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TESTING ASSUMPTIONS OF DELIBERATE PRACTICE THEORY RELEVANCE, EFFORT, AND INHERENT ENJOYMENT OF PRACTICE WITH A NOVEL TASK: STUDY II[1]

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Summary.—This study examined three assumptions of the theory of deliberate practice: that deliberate practice is perceived as relevant for improving performance and that it requires effort, but that it is not perceived as being inherently enjoyable. Of particular interest was how these perceptions change as practice difficulty changes. 30 college undergraduates practiced two different maze memorization and replication tasks and rated the practice relevance for improving performance on the task, the practice effort, and the inherent enjoyment of practice. The findings for each of the assumptions were consistent with those suggested by the theory and also showed that these perceptions are subject to the current performance on an activity and the difficulty of the practice.

A recent study by Hyllegard and Yamamoto (2005) reported findings supporting three assumptions of the theory of deliberate practice: that deliberate practice is perceived as relevant for improving performance and this requires effort but is not an inherently enjoyable activity. The participants practiced a novel maze laboratory task and then rated activity for each of the three practice assumptions; the outcomes for each of the assumptions were consistent with outcomes suggested by the theory. It was also reported that these perceptions can change relative to one another as performance improves with practice. In particular, while ratings of practice relevance and inherent enjoyment remained consistent across sessions, the effort ratings in practice changed as practice trials accumulated and performance on the task improved.

While those findings were consistent with the theory of deliberate practice, they were not altogether consistent with findings reported in related investigations. In each of the related studies, the three assumptions were examined through a process of rating the practice relevance, practice effort, and enjoyment (or pleasure) of practice for a variety of activities (concentration was also rated in some studies) by various types of experts including musicians (Ericsson, Krampe, & Tesch-Römer, 1993; Lehmann, 2002), wrestlers (Hodges & Starkes, 1996), figure skaters (Starkes, Deakin, Allard, Hodges, & Hayes, 1996), martial artists (Hodge & Deakin, 1998), soccer players and field hockey players (Helsen, Starkes, & Hodges, 1998), collegiate tennis,

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volleyball, and swimming coaches (Hyllegard, Radlo, & Early, 2001), and middle-distance runners (Young & Salmela, 2002). Collectively, those studies reported high practice relevance and practice effort of practice ratings for most rated activities of deliberate practice. However, most inherent enjoyment of practice ratings were either neutral or high, rather than low, as expected. Consequently, the lack of low inherent enjoyment ratings and the unexpected number of high ratings have prompted questions about the validity of the inherent enjoyment of practice aspect of the theory.

The Hyllegard and Yamamoto study (2005) differed from the previous studies because it involved novices deliberately practicing a maze memorization and recall task and then, at the conclusion of the session, rating the practice relevance for improving performance, the practice effort needed to improve, and the inherent enjoyment of that practice. This was different from previous studies in which experts just reflected on various practice-related and nonpractice activities to make the ratings (e.g., Ericsson, *et al.*, 1993; Hodges & Starkes, 1996; Starkes, *et al.*, 1996).

While the Hyllegard and Yamamoto findings were consistent with the theory of deliberate practice, one concern was that the findings were based on a practice activity of constant difficulty. That is, the same maze was used for all practice trials regardless of the accumulated amount of practice or performance by the participants. As a consequence, practice may have contributed to the declining effort ratings unlike those of a more frequent practice, such as for sports or music. During more ordinary practice, the difficulty of the practice activity changes as performance improves and as the learner attempts more challenging tasks. Owing to this limitation, the purpose of the present study was to replicate the results of Hyllegard and Yamamoto by adding a second more difficult maze memorization and recall task, to investigate how perceptions of the three assumptions change under practice conditions for a maze of increased difficulty. Based on the theory of deliberate practice and previous findings, two hypotheses were of particular theoretical interest. It was hypothesized that the inherent enjoyment of practice means would be lower than mean ratings for both practice relevance and effort across each of the blocks of practice; no difference between mean ratings of practice relevance and practice effort was predicted. Second, the means of practice effort during any given practice block were predicted to depend on performance level and on the difficulty of the task.

Method

Participants

Thirty college undergraduates ($n = 19$ men and $n = 11$ women) practiced two different maze memorization and recall tasks. All participants received course credit for participation; to receive the credit, participants were expected to make a good-faith effort throughout the study and meet all scheduling and practice requirements. They were also free to terminate involvement in the study at any time and earn the credit without penalty. All 30 participants completed the study and earned course credit.

