the development of music skills. Doing so not only may contribute to the understanding of human skill development but also may further illuminate and even encourage reexamination of current practices in music teaching and learning.

The definition of learning encompasses the acquisition, refinement, and retention of new memories, but from the perspective of neurophysiology, the definition extends further, stressing that learning relies on experience-dependent plasticity of the brain that mediates changes in behavior (Ungerleider, Doyon, & Karni, 2002). As individuals learn, neural representations of new experiences are created and transformed, establishing representations of memories that are retrievable even after extended periods of time and without the need for relearning. Externally, changes in behavior often serve as indication that learning has taken place. In motor learning, for example, actions such as riding a bicycle, signing one’s name, or executing a passage on a musical instrument are observable and measurable behavioral outcomes of the covert neurophysical processes that ultimately are the foundation of skill learning.

As any musician can attest, learning and refining skills require practice, but less obvious is the fact that skill practice initiates the gradual recruitment of distinct functional anatomies that underlie memory acquisition. Early in practice, when learners commonly make sizeable gains in performance speed and accuracy, heightened neural activity is evident in brain areas implicated in the initial execution of skills (Bangert & Altenmüller, 2003). Later, as practice progresses and large gains give way to more modest, incremental improvements, separate structures that take a more active role in preparing memory for long-term storage are recruited (Doyon & Benali, 2005; Doyon et al., 2002; Penhune & Doyon, 2005; Petersen, van Mier, Fiez, & Raichle, 1998; van Mier, Perlmutter, & Petersen, 2004).

A considerable amount of research demonstrates that the functional reorganization of neural connections that comprise new memories persists even after practice ends, indicating that the cessation of practice does not imply the end of learning processes. Instead, newly formed memory representations undergo further transformation through the “off-line” process known as memory consolidation, and the behavioral outcomes of this process are observable when skills are recalled at a later time (Walker, 2005; Walker, Brakefield, Hobson, & Stickgold, 2003; Walker, Brakefield, Seidman, et al., 2003).

During consolidation-based stabilization, which takes place during the 4 to 6 hr following practice, memories become increasingly resistant to interference from
other stimuli, such as trauma or the introduction of competing behavioral tasks (Bourtchouladze et al., 1998; Muellbacher et al., 2002; Trepel & Racine, 1999). If completed without interruption, stabilization of skill memory is reflected in the maintenance of performance levels reached at the end of practice (Brashers-Krug, Shadmehr, & Bizzi, 1996; Shadmehr & Brashers-Krug, 1997; Shadmehr & Holcomb, 1997).

Further consolidation-based modifications in neural structure and function occur during periods of sleep following practice, including overnight sleep and daytime naps. The effects of these changes are evident in faster and more accurate performance when skills are recalled (Brashers-Krug, Shadmehr, & Bizzi, 1996; Shadmehr & Brashers-Krug, 1997; Shadmehr & Holcomb, 1997). Consolidation-based enhancement has been observed in perceptual skills (Atienza, Cantero, & Dominguez-Marin, 2002; Atienza, Cantero, & Stickgold, 2004; Gaab, Paetzold, Becker, Walker, & Schlaug, 2004; Karni, Tanne, Rubenstien, & Askensy, 1994; Stickgold, James, & Hobson, 2000; Stickgold, Whidbee, Schirmer, Patel, & Hobson, 2000), in motor skills (Kuriyama, Stickgold, & Walker, 2004; Maquet, Schwartz, Passingham, & Frith, 2003; Walker, Brakefield, Hobson, et al., 2003; Walker, Brakefield, Seidman, et al., 2003), and in the behaviors of trained musicians (Allen, 2008; Simmons & Duke, 2006) and novices (Duke & Davis, 2006) practicing motor tasks relevant to music performance.

