

Changing our automatisms: the effect of implicit and explicit processes

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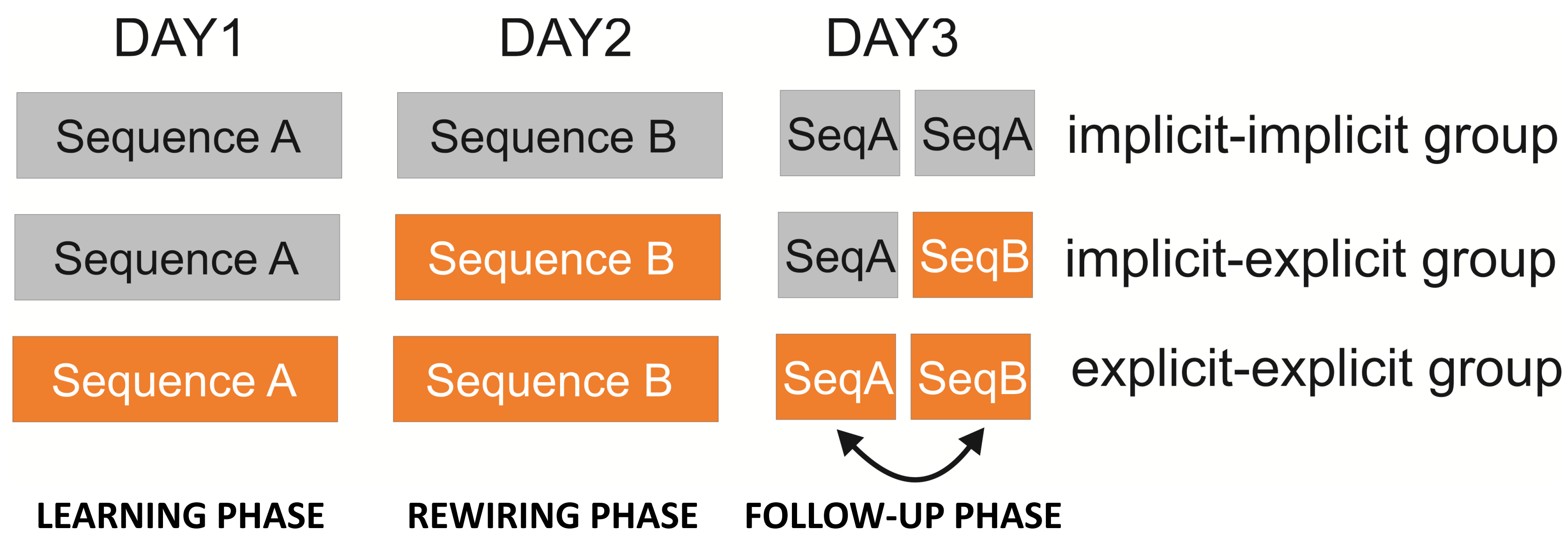
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Aim of the study