Procedure

Maze tasks.—Two maze patterns were used in the study: Maze-23 consisted of 38 segments with 23 segments forming a route from a starting-point to an ending-point. Maze-29 was similar in most respects to Maze-23 but was more complex and consisted of 66 segments with 29 of these forming the route from the start through to the end (Appendix A, p. 445). Both mazes were practiced following the same procedures with all of the Maze-23 trials (Blocks 1, 2, 3, and retention test) completed first and then the Maze-29 trials (Blocks 4, 5, 6, and retention test) two days after the Maze-23 retention test. The mazes were presented visually during a 1.5-sec. memorization interval. This was followed immediately by a 30-sec. replication interval during which participants drew on graph paper as much of the route from the starting point to the ending point as they could remember. For each maze, a total of 60 practice trials represented three blocks of 20 trials each, which practice blocks occurred over three consecutive days and were followed by a single-trial retention test two days later. Knowledge of results was given just prior to the start of Blocks 2 and 3 and the retention test. This consisted of a verbal report of the number of correctly drawn line segments for each of the 20 previous practice trials (60 knowledge of results instances for each maze. Counting the number of correctly drawn segments always started with Segment 1 of the maze consecutively to the segment on which the first mistake was made. The drawing did not have to be to scale, but the direction, i.e., up or down and left or right, of each segment had to be drawn correctly relative to the preceding one. Each maze was drawn on a fresh piece of graph paper, and the participants were not allowed to review previously completed drawings. These procedures met the four requirements for deliberate practice as defined by Ericsson (1996): a well-defined task with appropriate difficulty, informative feedback, opportunities for repetitions, and corrections of error (pp. 20-21).

An Apple iMac computer running the MindLab application was programmed to administer the practice trials automatically. Before starting the Maze-23 practice trials, a sample trial with a different maze was shown to familiarize the participants with the time intervals and the images seen on the computer during each phase of practice.

Ratings of practice.—At the completion of each of the six blocks of practice, the participants rated practice relevance, practice effort, and the inherent enjoyment of practice on a scale labelled low (0) and high (10). In the instructions, operational definitions for practice relevance, practice effort, and inherent enjoyment of practice were given. Practice relevance was defined as the extent to which the practice trials improved performance on the mazes. Practice effort was defined as the cognitive effort needed to improve performance. The inherent enjoyment of practice was defined as the extent to which practice was enjoyable regardless of outcome, such as improved performance on the task. The example used for inherent enjoyment of practice was adopted from Ericsson, *et al.* (1993): "When rating the inherent enjoyment of cleaning one's house, it should reflect the enjoyment of the actual activity, and it should disregard the enjoyment of the results (i.e., a clean and attractive house)" (p. 373).

Ratings of daily activity.—The participants also rated the effect of six other activities for improving school grades, including studying for finals, writing papers, attending class, practicing sports, playing sports, and watching movies. These ratings were made for two reasons: firstly, to help illustrate the concepts of practice relevance, practice effort, and inherent enjoyment of practice with activities familiar to college students, and secondly, these ratings were used to assess the consistency of ratings of the maze practice by comparing them with some activities commonly associated with college life. These school activity ratings were made just prior to starting the Maze-23 trials.

Results

Maze Practice Segments

The dependent variable for the maze task was the number of correctly drawn line segments, counting from line segment 1 to the first error. Scores on each trial could range from 0 to 23 for the Maze-23 and 0 to 29 for the Maze-29. Table 1 shows the mean (± *SD*) correctly drawn line segments for practice Blocks 1 through 6 as well as on the two retention tests. Also shown are scores represented in percentages based on the total number line segments in each of the two mazes.

TABLE 1

Mean (± *SEM*) Correctly Drawn Line Segments Expressed Both as Count and Percentage of Total Number of Line Segments in Maze by Block of Practice and Retention Tests

	Maze 23				Maze 29			
	Block 1	Block 2	Block 3	Retention	Block 4	Block 5	Block 6	Retention
Correct Line Segments*								
M	6.53	12.85	17.29	18.47	7.66	13.89	17.79	18.83
SEM	0.74	1.04	1.11	1.19	0.58	1.16	1.66	1.76
% Correct Line Segments*								
M	28.4	55.9	75.0	80.3	29.9	47.9	61.1	63.9
SEM	3.2	4.5	4.8	4.0	2.0	4.0	5.7	6.1

*$p < .01$.