Despite extensive evidence supporting memory consolidation hypotheses, there remain a number of inconsistencies regarding the behavioral effects of these phenomena. For example, performance enhancements have been found to develop across sleep and waking hours for certain types of procedural tasks (Atienza & Cantero, 2001; Robertson, Press, & Pascual-Leone, 2005; Roth, Kishon-Rabin, Hildesheimer, & Karni, 2005; Simmons, 2007; Simmons & Duke, 2006). Significant enhancements in motor skill performance also have been observed only moments after skill practice ends, prior to extended periods of consolidation (Hotermans, Peigneux, Maertens de Noordhout, Moonen, & Maquet, 2006). Hotermans and colleagues (2006) reported in their study a significant “boost” in motor sequence performance when practice resumed following a rest interval of either 5 or 30 min.

Naturally, these findings raise questions regarding the potential for performance enhancements across periods of wake and, in particular, across intervals of rest lasting just minutes. Hotermans et al. (2006) suggested that the behavioral improvements observed after brief rest periods may be associated with the same neurophysical processes that underlie changes in skill following much longer temporal intervals. If this indeed is the case, it may be appropriate to assume that enhancements following brief periods of rest are indication of another facet of memory consolidation that has yet to be fully understood.

Although the systematic study of rest in the context of motor sequence learning is rather limited, there is a long history of investigation regarding the influence of rest on verbal learning and on pursuit-rotor skills, which require learners to track a moving target (Eysenck & Frith, 1977). In the extant literature, the term reminiscence,
coined by Ballard (1913), is used to label performance enhancements that develop during rest intervals ranging anywhere from seconds to days (Eysenck & Frith, 1977). However, the definition of reminiscence has been refined to specify improvements developing across rest periods of minutes and that revert, after a limited number of repetitions, to performance levels prior to rest (Denny, 1951). Such effects are distinguished from enhancements following overnight periods of memory consolidation that are sustained across subsequent practice (Holland, 1963).

Rest is undoubtedly a common element in skill practice, but little is known about how intervals of rest function in the context of music learning. The development of motor skill in music across periods lasting hours and days has been addressed lately in the work of Duke, Allen, Davis, and Simmons (Allen, 2008; Duke & Davis, 2006; Simmons & Duke, 2006) and, prior to these investigations, in the landmark studies of Rubin-Rabson (1940), whose findings were the first to indicate that rest influenced the rate of learning in music. As evidence suggests, resting from skill practice for any length of time may do more than merely provide opportunity for recovery from mental or physical fatigue.

The purpose of the present study was to investigate the conditions that lead to changes in novices’ performance of a simple keyboard sequence following 5-min rest intervals. In prior investigations, performance enhancements following rest have been observed primarily during later stages of practice, when performance is typically stabilized. In this study, I tested the extent to which the insertion of rest either late in practice or early in practice, when large gains in performance are common, affected performances during training and following a period of overnight sleep.

**Method**

Participants were 36 undergraduate and graduate students in the Sarah and Ernest Butler School of Music at the University of Texas at Austin (20 females [F]; $M_{\text{age}} = 20.80, SD = 4.57$). All were right-handed nonmusicians who had had fewer than 3 years of formal instruction on a musical instrument and had participated in no music-making activities in the 5 years preceding the experiment. Participants agreed to abstain from caffeine, alcohol, and mind-altering substances 12 hr prior to and during their participation in the study. The experiment was approved by the institutional review board at the University of Texas at Austin, and participants received monetary compensation for their participation.

Participants learned to play a five-element sequence with their left (nondominant) hand on a Roland KR-4700 digital piano with full-size, fully weighted keys. Participants performed the sequence 2-5-3-4-2 (numbers indicate traditional piano fingerings; 2 represents index finger, 3 represents middle finger, etc.) on the keys F3, G3, A3, and B3. The sequential task is identical to that used in similar studies in which participants practiced on a piano keyboard (Duke & Davis, 2006) or a computer keyboard (Hotermans et al., 2006; Kuriyama et al., 2004; Walker, Brakefield,
Hobson, et al., 2003; Walker, Brakefield, Seidman, et al., 2003). Sound on the digital piano was turned off for the duration of the procedure to isolate the motor component of the task.

