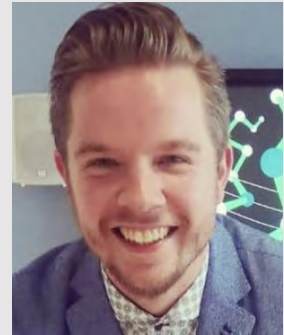# Afgestudeerd

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Project: Learning to play music. Exploring massed versus distributed
             practice regimes for non-musicians
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Introduction

What are the most effective practice strategies for learning to play an instrument? The goal of this study is to establish a deeper understanding of the acquisition of musical skills. Palmer and Meyer (2000) stated that the ability of playing an instrument is a highly complex task on different levels. First, there are motor requirements, such as finger and hand movements and coordination. Secondly, there is a conceptual structure, such as pitch, rhythm and harmony.

Motor learning is a mental or physical change in the capability to (re)producing actions that are result from practice or experience (Palmer & Meyer, 2000). Closely related to this is motor sequence learning which refers to the skill acquisition of effortlessly executing a movement sequence in a fast and accurate pace, with limited attentional monitoring (Abrahamse, Ruitenberg, de Kleine & Verwey, 2013). This skill can be obtained by repeating a small sequence of movements until it can be accurately reproduced.

Hallam (1997) studied if there were differences in practice strategies between beginning musicians and more advanced musicians. While studying 55 string players ranging from beginner to post-grade 8 standard, she found six levels of practice in which the first level represents beginner strategies and the sixth level represents advanced musicians' strategies. At the first level there was a lot of inefficient use of practice time, due to long pauses between sections and the materials were not played through entirely. The music was played through at the second level, without errors being corrected. Single notes were corrected at the third level. At the fourth level, the music pieces were played through with repetition of short sequences. At the fifth level large sections were practiced throughout the material. At the last level, the musician played the whole piece through. The difficult parts were marked and these parts were separately rehearsed (Hallam, Rinta, Varvarigou, Creech, Papageorgi, Gomes & Lanipekun, 2012). Hallam (2001) found that when expertise increases, the length of single practice sessions increased, while the number of practice days per week did not. This suggested that novice musicians take more frequently, shorter practice sessions distributed across the week.

In a study conducted by Simmons (2012), the effects of massed practice (all sessions performed on the same day) and distributed practice (sessions performed across two or more days) on experienced learners' performance were examined. The results showed significant improvements in performance accuracy only in the second practice session for the group with a rest period of 24 hours. According to Simmons and Duke (2006) this effect could be explained by consolidation, which is a process whereby motor skills and procedural memories become resistant to forgetting and interference from other stimuli, when time passes by (Walker & Stickgold, 2004; Simmons & Duke, 2006; Simmons, 2012; Cash, 2009).

Objective

Because the majority of music research focusses on people with prior musical knowledge and barely include subjects who are not familiar with playing an instrument at all, the goal of this present study was to see what the effect of massed versus distributed practice is on learning to play a song on the piano, for participants without prior musical experience and/or a musical background. In the light of the study conducted by Simmons and Duke (2006) and Simmons (2012), it was expected that distributed practice regimes improve the performance accuracy more than massed practice regimes, for non-musicians as well. An additional objective was to develop a methodology to investigate this issue including measures for musical performance.

Methods

A total of 40 participants without musical experience participated in this study, aged 18-35 years old. Participants were right-handed, 18 years or older and physically able to control a keyboard.

Participants learned to play a modified version of the song 'Hallelujah' (arranged by the researcher) on a MIDI keyboard by using their right-hand. The experiment consisted of two practice regimes. The first training
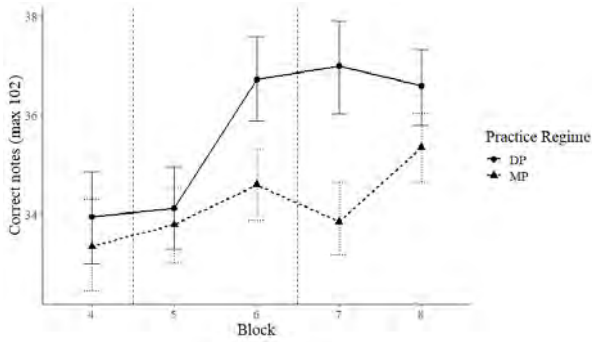
Figure 1. Line chart of correctly played notes per block and per practice regime. The error bars represent one standard deviation. The vertical dashed lines represent the transitions from day 2 to day 3 and day 3 to day 4 for the DP regime.

Figure 2. Line chart of mistakes per block and per practice regime. The error bars represent one standard deviation.

Figure 3. Line chart of duration accuracy per block and per practice regime.

regime, massed practice (MP), consisted of a single two-hour long session. The session was divided into eight blocks of ten minutes each with a five-minute rest between each block. The second training regime, distributed practice (DP), consisted of four 30-minute long sessions on four consecutive days. Each session for the distributed practice regime consisted of two blocks of ten minutes each with a five-minute rest between them. The contents of each block were the same for both conditions, from which the first three blocks were practice blocks and the last five blocks were the actual test blocks used for analysis. The experiment used a 2x5 mixed design with the dependent variables being *correctly played notes*, *mistakes* and *duration accuracy*. The independent variables were the two practice regimes and the five test blocks. A custom written script in R, a programming language for statistical computing, was used for analysis.

Results

The number of correctly played notes was significantly affected by the practice regime condition. As hypothesized, participants with a DP regime played more correct notes compared to participants in the MP regime (Figure 1).

There also was a significant interaction between the blocks and practice regime. The DP regime played more notes correctly in the blocks after a night of sleep, compared to the previous blocks. The MP regime did not have a significant higher score between these blocks.

This indicates that the effect of consolidation did occur within a distributed practice regime.