A repeated-measures analysis of variance indicated differences among the means for practice blocks and retention test were significant ($F_{7,203}$ = 23.88, $p<.01$, $\eta^2=.45$, *G-G epsilon* = 42). A Scheffé *post hoc* analysis showed that the mean scores for the Maze-23 trials compared to the Maze-29 trials did not differ, i.e., Block 1 vs Block 4, Block 2 vs Block 5, Block 3 vs Block 6. For the Maze-23 trials, the mean correct segments for Blocks 1 and 2, Blocks 1 and 3, and Blocks 2 and 3 were different from one another. The Maze-23 retention test mean differed from Blocks 1 and 2 means but not from the Block 3 mean. The same pattern was found for the Maze-29 practice trials: the mean correct segments for Blocks 4 and 5, Blocks 4 and 6, and Block 5 and 6 were different from one another. The Maze-29 retention test mean differed from those of Blocks 4 and 5 but not from the Block 6 mean.

A second analysis was conducted with the data expressed in terms of the percentages rather than counts. This analysis was conducted to evaluate the difficulty of the two maze tasks relative to one another. A repeated-measures analysis of variance showed differences among the mean percentages were significant ($F_{7,208}=27.95$, $p<.01$; $\eta^2=.49$, *G-G epsilon* = .49). Scheffé *post hoc* analysis indicated that performance on Blocks 1 and 4 was similar (28.93% vs 29.86%), performance on Block 2 was better than that on Block 5 (55.87% vs 47.90%), and performance on Block 3 was better than that on Block 6 (74.96% vs 61.07%). This suggests that Maze-29 was a more difficult task because using the data, expressed as a percentage of the total number of segments, the participants did not learn as many of the segments on this maze as they did for Maze-23.

Practice ratings.—A two-way analysis of variance for the type of rating (relevance, effort, inherent enjoyment) by practice block (Maze-23: Blocks 1, 2, and 3; Maze-29: Blocks 4, 5, and 6) with repeated-measures on a practice block indicated an interaction for type of rating by practice block ($F_{10,435}$ = 5.18, $p<.01$). Analysis of the simple effects for interaction involved examining the cell means for the practice relevance, practice effort, and inherent enjoyment of practice scores across pairs of practice blocks (e.g., Blocks 1 and 2, Block 2 and 3, and so forth) to identify specific interactions in the initial two-way analysis of variance (Keppel, Saufley, & Tokunaga, 1992; Vincent, 1999). Interactions were found for rated practice effort and practice relevance between Blocks 1 and 2 ($F_{1,58}=11.90$, $p<.01$), Blocks 2 and 3 ($F_{1,58}$ $=4.87$, $p=.03$), Blocks 3 and 4 ($F_{1,58}=7.69$, $p<.01$), and Blocks 5 and 6 ($F_{1,58}$ $=5.14$, $p=.03$). Further interactions were also found for rated practice effort and inherent enjoyment of practice between Blocks 1 and 2 ($F_{1,58}=15.21$, $p<$ $.01$), Blocks 3 and 4 ($F_{1,58}=10.48$, $p<.01$), and Blocks 5 and 6 ($F_{1,58}=8.84$, $p<.01$). No interactions were found between rated practice relevance and inherent enjoyment of practice since the means for these two ratings largely paralleled one another across the six practice blocks.

The mean ratings for practice relevance, practice effort, and inherent enjoyment of practice across the six practice blocks (±*SEM*) can be seen in Fig. 1. The figure shows that while the mean ratings for the practice relevance and inherent enjoyment of practice remained largely consistent across the practice blocks, those for practice effort decreased from Blocks 1 through 3, then increased for Block 4 and decreased again for Blocks 5 and 6. This showed that, when practice on the second more complex maze started (Block 4), the ratings of practice effort increased in magnitude similar to that for Block 1. Then, similar to Maze-23, the effort ratings for Maze-29 decreased again as performance improved.