Throughout the procedure, learners viewed the sequence fingering on a 12-inch Apple PowerBook computer mounted at the level of the keyboard’s music rack. Below each finger number on the screen was a circle that illuminated each time a key was pressed. The circles illuminated in order from left to right, regardless of whether participants pressed a correct key, thus helping participants maintain their place in the sequence without providing key-press accuracy feedback.

At training, which took place in the evening between the hours of 8:00 and 10:30 p.m., participants were instructed to repeat the sequence from beginning to end as quickly and accurately as possible in twelve 30-s practice blocks. Each training block was followed by a 30-s pause, during which participants turned away from the keyboard and computer screen.

To examine the effects of extended rest intervals on skill learning, participants were randomly assigned one of three experimental conditions. For 12 learners, a 5-min rest interval was introduced in place of the 30-s pause between Blocks 3 and 4 (early rest); for another 12 learners, a 5-min rest interval was introduced in place of the 30-s pause between Blocks 9 and 10 (late rest). The remaining 12 participants practiced for 12 blocks without an extended rest interval (no rest). During the 5-min rest intervals, I casually conversed with participants until the rest interval had expired, after which practice immediately resumed.1

Retest sessions were conducted in the morning between 8:00 and 10:30 a.m., approximately 12 hr after the training sessions and following a night of sleep. At retest, participants repeated the sequence for six 30-s practice blocks. A 5-min rest interval was inserted in place of the 30-s pause between Blocks 3 and 4 for all participants, regardless of whether they had rested for 5 min at training the evening before.

Musical instrument digital interface (MIDI) data from training and retest sessions were collected using software written specifically for this experiment based on Max/MSP Runtime, Version 4.5.2 (Puckette & Zicarelli, 2004). Performance of the sequence was assessed in terms of the mean number of correct key presses per 30-s block (CKP/B). This dependent measure, identical to that used in a previous study with similar protocols (Duke & Davis, 2006), combines the variables of speed (total number of key presses performed in a 30-s block) and accuracy (number of key presses in a block that were correct).

I analyzed performance in terms of the mean CKP/B for each set of three 30-s practice blocks (Blocks 1–3, 4–6, 7–9, and 10–12 of training and Blocks 1–3 and 4–6 of retest). This procedure provided a more stable measure of skill than comparing individual block means. Changes in performance between successive block triplets were calculated, providing difference scores at five time points across training and retest that were then used to evaluate learning among groups and over time.
Results

Sleep and Alertness

Participants reported an average of 6.99 hr ($SD = 1.98$) of overnight sleep prior to training and 6.44 hr ($SD = 1.02$) of sleep prior to retest. There were no systematic differences among groups in terms of hours slept prior to training, $F(2, 33) = 0.42$, $p > .66$, or prior to retest, $F(2, 33) = 0.72$, $p > .50$. I found no relationships between hours slept prior to training and the following variables: performance at the beginning of training, $r(34) = .09$, $p > .61$; performance at the end of training, $r(34) = -.06$, $p > .74$; and performance improvements from the beginning to the end of training, $r(34) = -.16$, $p > .34$. I also found no relationship between performance improvements observed at retest and hours slept in the preceding night, $r(34) = .20$, $p > .24$.

At the start of each session, participants rated their level of alertness using the Stanford Sleepiness Scale, a 7-point scale with 1 representing *feeling active, alert, vital, and awake* and 7 representing *asleep* (Hoddes, Zarcone, Smythe, Phillips, & Dement, 1973). Participants reported a mean sleepiness rating of 2.28 ($SD = 0.91$) at the start of training and 2.32 ($SD = 0.98$) at retest. No significant differences were found among experimental groups in terms of reported sleepiness ratings prior to training, $F(2, 33) = 1.49$, $p > .10$, or prior to retest, $F(2, 33) = 0.51$, $p > .60$. There were no relationships between sleepiness rating at training and performance at the beginning of training, $r(34) = .15$, $p > .37$; performance at the end of training, $r(34) = .10$, $p > .55$; or improvements made from the beginning to the end of training, $r(34) = -.02$, $p > .88$.

