SELF-CONTROLLED PRACTICE OF DECISION-MAKING SKILLS

DANIEL MEMMERT
Ruprecht-Karls-University Heidelberg

Summary.—This study analyzed the effects of self-controlled practice on learning cognitive decision-making skills, focusing primarily on how participants used the time available to them during the practice sessions. 30 college students (10 women) ages 22 to 29 years volunteered to practice the game of tic-tac-toe under one of two conditions, self-controlled practice and a yoked-control condition. Learning and retention performance (game success, mean decision-making time) were assessed on tic-tac-toe game performance before training, immediately, and 3 wk. after training. Analysis showed considerable learning and retention in both groups. No differences were found during acquisition, but the self-controlled practice group had better performance than the yoked-control group on the retention test.

For a considerable time now, psychological research has concerned effects of self-initiated and self-controlled practice on learning (for a review, see Strake, 2000). Numerous studies of sports have reported the influence of self-controlled activities on learning motor skills (cf. Wulf & Toole, 1999; Wulf, Clauss, Shea, & Whitacre, 2001; Chiviacowsky & Wulf, 2002; Wrisberg & Pein, 2002). Knowledge of results, use of physical aids, or skill observation have been examined as self-control variables. Findings consistently show that giving learners control over the practice situation has a beneficial effect on learning motor skills. However, this effect is not evident during acquisition but is at retention.

Recent research in motor learning suggests that cognitive activities play an important role during the execution of motor skills (cf. Lee, Swinnen, & Serrien, 1994; Sherwood & Lee, 2003). A good example is the basketball player who waits for the best moment to shoot and decides at the last second to pass the ball to his teammate. Some motor skills are highly cognitive (Starkes & Allard, 1993), and the cognitive processes that subserve these movements require practice as well. Lee, et al. (1994, p. 328) described the role of cognitive processes as cognitive effort, defining this as “the mental work involved in making decisions.” They suggested that not only do move-

1 Address correspondence to Dr. Daniel Memmert, Ruprecht-Karls-University Heidelberg, Germany, Institute for Theory and Practice of Training and Movement, Im Neuenheimer Feld 700, 69120 Heidelberg, Germany or e-mail (Daniel.Memmert@urz.uni-heidelberg.de).
2 Many thanks to Julian Schäfer who analyzed the data of the self-controlled practice group. Also many thanks to Nina Dobberstein, Rieke Tittel, Thorsten Vollmar, Stefanie Lohr, Erik Schütze, and Jasmine Schumacher for helping to collect data. Many thanks to Andreas Born for giving permission to use the TicTacToe test and for helping in the collection of data, and also to the four anonymous reviewers for helpful comments on earlier versions of this manuscript. Special thanks go to Markus Gerhart for producing the final TicTacToe test.

DOI 10.2466/PMS.103.3.879-882
ment skills need to be practiced but that the cognitive, decision-making processes underlying those skills also require training.

The aim of this study was to investigate self-controlled learning processes in the acquisition of simple, cognitive decision-making processes. The popular game of tic-tac-toe was chosen as the experimental task. This old game of strategy permits evaluating simple cognitive learning strategies as it has a clear win-lose structure. Like many sports games, the task is to initiate one's own attacks and defend against attacks by one's opponent. Cognitive demand is of medium difficulty, and the quality of the moves can be clearly assessed. The relative speed of the game (between 4 and 10 sec.) allows numerous repetitions without fatiguing participants, and time pressure can be easily simulated, as this is a significant component in many types of sports.

The main goals of this experiment were to study learning and retention of cognitive decision-making processes based on a self-controlled practice schedule. The self-control group had complete freedom over the frequency of the practice sequence, while fixed intervals were specified for the yoked-control group. Preliminary studies showed that decision-making in the context of the tic-tac-toe game used at the start of the learning process required between 10 and 15 sec. It was predicted that the self-control group would demonstrate better learning and retention of decision-making skills than the yoked-control group with regard to game success and decision-making time.

**Method**

The participants were 30 undergraduate students (20 men and 10 women), whose average age was 25.6 yr. (SD=2.9, range=22–29 years). All took part in the experiment voluntarily. Informed consent was obtained before commencing the experiment. All participants were given a 3-min. period to familiarize themselves with the game of tic-tac-toe presented on a PC. Although participants differed in terms of prior sports experience, none had any experience of the game of tic-tac-toe. Participants played 20 games of tic-tac-toe to estimate a baseline. In each game, the participant made the first move. The goal was to defeat the programmed computer as quickly as possible. They were allowed 4 sec. per move with time displayed on the monitor. If they exceeded this time, the computer was declared the winner of that game. The result (win, draw, lose) was also displayed at the end of each game.

Participants were matched by baseline performance and assigned to one of two groups. The self-control group practiced the game for 26 min.; there was no specific number of games required to complete during this period. These participants had the opportunity to reflect on solution strategies after each game for as long as they wished. They then started the next game by clicking the mouse. The self-control group played between 110 and 268 games (M=180, SD=51). Each participant in the yoked-control group was yoked to a participant in the self-control group and completed the same
number of practice trials played by the counterpart in the self-control group. There was a 5-sec. break between individual games. The next game was then started automatically. Two minutes after the training session, all participants completed an immediate retention test of 20 trials. Three weeks later, the groups completed two delayed retention tests, each consisting of two sets of 20 trials. They were not told before this point that they would be tested again after 3 wk. A follow-up questionnaire was also completed at the 3-wk. posttest to check that no participant had continued to practice the task systematically during the delayed retention interval. None had.

