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Research article

Practicing field hockey skills along the contextual interference continuum: A comparison of five practice schedules

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Abstract
To overcome the weakness of the contextual interference (CI) effect within applied settings, Brady (2008) recommended that the amount of interference be manipulated. This study investigated the effect of five practice schedules on the learning of three field hockey skills. Fifty-five pre-university students performed a total of 90 trials for each skill under blocked, mixed or random practice orders. Results showed a significant time effect with all five practice conditions leading to improvements in acquisition and learning of the skills. No significant differences were found between the groups. The findings of the present study did not support the CI effect and suggest that either blocked, mixed, or random practice schedules can be used effectively when structuring practice for beginners.

Key words: Skill acquisition, blocked practice, random practice.

Introduction

Over the years, an extensive amount of research has been directed toward finding the best practice structure to maximize learning. The two most common practice schedules that have been investigated and compared are blocked and random practice. These practice regimes represent low and high interference practice schedules, respectively. The first study comparing the effectiveness of both schedules in the motor learning domain was conducted by Shea and Morgan (1979) using a variety of laboratory tasks. The results revealed that there were immediate improvements in practice performance for blocked practice. However, when subjects were tested for retention on the same skills, the random practice group (who had performed worse during acquisition) subsequently performed better during retention. The term contextual interference (CI) was used to explain this effect.

According to the CI effect, practicing a motor skill in a random order causes high interference to the learner and hinders performance during acquisition but aids performance during retention and transfer. Conversely, practicing in blocked order creates low interference which allows for improvements in performance during acquisition, but these improvements diminish in retention or transfer. A review paper by Magill and Hall (1990) provides an overview of other studies that showed this effect.

More recently, a review by Brady (2008) found that while the CI effect was robust in laboratory settings, support for the effect in applied settings was not strong. Among other reasons, the complexity of sport skills when performed in field settings was suggested as a mitigating factor that negated the potential benefits of random practice. It is possible that when complex tasks are coupled with high interference practice schedules, the demands are too high on the information processing system and it is difficult for learning to take place (Wulf & Shea, 2002). Alternately, the intra-task difficulty of complex tasks could provide sufficient interference for learning even in low interference conditions.

Hence, instead of focusing on low and high interference schedules, there is an increasing need to examine different combinations of blocked and random practice within applied settings in order to determine the effects of moderate interference. It is possible that a moderate interference protocol could provide the benefits of both blocked and random practice orders for learning sport skills within applied settings. Lee and Wishart (2005) noted that an additional advantage of moderate interference could be avoidance of a mistaken impression about learning caused by overestimates or underestimates of progress when using blocked and random practice, respectively.

Most prior studies have compared only one mixed practice schedule with blocked and random practice. In some studies (e.g., Bortoli et al., 1992; Jarus & Goverover, 1999; Landin & Hebert, 1997; Porter & Magill, 2010; Porter & Saemi, 2010), the results favored the mixed interference groups. In other studies, no significant differences were found between the blocked, mixed, or random groups in retention (e.g., French et al., 1990; Granda et al., 2008; Jones & French, 2006; Landin, et al., 2001), while in one study, learning using a mixed schedule was found to be inferior to a high schedule but superior to a low schedule (Porter et al., 2007). Given these mixed findings, it is not possible to specify which moderate schedule will produce better learning or better retention. Moreover, different mixed practice schedules were used and no prior studies have compared two or more combinations of high and low interference in applied settings using sports skills.

Brady (1998) and Barreiros et al., (2007) also commented on the lack of support for the CI effect in applied settings, and they suggested that task characteristics could be responsible. Examination of previous studies using different sports or motor skills in their ap-

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plied/natural environment found that a majority consisted of ballistic propulsive tasks (e.g., baseball batting, badminton serve). However, in studies using serial tasks with high degrees of complexity, positive CI effects were found. For example, in Arnone-Bates et al., (1999), participants who practiced aerobic exercise skills which involved a series of movements under random conditions made the fewest errors. Similarly, in Smith (2002), participants in a random practice group were able to make the most controlled turns on a snowboard. To date, little information exists about the use of continuous tasks in CI studies and only two studies had incorporated continuous tasks. These tasks were hurdle running (Bortoli et al., 2002) and soccer dribbling (Granda, et al., 2008).

Therefore, the major purpose of this study was to further explore the influence of different practice schedules located along the CI continuum using sport skills. The secondary purpose was to investigate the influence of these practice schedules on a continuous skill while the tertiary purpose was to make comparisons between three moderate or mixed interference schedules which consisted of different combinations of high and low interference. It was hypothesized that a moderate interference practice schedule would be better for learning sport skills and in particular, a continuous skill. A moderate interference condition provided the advantages of practicing skills repeatedly as found in blocked practice and the benefits of enhanced processing as found in random practice. More specifically, the block-random schedule with progressions from blocked to random conditions may be most suitable for learning.

Methods

Participants

Fifty-five pre-university students (male =30, female = 25, *mean* age = 18.0 years, SD = 0.3) volunteered to participate in this field experiment. Participants were first screened using a Sport Experience Information Form to ensure that they had no prior experience in field hockey. Informed consent, in accordance with institutional ethical guidelines, was obtained from the students and parents (for participants under 18 years).