Performance Data

Overall, there was an increase in CKP/B for all groups during training, from 36.81 ($SE = 2.69$) at Block 1 to 91.92 ($SE = 3.62$) at Block 12, a 149.7% improvement. There was an additional 16.9% increase between the last block of training and the last block of retest (107.44 CKP/B, $SE = 4.11$). Whereas all groups made improvements in CKP/B within and between sessions, marked increases in the rate of learning were clearly evident following 5-min rest intervals (e.g., at Blocks 4 for the early-rest group and at Block 10 for the late-rest group; see Figure 1).

Figure 2 shows the mean CKP/B for each three-block triplet. I was most interested in the changes in performance after intervals of rest, specifically, the 5-min intervals interposed during training and retest and the overnight interval. I compared the difference scores, which represent the extent of improvement over time, between successive block triplets in a 3 (group) × 5 (difference score) repeated-measures ANOVA. I found significant differences among the five difference scores, $F(4, 132) = 31.05$, $p < .001$, $\eta^2_p = .49$; no significant differences among groups overall, $F(2, 33) = 2.26$, $p > .12$; and significant Group × Difference Score interaction, $F(8, 132) = 4.198$, $p < .001$, partial $\eta^2_p = .20$. The results of the statistical test indicate that
the rate of learning differed across the course of the experiment, as is evident in the figures, and that the extended rest intervals during training differentially affected the rates of learning among groups. Results below describe changes in performance across each of the five intervals separating consecutive block triplets.

**Learning Between Block Triplets 1-2-3 and 4-5-6 of Training**

All group performances improved between Block Triplets 1-2-3 and 4-5-6 of training, with learners in the early-rest group showing the greatest gains: an average increase of 33.61 CKP/B ($SE = 3.03; +65\%$) as compared to 23.39 ($SE = 2.44; +47\%$) in the late-rest group and 20.28 CKP/B ($SE = 2.86; +44\%$) in the no-rest group.

More specifically, although the rates of learning during the first three blocks of practice were similar across all groups, differences between groups became immediately apparent at Block 4, where the performance of learners who had rested for 5 min (early rest) was superior to the performance of the other two groups (77.33, $SE = 4.34$; compared to late rest, 66.92, $SE = 5.40$; and no rest, 64.75, $SE = 6.96$). By Block 6, learners in the early-rest group had reached an average of 90.42 CKP/B ($SE = 5.70$), markedly higher than mean performances of the late-rest (78.25 CKP/B, $SE = 5.32$) and no-rest (70.00 CKP/B, $SE = 6.70$) groups.
Compared to changes made between Block Triplets 1-2-3 and 4-5-6 of training, the rates of skill learning between Block Triplets 4-5-6 and 7-8-9 decelerated in all groups. Performances between the second and third block triplets of training improved an average of 7.17 CKP/B ($SE = 2.28; +8\%$) in the early-rest group, 7.22 CKP/B ($SE = 1.20; +10\%$) in the late-rest group, and 9.98 CKP/B ($SE = 3.02; +15\%$)
in the no-rest group. No considerable changes in the performance of any group are evident between Blocks 5 and 9, nor were they expected, given that an extended rest interval was not introduced for any groups during this time.

**Learning Between Block Triplets 7-8-9 and 10-11-12 of Training**

With the exception of improvements made by participants in the late-rest group, the rate of learning between Block Triplets 7-8-9 and 10-11-12 of training indicated further deceleration—recognized as the stabilization of skill performance common in the later stages of initial practice. The introduction of a 5-min rest interval between Blocks 9 and 10 for learners in the late-rest group, however, altered the course of expected improvements. Performance of this group increased by an average of 13.03 CKP/B ($SE = 2.56; +16\%$), compared to increases of only 3.97 CKP/B ($SE = 2.39; +4\%$) in the early-rest group and 4.64 CKP/B ($SE = 1.35; +6\%$) in the no-rest group.

Although CKP/B of the late-rest group was markedly improved when practice resumed after the 5-min rest interval, learners’ performance declined by an average of 4% between Blocks 10 and 12. Although slight, this was the only instance of a performance decrement for any of the groups across training and retest sessions.