The dependent variables were game success (win = 2 points, draw = 1 point, lose = 0 points) and mean decision-making time per trial. Total scores on the learning and retention tests were subjected to 2 x 2 (group x measurement time) mixed analyses of variance for acquisition and retention, respectively. An alpha level of .05 was used for all statistical comparisons, and effect sizes were calculated.

**Results**

Table 1 reports means and standard deviations in the two groups.Baseline performance of game success (t_{28} = -1.14, p > .10) and decision-making time (t_{28} = -1.18, p > .10) did not differ between the two training groups. Both groups improved their performance considerably during acquisition (game success: f_{1,28} = 49.47, p < .001, \eta^2 = .64; mean decision-making time: f_{1,28} = 37.64, p < .001, \eta^2 = .57), indicating that the training program performed was successful for both groups. The fact that there was no significant interaction supported previous self-control effect, indicating that the self-controlled practice group was no more effective than the yoked practice group during acquisition (game success: f_{1,28} = 1.21, p > .10; mean decision-making time: f_{1,28} = 1.16, p > .10). During retention, a significant interaction supported the anticipated self-control effect (game success: f_{1,28} = 4.32, p < .05, \eta^2 = .14; mean decision-making time: f_{1,28} = 22.78, p < .001, \eta^2 = .45). Within-

| Table 1 |

| Period/Test                      | Self-controlled Group |                          | Yoked-control Group |
|----------------------------------|-----------------------|--------------------------|---------------------|
|                                  | Game Success M | SD | Decision Time M | SD | Game Success M | SD | Decision Time M | SD |
| Acquisition                      |                        |                            |                          |        |
| Pretest                          | 25.73 | 4.95 | 5.81 | 1.20 | 23.27 | 6.78 | 5.72 | 1.47 |
| Immediate Retention Test         | 33.40 | 3.60 | 3.76 | 0.78 | 30.00 | 4.78 | 4.28 | 0.69 |
| Retention                        |                        |                            |                          |        |
| Retention Test 1                 | 29.73 | 4.56 | 5.05 | 0.93 | 28.93 | 4.71 | 4.19 | 0.70 |
| Retention Test 2                 | 32.67 | 3.68 | 4.06 | 0.91 | 29.60 | 4.03 | 4.20 | 0.92 |
group contrasts of the interaction for group × measurement time yielded no significant changes for the yoked-control group but significant improvements for the self-control group according to both dependent variables.

**Discussion**

Taken together, the results indicate that self-controlled practice improves decision-making components of a motor skill more effectively than a yoked-control condition, as is found for motor skills with less cognitive involvement (see Wulf & Toole, 1999). One explanation could be that participants allow themselves more time at the beginning to plan and try out strategies in advance. Shorter intervals can be selected for testing combinations of moves and later on in the practice sessions. Researchers could examine further options for self-control variables, for instance, the same overall time or the same time interval between moves or comparing the number of times participants and the computer make the first move. In addition, an interesting focus for research would be to analyze the time taken by participants for the second, third, or fourth moves. It is possible that an experienced, self-controlled participant may require more time to think for the second move than for the later moves as he searches for an optimum strategy.

It is further recommended that studies incorporate questionnaires or tests of knowledge to gain insights into possible differential effects that self-control or yoked-control conditions may have on learners' decision-making processes. Furthermore, researchers should examine self-controlled learning conditions in sport-related learning contexts, including more complex perceptual-motor activities, such as the planning and execution of badminton strokes (cf. Williams, Ward, Knowles, & Smeeton, 2002).

**REFERENCES**

Chiviacowsky, S., & Wulf, G. (2002) Self-controlled feedback: does it enhance learning because performers get feedback when they need it? *Research Quarterly for Exercise and Sport, 73*, 408-415.

Lee, T. D., Swinnen, S. P., & Serrien, D. J. (1994) Cognitive effort and motor learning. *Quest, 46*, 328-344.

Sherwood, D. E., & Lee, T. D. (2003) Schema theory: critical review and implications for the role of cognition in a new theory of motor learning. *Research Quarterly for Exercise and Sport, 74*, 376-382.

Starkes, J. L., & Allard, F. (1993) Cognitive issues in motor expertise. Amsterdam: Elsevier Science.

Strake, G. A. (2000) *Conceptions of self-directed learning: theoretical and conceptional considerations*. Münster: Waxmann.

Williams, A. M., Ward, P., Knowles, J. M., & Smeeton, N. J. (2002) Anticipation skill in a real-world task: measurement, training, and transfer in tennis. *Journal of Experimental Psychology: Applied, 8*, 259-270.

Wrisberg, C. A., & Pein, R. I. (2002) Note on learners' control of the frequency of model presentation during skill acquisition. *Perceptual and Motor Skills, 94*, 792-794.

Wulf, G., Clauss, A., Shea, C. H., & Whitacre, C. A. (2001) Benefits of self-control in dyad practice. *Research Quarterly of Exercise and Sport, 72*, 299-303.

Wulf, G., & Toole, T. (1999) Physical assistance devices in complex motor skill learning: benefits of a self-controlled practice schedule. *Research Quarterly for Exercise and Sport, 70*, 265-272.

Accepted December 1, 2006.