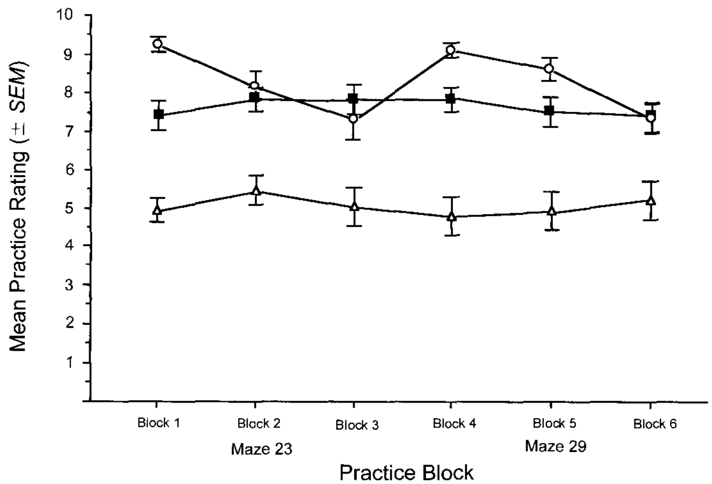

FIG. 1. Mean (±*SEM*) for ratings of relevance (■), effort (○), and inherent enjoyment (△) of practice on practice Blocks 1–6 for the maze memorization and replication tasks

The figure also shows practice relevance and practice effort were both comparatively high, and the practice inherent enjoyment ratings were comparatively low across all practice blocks, as predicted from theory. The mean ratings across all practice trials for practice relevance ($M=7.72$, $SEM=0.12$), effort ($M=8.4$, $SEM=0.15$), and inherent enjoyment of practice ($M=5.1$, $SEM=0.16$) were significantly different ($F_{2,87}=40.26$, $p<.01$). Scheffé *post hoc* analysis showed that the overall mean ratings for the inherent enjoyment of practice were lower than the overall means for practice relevance scores ($p<.01$) and for effort ($p<.01$) but not for practice relevance and practice effort ($p=.19$).

Daily Activity Ratings

Table 2 shows the mean ratings for the daily activities as well as the mean maze scores for the six blocks of practice. Maze scores were collapsed across the six practice blocks for comparison with means for daily activities. Ratings for both were consistent with the practice relevance, practice effort, and the inherent enjoyment of practice assumptions of the theory. For example, studying for finals received comparatively high ratings for activity relevance and high activity effort but low inherent enjoyment of the activity. Conversely, watching movies received low ratings for relevance and effort and high ratings for inherent enjoyment. The maze practice scores were consistent with the daily activities scores since mean practice relevance and practice effort ratings were comparatively high, while the mean inherent enjoyment practice rating was low. Pearson product-moment correlations for the activity rating were significant for pairs of scores: relevance with effort ($r = .83$, $p < .05$), relevance with inherent enjoyment ($r = -.82$, $p < .05$), and effort with inherent enjoyment ($r = -.64$, $p < .05$), as might be expected for common methods variance.

TABLE 2
Mean Relevance, Effort, and Inherent Enjoyment of School-related Activities and Ratings For Maze Memorization and Replication Practice Collapsed Across Practice Blocks 1–6 (0: Low; 10: High)

Task	Relevance[a]		Effort[b]		Inherent Enjoyment[c]	
	M	*SD*	*M*	*SD*	*M*	*SD*
Studying for Finals	9.4	1.0	9.1	1.4	2.2	2.1
Writing Papers	8.1	1.6	8.6	1.3	3.0	2.3
Attending Class	9.4	0.9	7.0	3.1	6.1	2.4
Practicing Sports	4.5	3.4	6.6	3.7	9.3	1.0
Playing Sports	4.3	3.5	6.9	3.6	9.6	0.9
Watching Movies	1.8	1.9	1.5	1.8	8.6	2.3
Maze Tasks	7.7	1.5	8.4	2.0	5.1	2.2

[ab]$r = .83$. [ac]$r = -.82$. [bc]$r = -.64$.

Discussion

The present findings are consistent with the assumptions of the theory that deliberate practice is perceived as relevant for improving performance and that it requires effort, but that it is not inherently enjoyable. These findings were also consistent with previous research showing that perceptions about the nature of deliberate practice can change as experience and performance changes (Hyllegard & Yamamoto, 2005).