For mistakes, both practice regimes played fewer incorrect notes as the experiment progressed (Figure 2). The number of mistakes was also significantly affected by the practice regime condition. As hypothesized, participants with a distributed practice regime played fewer incorrect notes compared to participants in the massed practice regime.
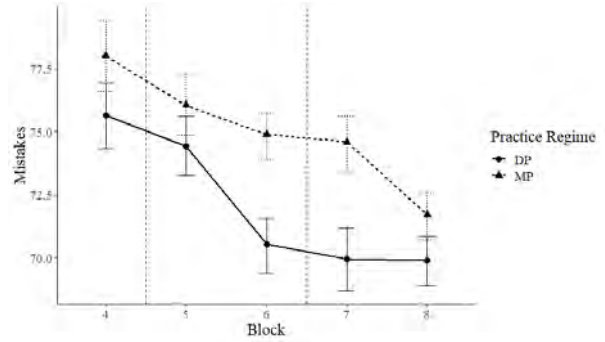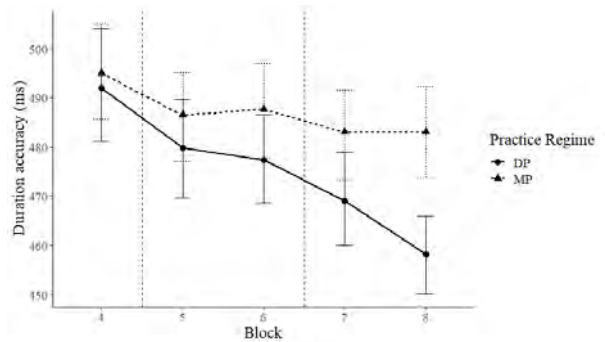
However, there was no significant interaction effect found between the blocks and practice regimes, which indicates that overnight consolidation did not occur.

The final part of the analysis consisted of the absolute note duration accuracy of correctly played notes, compared with the corresponding note duration from the original song file. The results of both practice regimes are graphically displayed per block in milliseconds (ms) in Figure 3.

Results show that the length of note deviation significantly decreased over time. Both practice regime's timing accuracy improved as the experiment progressed.

Participants with a distributed practice regime did not have a significantly smaller deviation in absolute note duration than participants in the massed practice regime.

Finally, no significant interaction was found between the blocks and practice regimes. This again indicates that there was no effect of consolidation for timing accuracy performance.

Discussion

We found that when a distributed practice regime is applied, participants indeed perform better than when a massed practice regime is applied. The DP regime played more notes correct and made fewer mistakes. For duration accuracy there were no significant differences between the practice regime, although a trend is visible in favour of the DP regime (see Figure 3).

The effect of overnight consolidation was only found for the number of correct notes within the DP Regime. Surprisingly, consolidation did not only occur at the first night. It also occurred at the second night with a slightly higher effect size. This finding contradicts the results of the study conducted by Simmons (2012), in which the third session did not show significant accuracy improvements compared to the second session. An explanation can be that from Block 1 to 3, the tempo was determined by the input of the participant. Block 4 was the first block in which the tempo was set at 60bpm. It seems that the participants needed time to adjust to this set tempo, which might explain the low number of correctly played notes in Block 4 and Block 5. From Block 6 the participants of the DP Regime seemed to improve their score, which suggests that they got used to the set tempo.

This study offers an exciting new method for teaching how to play a piano, for complete beginners who are not able to read sheet music. Furthermore, the custom written script in the programming tool R, enables researchers to analyse large amounts of MIDI data all at once, which was largely done before manually. It also makes it possible to analyse complete musical pieces at once, instead of breaking it down into small chunks. This new way of analysis not only saves time, it is also a safer and more consistent method for analysis.

This study further confirms that sleep has a positive effect on performance for complete beginners, which was mainly examined with experienced learners only in most similar studies.

This study obviously has its limitations. The song which the participants had to learn consisted of 102 notes. At the end of the experiment, DP regime participants managed to play only around 36.5 correct notes against 70 mistakes. This suggests that the task appeared to be too difficult for the participants to perform. It is recommended to let participants practice in a familiar environment to reduce this possible internal validity threat. This can be established by handing out the required software and hardware to the participant with instructions and let them practice at home.

Furthermore, some participants told that the task was very repetitive towards the end and this affected their focus and motivation. A possible solution to increase a participant's intrinsic motivation is to add game elements in non-game context. This so-called gamification rewards the participant as they progress (Buckley, DeWille, Exton, Exton & Murray, 2018; Buckley & Doyle, 2016; Wagner, 2017). Even though the program used (Synthesia) provides feedback on the performance of the player (for example the number of correctly played notes in a row), the appearance of the program is quite simplistic. When a more sophisticated interface is used, it might help to keep the participant focussed. Of course, this interface should not distract the participant from performing the actual task.

Finally, for future studies it is recommended to increase the duration of the experiment. Participants in both practice regimes did not seem to reach a ceiling across the blocks, so it is likely that continued improvements in performance would be observable when more sessions were held. According to Ericsson, Krampe and Tesch-Römer (1993), around 10,000 hours of deliberate practice are needed distributed across one decade, for mastering a skill like piano playing. This statement stands in sharp contrast with the two hours of practice in this study.

Conclusion
Despite the limitations that came to light in this study, it can be concluded that it offers an interesting starting point for further research on musical skill acquisition for both untrained and trained musicians. It confirmed that distributed practice has a greater effect on skill acquisition than a massed practice regime. This difference was substantiated by the effect of sleep-based consolidation. This present study offers a valuable and interesting new method for gaining insight in the development of practice strategies and skill acquisition for (non)musicians. With further development of training regimes based on distributed practice, the answer to what kind of practice makes perfect, might be right around the corner.

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