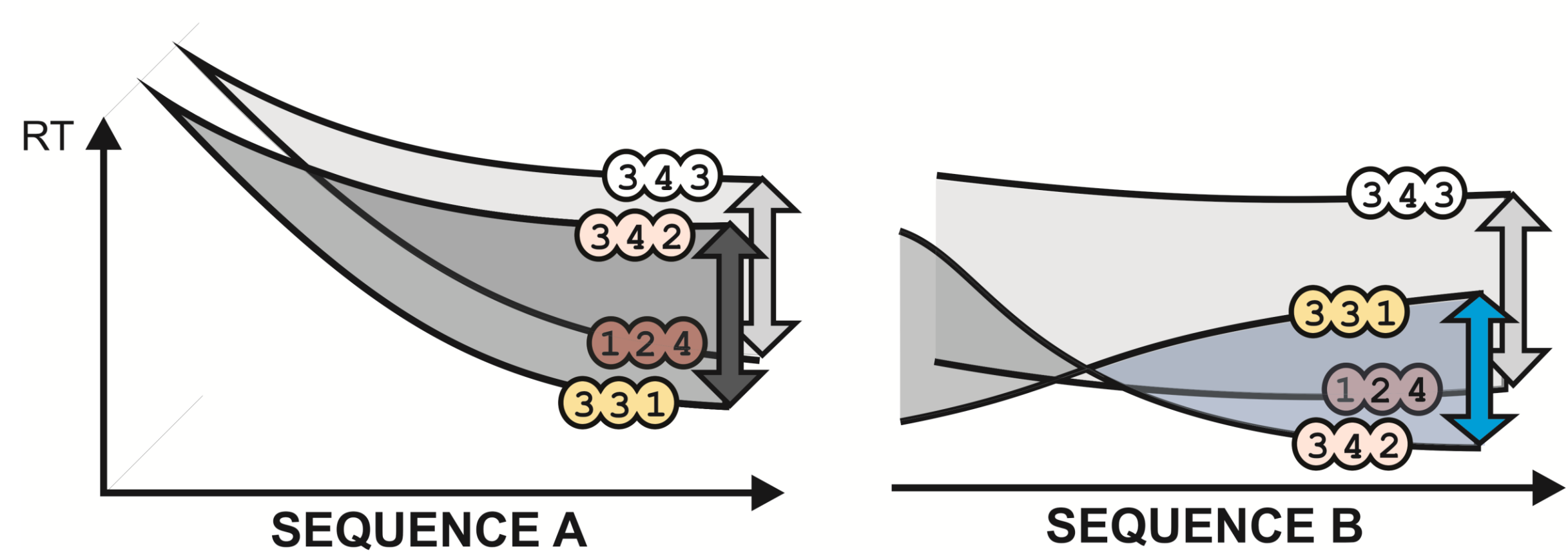
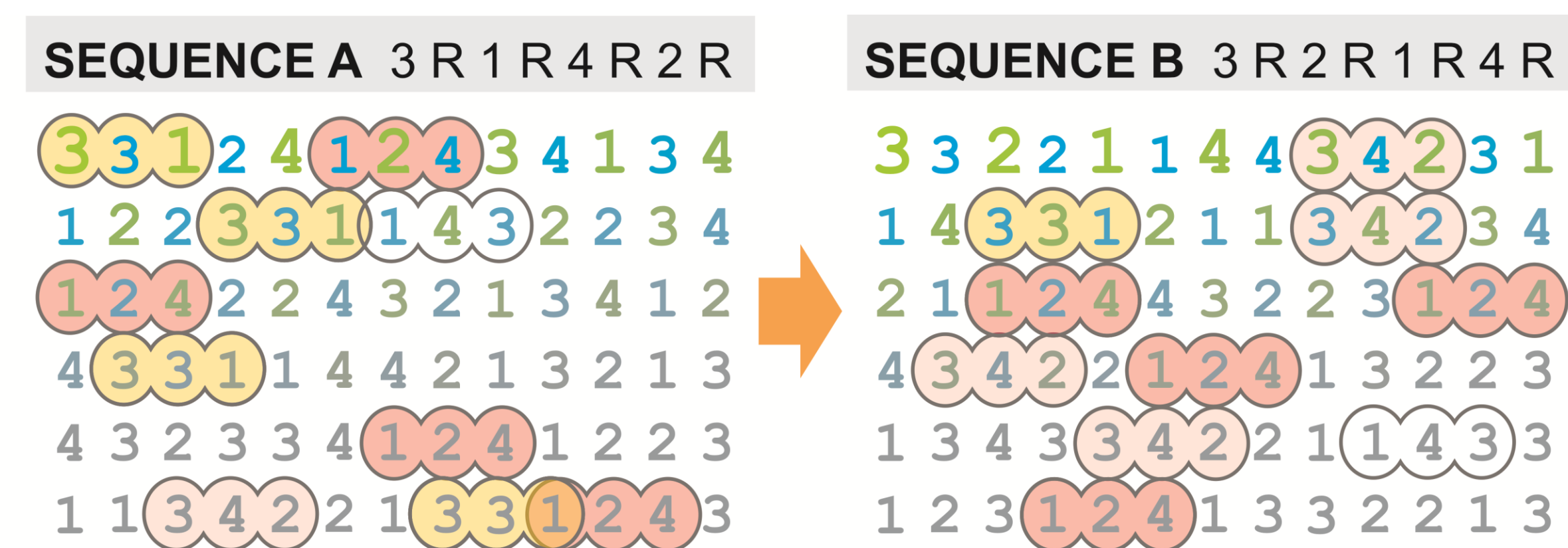
Skill modification can be empirically tested by teaching two differing sequences of regularities to participants. Characterizing the interference between the first-learned sequence and the newly encountered one is the key to understand the rewiring process. Retroactive interference can hinder our ability to activate old sequence knowledge once new regularities have been learned; likewise, our previously developed automatisms can make it more difficult to learn new regularities. Our goal was to assess the impact of implicit and explicit processes on skill modification (i.e. on interference effects).

