The effect of the delay between response and presentation of the next trial on transition from algorism to memory retrieval

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Abstract

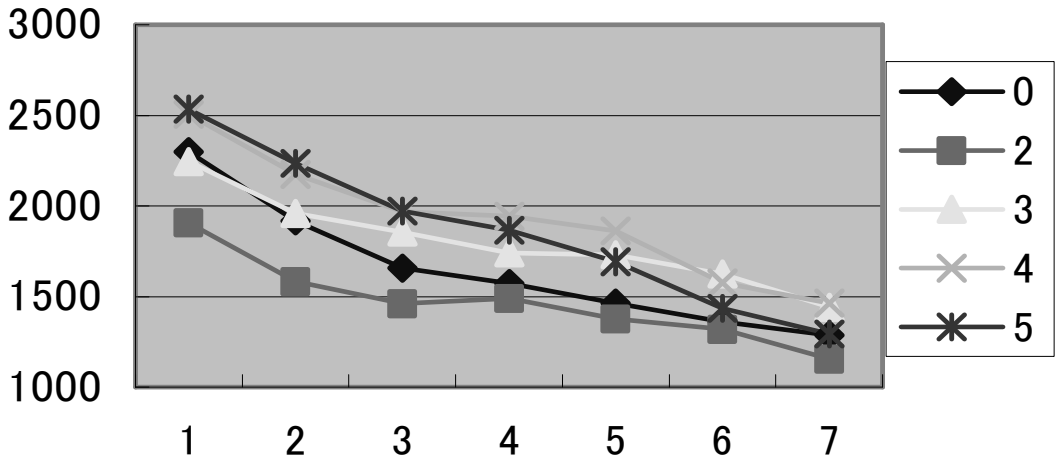
We added the variables as the delay between response and presentation of the next trial into alphabet arithmetic tasks of Zbrodoff and Logan. When participants have to learn to do a new form of arithmetic called alphabetic arithmetic: such as A+2=C and B+5=G, with practice, participants became very fast making true/false decisions to these (Zbrodoff and Logan, 1986).We had two conditions controlled by the delay between response and presentation of the next trial; one condition had 1 sec and the other condition had 5 sec interval. Consequently, we obtained the evidence that long interval (the delay between response and presentation of the next trial) made weak automaticity in 7 days sessions. Logan's instance theory says that transition from algorism to memory retrieval in automaticity and skill acquisition is based on obligatory memory encoding and retrieval through attention. Furthermore, it says that that we can investigate this shift through measuring reaction time. (Logan, 1988). However, instance theory does not explain the delay between response and presentation of the next trial. Our data suggests that interval of exposure as additional factors may be important to acquisition of automaticity.

Method

Experimental subjects were ten university students. These experiments were conducted in the darkroom. The apparatus consisted of general PC, a monitor, a keyboard, and the software made by ourselves. The participans had to judge whether correct or not were the arithmetic propositions such as "(A~J) + (2~5) = (one alphabet character)" which displayed in the PC monitor. After the propositions were presented, the experimental subjects carried out judgment through input of the keyboard, and they got information about their correct or incorrect answers through display on every trial. There were two conditions with respect to the delay between response and presentation of the next trial. One condition included the short delay (one second) and the other condition included the long delay (five seconds) between response and presentation of the next trial. There was no difference with other thanfactors. The participants were divided into two groups on each condition. We carried out experiments through total 3360 trials for seven days by 480 trials a day to one subject.

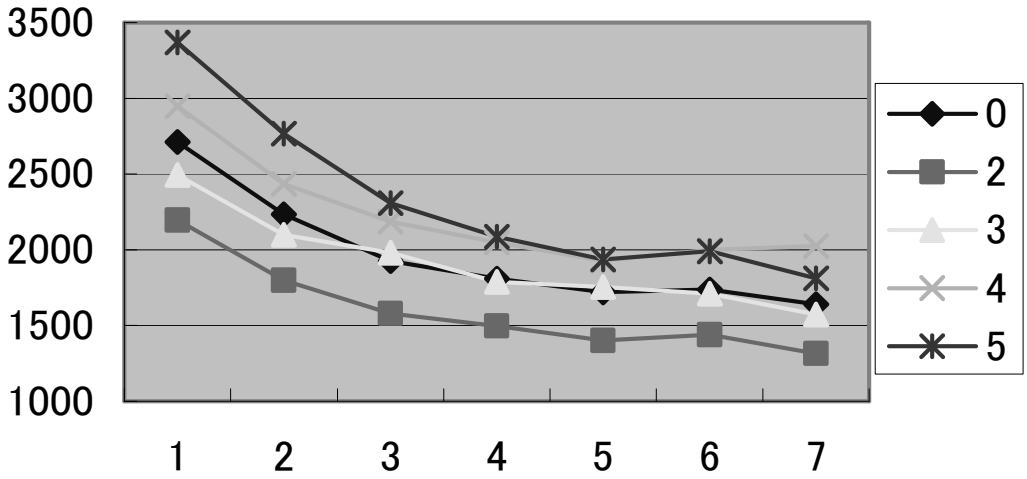
Results and Discussion

Figure 1 and Figure 2 show the transition of the average reaction time of each condition.