While other investigations have supported the practice relevance and practice assumptions, at the same time, data also questioned the assumption of inherent enjoyment of practice based on findings that were opposite to those predicted (e.g., Helsen, *et al.*, 1998; Hodge & Deakin, 1998). The majority of the participants in those related studies had already achieved an expert or near expert performance in their particular domain of expertise. In those studies, the participants reflected on the relevance of general practice activities such as practice alone or technical skills for improving performance, the effort associated with activity, and the inherent enjoyment (or pleasure) associated with the activity (concentration was also rated in some studies). However, the participants did not actually engage in any specific deliberate practice activities and then rate those activities. As a consequence, the resulting ratings may have reflected more than a judgment following a practice session.

Another factor that may have contributed to the inherent enjoyment findings in the previous studies is that, when experts participated in practice, such practice often resembles rehearsal more than deliberate practice. The difference between rehearsal and deliberate practice is that deliberate practice is used to learn new skills, while rehearsal is used to refine already mastered or nearly mastered skills. Starkes, *et al.* (1996) found, for example, that high-level ice figure skaters allotted more practice time to rehearsing familiar skills, e.g., double jumps, than to practicing deliberately new or more difficult skills, e.g., triple jumps. In addition, the skaters tended to overestimate the number of jumps attempted during a given practice session than what they thought they actually attempted. So while the skaters may have thought they were engaging in deliberate practice activities during a practice session, they were actually spending more time either resting or rehearsing familiar skills. Similarly, in the same study wrestlers spent less time sparring than they believed they did, while at the same time they rated sparring as the most relevant activity for improving performance. As a consequence, the ratings reported in previous studies involving experts may have represented the enjoyable aspects of a typical practice session more than the more challenging aspects of practice.

Several of these related studies also reported ratings for a number of physical fitness-related activities, e.g., running, weight lifting, and swimming, along with ratings for domain-specific deliberate practice activities, e.g., technical skills, tactical skills, and working with the coach, for improving performance in their particular sport (Hodges & Starkes, 1996; Starkes, *et al.*, 1996; Helsen, *et al.*, 1998; Hodge & Deakin, 1998). In these studies, a total of 44 sets of fitness ratings and 18 sets of deliberate practice, practice relevance, practice effort, and inherent enjoyment of practice (or pleasure), as well as concentration ratings were reported. An examination of the mean ratings for these two types of activity shows that the deliberate practice activities were perceived as more relevant for improving performance than the fitness activities; the amount of effort for the two types of activity were similar; and the deliberate practice activities were rated higher on enjoyment than the fitness activities (see Appendix B, p. 446). This pattern for the domain-specific deliberate practice activities, when compared with fitness activities, is more consistent with ratings that would be expected for rehearsal rather than for deliberate practice, based on the theory of deliberate practice. The theory of deliberate practice does not specifically predict how experts would rate the relevance of rehearsal for improving performance, the effort needed to rehearse. When compared to deliberate practice, the theory would probably suggest that rehearsal is relevant for reliable performance, that rehearsal does not require as much effort, and that rehearsal is an inherently enjoyable activity.

One difference between the present study and other related studies concerns the activities which were the focus of the investigations. Each of the related studies involved experts in the psychomotor domain (either musicians or athletes) (e.g., Ericsson, *et al.*, 1993; Helsen, *et al.*, 1998; Lehmann, 2002; Young & Salmela, 2002), while the present study involved a novel task in the cognitive domain. One concern is whether the theory of deliberate practice applies to the type of activity found in the present study. Ericsson (2002) addressed this question and suggested that the same basic mechanisms which mediate performance improvements apply to any form of deliberate practice in any domain. Moreover, Ericsson and Lehmann (1996) suggested that experts in the cognitive and psychomotor domains rely on similar cognitive processes, while Ericsson and Kintsch (1995) suggested that memory processes in different domains function in the same way. Ericsson (1998, 1999) even suggested that the effects of deliberate practice also apply to creative activities in the arts in a fashion similar to practice in other domains. So while previous research has centered on experts in music and sports, it appears that investigations involving cognitive tasks may also be relevant for this line of research.

To the extent that the practice on this maze task can be generalized to other activities, present findings support the assumptions investigated here as suggested by the theory of deliberate practice. The theory only suggests that practice is perceived as relevant for improving performance, that it requires effort, but that it is not perceived as inherently enjoyable in a general sense. The theory does not specifically predict how these perceptions may be affected by changing practice conditions and performance (Ericsson, *et al.*, 1993). The present findings, as well as Hodges, Kerr, Starkes, Weir, and Nananidou's (2004) and Lehmann's (2002), suggest that perceptions formed about the nature of practice may depend, to some extent, on the nature of the specific practice activities and expertise of the performer.