Procedure and Analysis



Two different sequences were taught on two consecutive days of the study (Learning Phase and Rewiring Phase). Statistical learning for both sequences was assessed on the third day (Follow-up Phase) in counterbalanced order.

Three groups of participants were compared: in the Implicit-Implicit group, participants learned both sequences implicitly (thus rewiring was also implicit); the members of the Implicit-Explicit group learned the first sequence implicitly and the second sequence explicitly; the Explicit-Explicit group learned both sequences explicitly. In the Follow-up Phase both sequences were performed under the same conditions as the original learning.



The two sequences' statistical structure was partially different. Some transitions were frequent in both sequences, other were frequent in only one of the sequences, and some were infrequent in both.

We expected shorter reaction times to the final elements of frequent transitions than to final elements of infrequent transitions (e.g. faster reactions to 331 and 124 than to 342 and 343 when performing Sequence A; but faster reactions to 124 and 342 than to 343 and 331 when performing Sequence B). Statistical learning was measured as difference in reaction times given to final elements of frequent vs. infrequent transitions (Statistical Learning Effect, SLE).

SLE was separately calculated for the never changing statistical dependencies (**SLE for unchanched transitions**, e.g. reaction time to 124 is expected to be shorter than reaction time to 343 in both Phases; SLE is shown by **light gray arrows**) and for the changing dependencies (**SLE for changed transitions**, e.g. shorter reaction times to 331 than 342 during Sequence A – **dark gray arrow** –, and the opposite pattern during Sequence B – **blue arrow**). This way we could compare learning with and without interference from the previous day by contrasting SLEs for the unchanged transitions and SLE for the changing transitions over the Phases.

Conclusions

The dynamics of rewiring shows a complex picture: proactive interference (which works against rewiring) was stronger when learning and rewiring was implicit, while explicit cues about the changed regularities helped to speed up the rewiring process. After the 24 hours consolidation period, however, retroactive interference was volumed up while proactive interference was volumed down; furthermore, group differences were no longer observed. These results point to the critical role of the consolidation period.