**Learning Between Block Triplet 10-11-12 of Training and Block Triplet 1-2-3 of Retest**

To examine overnight, sleep-dependent learning across a 12-hr period, performances were compared between the last three blocks of training, Block Triplet 10-11-12, and first three blocks of retest, Block Triplet 1-2-3. An increase in mean CKP/B of 14.22 ($SE = 1.66; +15\%$) was observed in the early-rest group. Across the same interval, the late-rest group improved by 1.86 CKP/B ($SE = 2.71; +2\%$), and the no-rest group increased by 9.36 CKP/B ($SE = 2.75; +12\%$).

**Learning Between Block Triplets 1-2-3 and 4-5-6 of Retest**

Performance changes between Block Triplets 1-2-3 and 4-5-6 of retest were compared to examine the effects of a 5-min rest interval on a recently consolidated motor sequence. All groups showed improvements in performance following 5-min rest intervals at retest, regardless of whether they had rested at training: 7.67 CKP/B ($SE = 2.77; +7\%$) for the early-rest group; 7.28 CKP/B ($SE = 3.01; +8\%$) for the late-rest group; and 8.78 CKP/B ($SE = 1.74; +10\%$) for the no-rest group.

**Discussion**

The results are consistent with extant behavioral data, including those reported by Hotermans et al. (2006), which suggest that rest intervals of minutes provide sufficient time for neural processes that develop absent practice to yield enhancements in
the subsequent performances of motor skills (Eysenck & Frith, 1977; Hotermans et al., 2006). Furthermore, results of this study extend previous findings by showing that the temporal placement of rest during practice had differential effects on within-session performance and on between-session, overnight memory consolidation processes.

**Effects of Early Rest in Practice**

In the early stage of acquisition, learners typically exhibit sizeable gains in speed and accuracy as they adapt to new experiences. The current study shows that the introduction of a 5-min rest interval near the beginning of practice, when significant gains in performance were already occurring, resulted in continued improvements both during and following the rest interval. This is different from other observations of reminiscence, which in the past have consistently shown decrements in performance subsequent to postrest enhancements (Eysenck & Frith, 1977), much like that observed in the late-rest group in the experiment reported here. When learners did not rest for an extended interval following three blocks of practice (as in the no-rest and late-rest groups), performance improvements began to decelerate, a common occurrence after the initial stage of skill practice.

The continued improvements observed following early rest during training may indicate that extended rest periods early in the course of practice allow the neural processes triggered by repetition—and perhaps consequently attenuated during sustained practice—to develop fully while learners are physically at rest. Learners’ continued rates of improvement following the 5-min rest period, specifically between Blocks 4 and 5, may signify that the ability to produce sizeable gains in performance, typically limited to early practice, is extended by the rest period.

The data also show that the effects of extended rest periods early in practice may be far-reaching in that learners who achieve an overall higher level of skill execution sooner in practice may have the capacity for greater overnight enhancements. It may be that resting early in practice allows individuals to improve their skill at a faster rate early on, affording them more repetition at that skill level before practice ends. The added practice may increase the likelihood of a more stabilized skill memory and, subsequently, greater overnight enhancements.

**Effects of Late Rest in Practice**

Current descriptions of motor acquisition suggest that following large performance gains early on in practice, meaningful skill improvements are rare and often observable again only following periods of postpractice sleep (Walker, 2005). The results I report here show that although performance had stabilized in the second half of practice for all learners, a rest period of 5 min introduced before the last three practice blocks yielded gains similar in magnitude to enhancements expected early in practice or following overnight sleep.
Nevertheless, the impact of extended rest late in practice appears limited in that after the immediate postrest enhancement in skill, there were no further gains in performance during training and following overnight sleep. The lack of continued improvements both within and between sessions may imply that after performance is stabilized, rest in the later stages of practice does little to influence subsequent memory consolidation processes. Instead, postrest behavioral improvements may simply serve to predict the extent to which performance may improve after a night of sleep. Hotermans et al. (2006) addressed this possibility by examining the relationship between behavioral outcomes following within-session, extended rest periods and off-line, overnight improvements. In addition to noting differences between the last blocks of training and the first blocks of retest, the authors also analyzed the rate of learning between the last two blocks of training prior to extended rest intervals and the first two blocks of retest and found a significant relationship between improvements after brief rest periods and enhancements after a night of sleep. In the present study, when differences were compared between the late-rest group’s last block triplet before the rest period (Block Triplet 7-8-9) and the first block triplet of retest, I observed overnight enhancements similar to those of the early- and no-rest groups. A strong correlation also was found between the late-rest group’s performance enhancements after rest and the magnitude of change after a night of sleep, \( r(10) = .70, p < .01 \).

