Self-Regulated Learning of Movement Sequences in Advanced Age

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Background

Self-regulation plays an important role in human learning. Self-regulated learning can be defined as thoughts, feelings, and actions systematically oriented towards the attainment of learners' own goals. People of all ages regulate their learning by (consciously or unconsciously) setting goals, choosing strategies, engaging in activities, monitoring activities, and evaluating learning processes.

Purpose of the Study

While there is a growing body of research on self-regulation in academic learning, knowledge about elderly people's self-regulation in movement learning is still fragmentary. The purpose of the study was to describe the self-regulation of elderly people when learning movement sequences by immediate imitation.

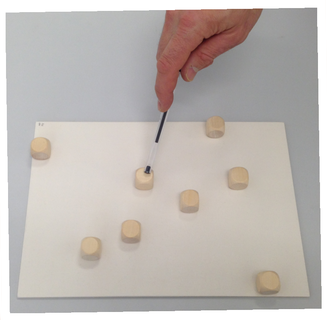

Fig. 1: Training board

Methods

N=85 participants (⌀ 70 y.o.; 60…95) trained a sequence of typing movements. During each training cycle, participants imitated a section of a sequence presented on a board with eight small blocks. They received immediate, concurrent feedback. At the end of the training, participants were prompted to judge the likelihood of recalling the trained elements later on (judgement of learning). After completing a two-sided survey during an active pause of about 10 minutes, they were asked to reproduce the acquired sequence.

Participants were asked to acquire as many elements as possible, while remaining able to flawlessly demonstrate the trained section in the later test phase. They determined their own duration of training (number of training cycles), pace (number of elements per cycle), and learning goal (final number of elements).

Hypotheses

The current analysis focuses on one particular decision participants had to take. At the start of each learning cycle, they had to decide how many sequence elements they wanted to learn next. It was hypothesized that this decision would be guided by three well-documented metacognitive processes:

Memory for Past Test Heuristic (MPTH)

Learners judge the current state of learning by relying on their most recent memory performance. It was expected that participants would base their decision on the performance in their previous training cycle. The current number of elements should depend on the prior number of elements and the prior accuracy of imitation.

Memorizing Effort Heuristic (MEH)

Learners value the difficulty of a learning item based on the previous effort when committing that item to memory. It was expected that participants would choose more sequence elements after experiencing only a minor learning effort. The current number of elements chosen should be higher when the learning slope was already steep in past cycles.

Stability Bias (SB)

Leaners fail to appreciate the degree to which memory can change over time, thus underestimating the potential gain of continued learning. It was expected that in later training cycles, participants would be less willing to further expand the number of elements.

Results

Participants chose to train for ⌀ 18 training cycles. In ⌀ 73% of the training cycles, all presented elements were correctly imitated. Participants chose a training goal of ⌀ 10 elements. For ⌀ 75% of the trained elements, the judgement of learning was at maximum level immediately after the training. After the pause, participants reproduced ⌀ 90% of the elements correctly.

Age was negatively correlated with the proportion of correct training cycles (r=-.44), the number of elements trained (r=-0.25), and the proportion of elements reproduced correctly (r=-0.3). No other significant associations between age and training characteristics were identified.

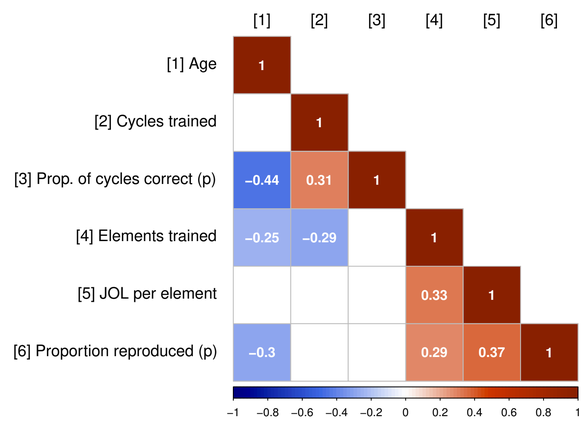

Fig. 2: Correlations of age and training characteristics (Pearson's r)

A visual comparison of the growth of training elements between two age groups indicate a similar steep growth in the first cycles. Later on, participants aged 75+ tended to remain at an element number reached at an intermediate learning cycle. Younger participants tended to increase the number of elements, even in later training cycles.

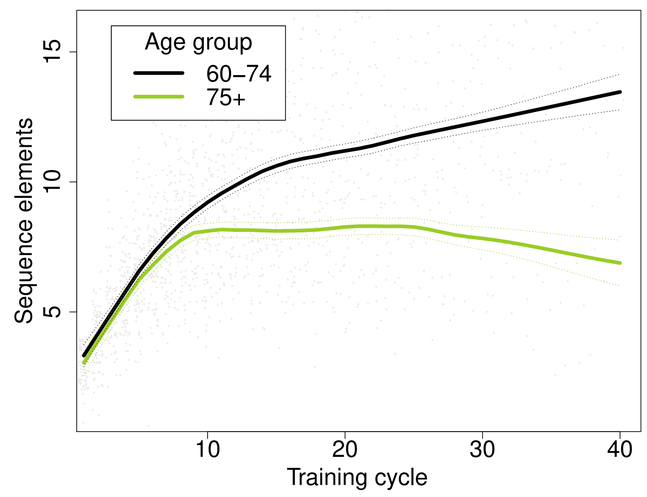

Fig. 3: No. of elements by training cycle and age (LOESS)

The number of training elements chosen per training cycle was analyzed by conditional linear growth modelling (N_{part}=78, N_{obs}=1263). In the final model (R^2_{adj}=96%), participants chose more elements when the number of elements trained in the last cycle was higher and when the prior cycle was correctly reproduced. They also chose fewer elements when at higher training duration. Participants' age and the slope of elements prior to the previous cycle did not influence the choice of training elements.

	Unconditional growth			Conditional growth		
	b	se	p	b	se	p
Intercept	6.694	0.135	0.000 ***	0.483	0.056	0.000 ***
Time (Training cycles)	0.146	0.008	0.000 ***	-0.016	0.002	0.000 ***
Age				-0.012	0.027	0.659
Last cycle: Imitation correct				0.503	0.028	0.000 ***
Last cycle: Element trained				0.999	0.007	0.000 ***
Prior slope of element number				0.018	0.025	0.473
R^2_{adj}		21%			96%	

$^{\dagger}p < 0{,}1$ $^{*}p < 0.05$ $^{**}p < 0.01$ $^{***}p < 0.001$

Fig. 4: Linear growth models: No. of elements chosen per training cycle

Discussion

As predicted, decisions on the number of elements participants wanted to learn next were based on both the Memory for Past Test Heuristic and the Stability Bias. In contrast, no indication of the influence of the Memorizing Effort Heuristic was found. Because participants' age did not influence the choice of sequence length in the multivariate model, it can be inferred that age-related differences in the selection of training goals are due to different uses of MPTH and/or SB.

Overall, participants regulated their training efficiently. Most chose appropriate training goals, resulting in a accurate reproduction in the test phase. Compared to younger participants, however, older participants were less accurate during the training and test phases, and they also chose less ambitious training goals. Presumably, a lower accuracy in imitation during the training gave older participants the impression of a difficult learning process, resulting in a more defensive choice of training (sub-)goals.

Conclusion

In advanced age, the choice of training goals in self-regulated, imitative learning of typing movements can be influenced by the Memory for Past Test Heuristic and the Stability Bias.

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