Acknowledgments

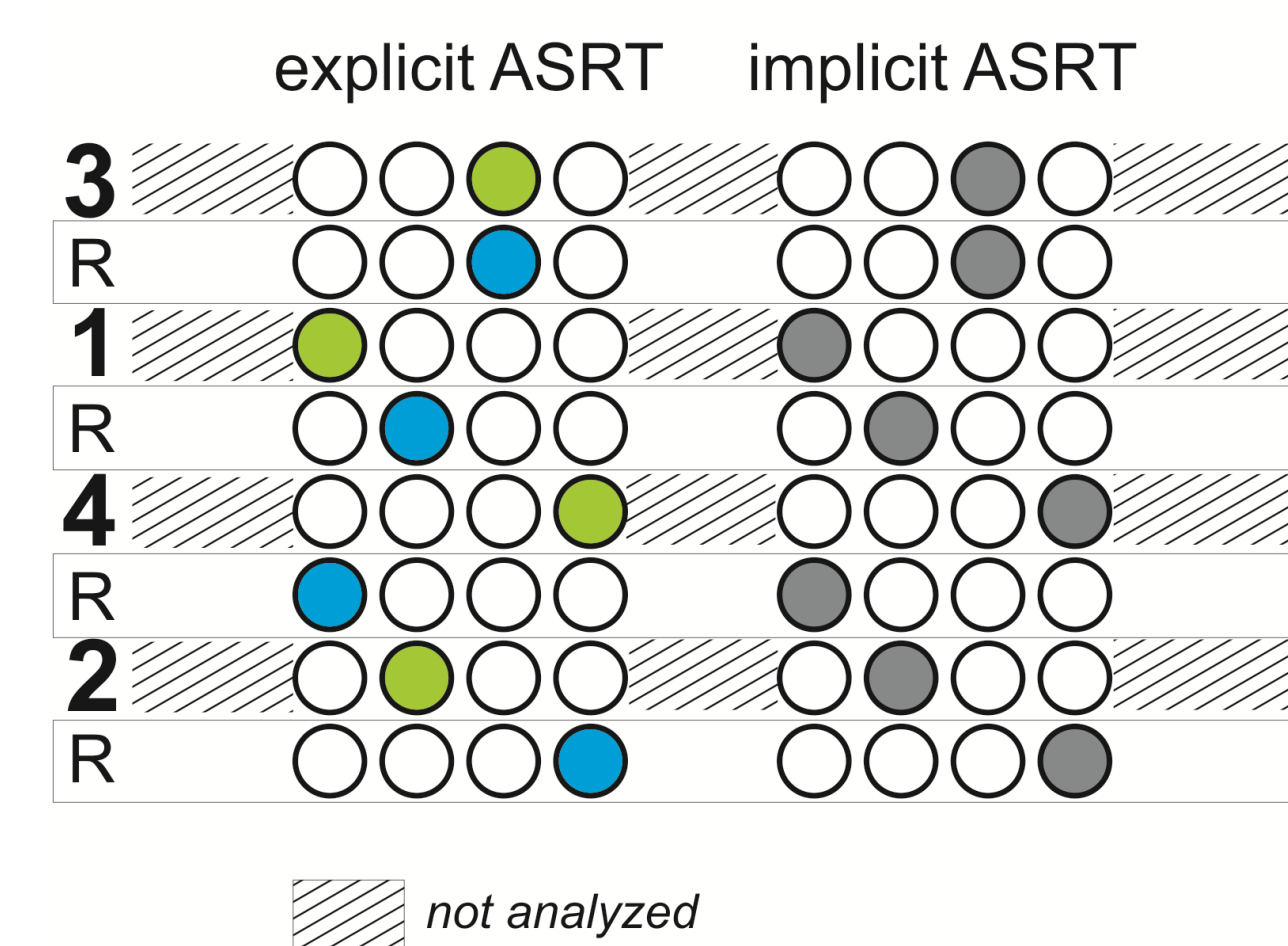
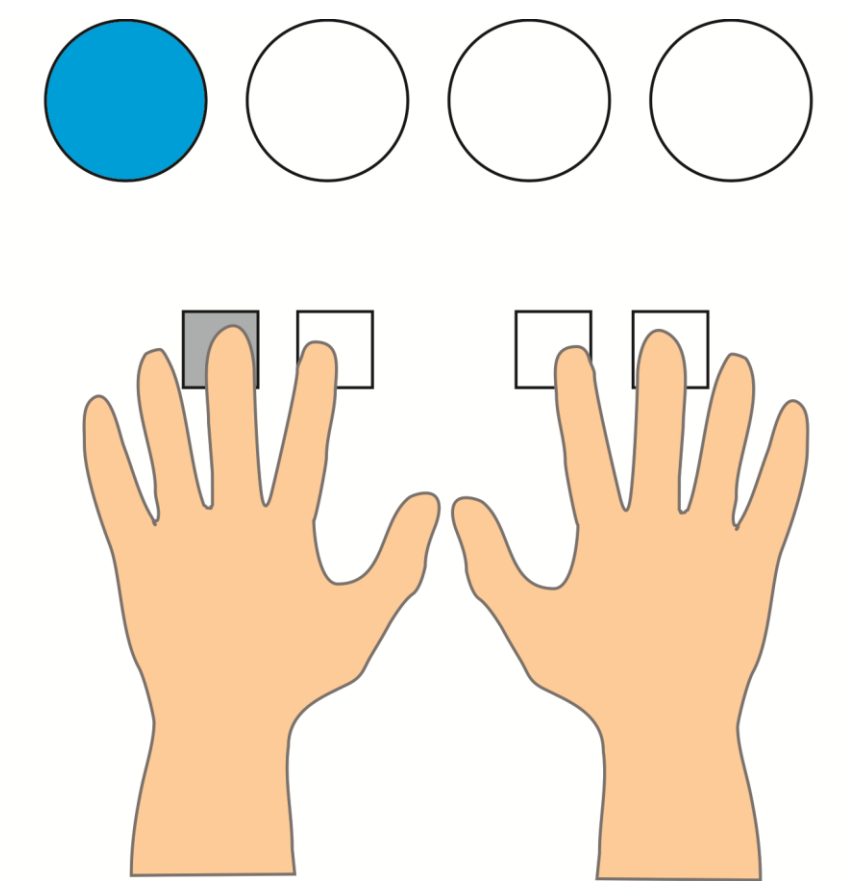
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Methods

Sequence learning was assessed via the Alternating Serial Reaction Time (ASRT) Task. Participants had to react to stimuli appearing on one of four possible locations by pressing the corresponding key on the keyboard.