Longitudinal axis: average reaction time (ms). Horizontal axis: Lapsed days (date)

Figure 1　short delay between response and presentation of the next trial.



Longitudinal axis: average reaction time (ms). Horizontal axis: Lapsed days (date)

Figure 2　long delay between response and presentation of the next trial.

Analysis of variance (ANOVA) with three within-subjects (repeated) factors and one between-subject factor revealed four main significant effects; main effect A [F=130.9329, p<.001], main effect B [F=320.1346, p<.001], main effect C [F=7.914, p<.001],andmain effect D [F=＝104.1646, p<.001] . Main effect A is involved in the delay between response and presentation of the next trial (between-subjects), main effect B is involved in date (within-subjects), and main effect C is involved in judgement whether correct or not(within-subjects), and main effect D is involved in added numbers (within-subjects). Four significant

interactive effects (A x B, F=4.2098, P<.001; B x C, F=2.3502, P<.05; B x D, F=2.7518, P<.05; C x D, F=5.4866, P<.001; and A x B x D, F=1.8, P<.05) were obtained.

In the condition of short delay between response and presentation of the next trial, we obtained the evidence of aquisition of automaticity, which reveaved no significance difference among reaction times to arithmetic formula consisting of varied addited numbers in 7th day (see Fig. 1). The results revealed that there was strong convergent tendency during seven days, because the significant effects caused by the addited numbers dissapeard completely after seven days according to multiple comparison method. This phenomenon can be identified as shift from algorism to memory retrieval in automaticity(Logan, 1988).

In contrast with it, in condition of long delay between response and presentation of the next trial we did not obtain the evidence of aquisition of automaticity, which reveaved significant difference among reaction times to arithmetic proposition consisting of varied addited numbers in 7th day (see Fig. 2). The results revealed that there was only weak convergent tendency during seven days, because the significant effects caused by the addited numbers remained after seven days according to multiple comparison method though there was decreasement of reaction time during seven days.

We operated the delay between response and presentation of the next trial in skill acquisition. The influence of the presentation time was researched in acquisition of the automatic operation in alphabetic arithmetic performance. When participants have to learn to do a new form of arithmetic called alphabetic arithmetic: such as A+2=C and B+5=G. with practice, participants became very fast making true/false decisions to these (Zbrodoff and Logan, 1986). Instance theory says that there occurs the shift of process from the algorithm to the automaticity (skill: procedure memory) in progress of skill acquisition (Logan, 1988). We can investigate this shift through measuring reaction time.

In early stage of progress in skill aquisition, people try to resolve arthmetic formula through algorithm. Thus arthmetic performance is better in A+1=B than A+5=F. Reaction time (for arthmetic performance) increases in proposion to the number of added numbers. In contrast with it, when automaticity has been obtained completely, arthmetic performance is very fast and constant in spite of the number of added numbers. Thus there occurs the direct-access and memory-based processing, that is automaticity as skill aquisition.

Instance theory says that skill acquisition is based on obligatory memory encoding and retrieval through attention. However, it does not say the delay between response and presentation of the next trial.

We obtained the evidence that long delay between response and presentation of the next trial make disturbance to progress of skill aquisition. In our experiment, we operated only the delay between subject's response and presentation of stimulus in the next trial. The other variables remained constant without operation. Thus, the long delay (only five second) seems to have rather long interval between trials and relaxing pause.

Such situation of leaning in the experiment seems suitable to acquisition of automaticity. However, these findings proved different in fact. This situation was not appropriate to get skill acquistion. We consider that memory-encoding for specific item (i.e., instance) may need to some extent sequential and consecutive addition of information to be encoded in constant, because individual memory trace might have own duration.

Conclusion

We added the variables as the delay between response and presentation of the next trial into alphabet arithmetic tasks of Zbrodoff and Logan. We had two conditions controlled by the delay between response and presentation of the next trial; one condition had 1 sec and the

other condition had 5 sec interval. Consequently, we obtained the evidence that long interval (the delay between response and presentation of the next trial) made weak automaticity in 7 days sessions. Although instance theory does not explain the delay between response and presentation of the next trial, our findings suggest that the temporal factor is very important to skill acquisition.

References

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