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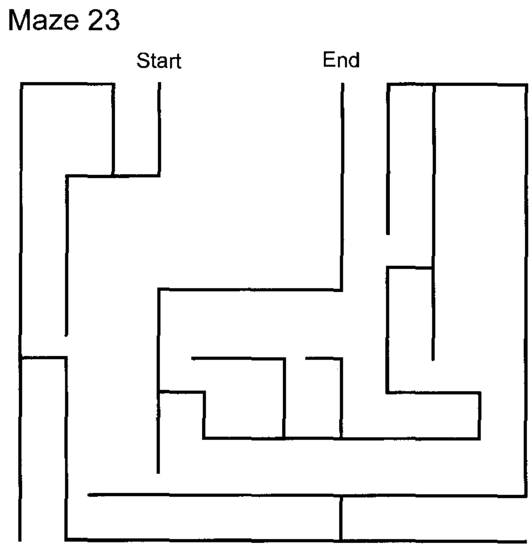
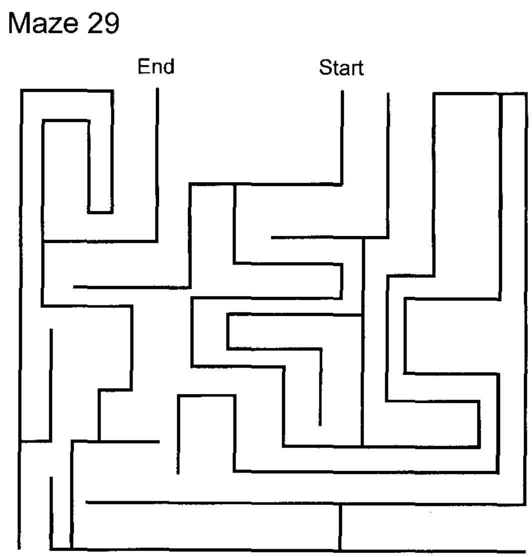
APPENDIX A

MAZE 23 AND MAZE 29 PATTERNS USED FOR MAZE MEMORIZATION AND REPLICATION TASKS





APPENDIX B

Physical Fitness and Deliberate Practice Activities Rated For Practice Relevance, Practice Effort, and Inherent Enjoyment of Practice in Prior Research

Table 3 shows combined mean ratings for physical fitness and deliberate practice for activities listed.

TABLE 3

Mean (±*SD*) Ratings of Practice Relevance, Practice Effort, and Inherent Enjoyment of Practice For Deliberate Practice Activities ($n = 18$) and Physical Fitness Activities ($n = 44$) Listed in Appendix B

Measure	Deliberate Practice		Physical Fitness		t_{60}	p
	M	*SD*	*M*	*SD*		
Practice relevance	8.3	2.0	6.0	1.9	4.26	<.01
Practice effort	7.2	2.0	6.6	1.2	1.63	.11
Inherent enjoyment	8.3	0.9	5.3	1.0	11.44	<.01

Starkes, J. L., Deakin, J. M., Allard, F., Hodges, N. J., & Hayes, A. (1996) Ice skating fitness practice; weight training, flexibility, jogging, cycling, swimming, and in-line skating; Ice skating deliberate practice; lessons with coach and on-ice training.

Helsen, W. F., Starkes, J. L., & Hodges, N. J. (1998) Soccer individual fitness practice; weights, flexibility, running and cycling; Team fitness practice: weights, running, flexibility, swimming, and cycling; Soccer individual deliberate practice: coach alone; Team deliberate practice: games and practice, and technical skills; Field hockey individual fitness practice: weights, flexibility, and running; Team fitness practice: weights, running, flexibility, and swimming; Individual deliberate practice: coach alone, and technical skills; Team deliberate practice: technical skills, and tactical skills.

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Hodges, N. J., & Starkes, J. L. (1996) Wrestling fitness practice with others: jogging, weights, running, flexibility, swimming, and cycling; Wrestling fitness practice alone: weights, flexibility, running, jogging, swimming, and cycling; Wrestling deliberate practice with others: mat work; Wrestling deliberate practice alone: work with coach.