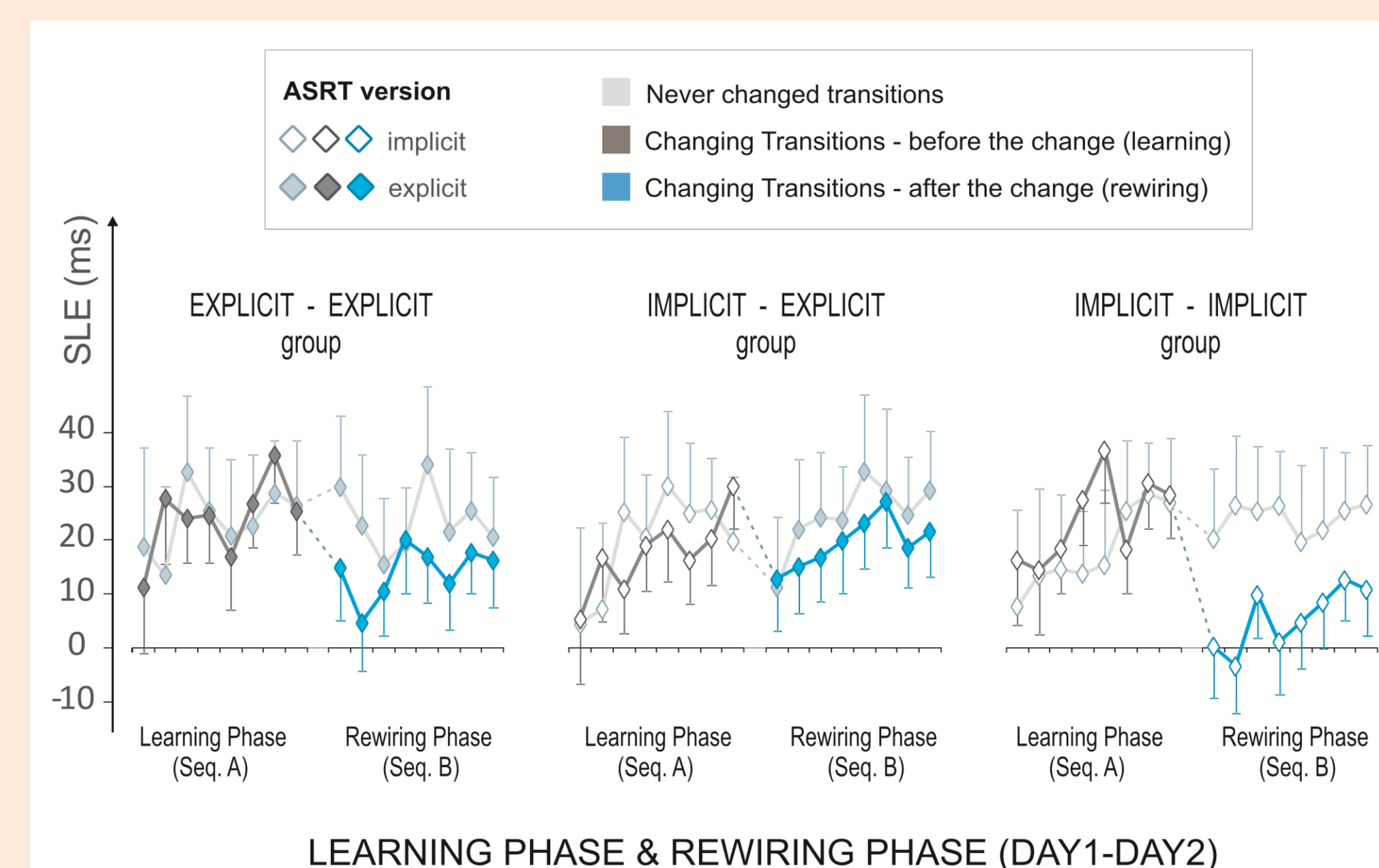
A 4 element-long pattern is embedded in random noise (random and pattern trials alternate); eg. 3-R-1-R-4-R-2-R...

In the **EXPLICIT** version of the task pattern and random trials were of different colors (green and blue). Participants were asked to monitor the pattern. In the **IMPLICIT** version all stimuli were of the same color (grey). Participants were not told about the regularities.