**Effects of Rest on Recently Consolidated Skill Memory**

Although the rates of enhancement after a night of sleep varied between groups, performance gains were similar for all groups during retest. Additionally, all learners showed performance improvements following a 5-min rest period introduced halfway through retest sessions. Results support the notion that recalled skills also benefit from rest intervals (Hotermans et al., 2006); however, in the present study, no control group existed to compare performance improvements in the absence of the rest interval. Nevertheless, Walker, Brakefield, Hobson, et al. (2003) suggested that when consolidated memories are retrieved, they are againlabile and susceptible to interference, requiring a period of reconsolidation. Reactivated memories may be predisposed to further modifications through practice and during subsequent periods of rest, although further study is needed to formally test for this hypothesis in motor sequence learning.

**Basis for Enhancements Following 5-Min Rest Intervals**

In previous investigations of reminiscence effects, the basis for postrest enhancements is often attributed to one of several explanations, including that rest allows either for the dissipation of practice-induced physical or mental fatigue (Heuer & Klein, 2003) or for the reduction of neural inhibitory effects amassed during repetition (Ammons, 1947; Kimble, 1952). In the present study, it is unlikely that fatigue played a role in the performance of the motor sequence. Practice blocks of 30 s were
alternated with 30-s pauses precisely to combat physical and psychological fatigue accumulated during repetition. On the other hand, the conjecture that rest supports learning-induced neural processes that are otherwise suppressed by sustained repetition is certainly viable and may explain the results of this study. Prior research suggests that posttraining memory consolidation processes develop after practice ends and learners are at rest from physical activity. It is conceivable that any opportunity for rest from skill practice, albeit for only a few minutes during the earliest stages of learning, may allow for memory processing events to initiate, advantaging learners when practice resumes.

Results of this study also bring attention to the permanence of behavioral enhancements following rest. The currently understood definition of reminiscence proposes that unlike gains observed after several hours of memory consolidation, reminiscence effects are short-lived and rarely sustainable within a given practice session. Previous research has shown that when practice resumes after rest, the elevated performance regresses to that of prerest levels after a limited number of repetitions (Eysenck & Frith, 1977; Hotermans et al., 2006). In the current study, although performance in neither of the two groups who rested for 5 min during practice reverted to prerest levels, a slight decline in skill across the blocks that followed late rest may suggest that the postrest enhancements were temporary. Interestingly, this effect was not observed in the early-rest group, which continued to show gains in CKP/B following the initial, postrest enhancements. Thus, the theory that behavioral effects observed following brief rest periods diminish across subsequent repetitions may be applicable only to skill performance that has stabilized. Introducing a rest interval in the early stages of practice, when learners are producing large gains in performance, may be of more benefit because the capacity to make large improvements still exists when practice resumes.

Given the interesting implications of these results, it is tempting to make generalizations to music-learning contexts. It would be premature to do so at this time, however, because obviously there is a large discrepancy between the method in which skills were acquired in this experiment and the way music skills are typically practiced in authentic settings. Certainly, these results only begin to clarify how musicians acquire skills during periods of practice, but more importantly, they provide the necessary groundwork for the development of more precise experimental methods to better study the complex behaviors of musicians.

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Note

1. A few participants left the room during the 5-min rest period to visit the restroom or get a drink of water. I compared the performance of those who left the room with the performance of those who sat with me during the entirety of the rest period and found no differences in changes in their performance levels following the rest.

References


**Bio**

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