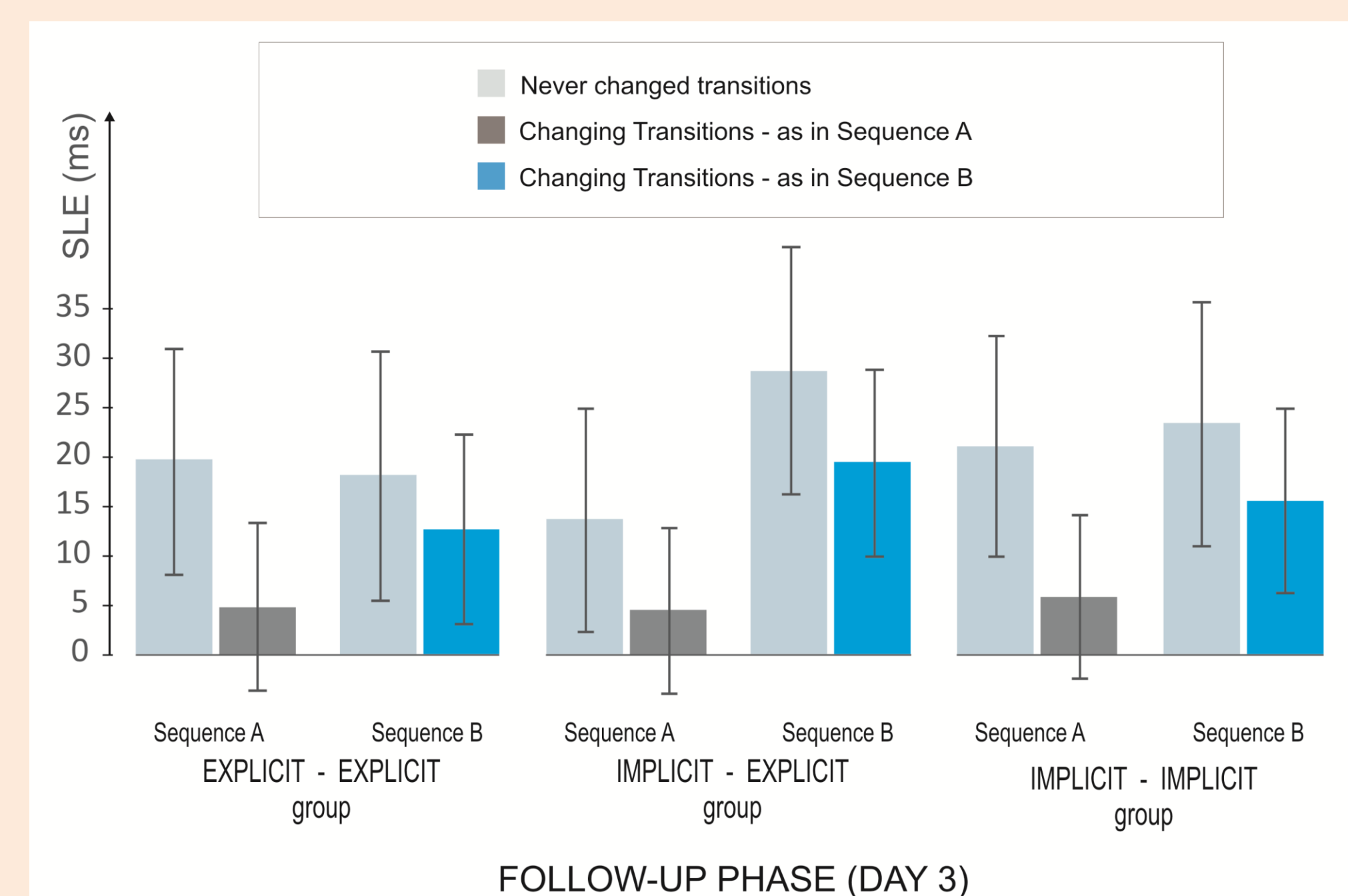
In the ASRT task the statistical structure of the sequence is learned (conditional probabilities of transitions, eg. 1-2-4 being frequent, 1-2-2 being infrequent triplets). People respond faster and more accurately to the final elements of frequent triplets.

Only **random** trials were analyzed.

Results



As expected, learning of never changing sequence parts had not decline in the Rewiring Phase ($p = .151$, $d = .021$, light grey line in the Learning vs. Rewiring Phase), while learning of the changed sequence parts was significantly lower in Rewiring Phase than the original learning in the Learning Phase ($p < .001$, $d = .729$, dark gray line vs. blue line). This was apparent in the Implicit-Implicit ($p < .001$, $d = 1.562$) and Explicit-Explicit ($p = .028$, $d = .850$) groups, but not in the Implicit-Explicit group ($p = .561$, $d = .155$).



Performance was better on the transitions that never changed their frequency (light grey bars) than on those that changed (blue and dark grey bars; $p = .003$, $d = .506$). Overall, better performance was expressed for Sequence B than for Sequence A ($p = .015$, $d = .404$). No group differences were observed (all $p > .303$).