Tasks and measures

Participants were required to practice three basic field hockey skills: Indian dribble, push pass and hit. For the Indian dribble, participants were instructed to move the ball between two white lines indicated on an artificial turf surface. It is executed by dragging the ball to the left over a certain distance before turning the stick over the ball so that the flat side is to the left of the ball. This is followed by dragging the ball to the right before turning the stick over the ball so that the flat side of the stick is on the right side of the ball. Each time the ball crossed a line, a score of one point was awarded. The total number of times the ball was moved from end to end in 15 seconds was recorded. For the push pass and hit, participants were asked to push or hit the ball as fast and as accurately as possible towards a target. The target for the push pass was 2.44 m long (8 feet) and consisted of 11 segments that were alternately painted black and white. A score of 10 points was awarded when the ball was in contact with the centre part of the target. Corresponding segments away from the target were awarded 8, 6, 4 2 and 1 point, respectively. The target for the hit was 3.66 m long (12 feet), and the percentage of the number of times the ball contacted the target was recorded. In addition, a speed gun (Bushnell Speedster II©) was used during the testing sessions to record ball speed in kilometers per hour (km/h) for both the push pass and the hit. Figure 1 illustrates the layout for the Indian dribble, push pass and hit.

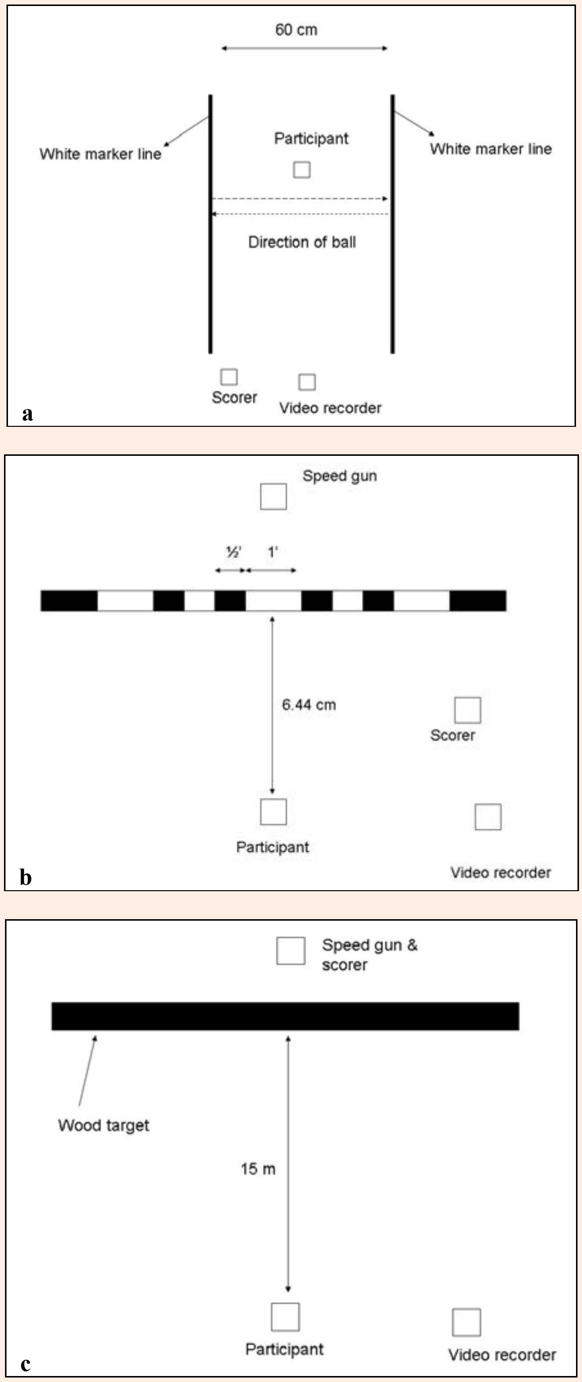

Figure 1. Design layouts for the a) Indian Dribble, b) Push Pass and c) Hit

Besides ball control, accuracy and speed, movement form was also assessed. A field hockey coach referred to a field hockey skills movement checklist which comprised of two phases. For Indian dribble, the two phases comprised of the preliminary position and ball control phases, with the scores ranging from 1 to 3 points for both phases. For the push pass and the hit, the two phases comprised of the preliminary position and ball contact/follow-through phases and the scores for both phases ranged from 1 to 4 points. Only the third trial for each participant was viewed and provided with a rating score. Another field hockey coach randomly viewed 20 trials of each skill and inter-tester reliability was calculated using intraclass correlation (ICC). For Indian dribble, ICC was .74 for preliminary position and .71 for ball control. For push pass, ICC was .73 and .81 for preliminary position and ball contact phases, respectively. As for the hit, ICC was .73 for the preliminary position and .71 for the ball contact phase. By convention, values above 0.70 are considered as substantial and acceptable inter-rater reliability (Garson, 2010).

Experimental practice groups

Based on their locations on the CI continuum, the five practice groups in order were blocked, serial, randomized-blocks, block-random and random. The blocked group represented a practice schedule nearer to the low interference end of the continuum, while the random group represented a practice schedule nearer to the high interference end of the continuum. The other three practice schedules represented moderate interference and consisted of different combinations of blocked and random orders. The block-random condition had a higher number of random changes than the randomized-blocks and serial groups. The serial condition had the same amount of task changes as the randomized-block group but with less interference as these changes were predictable.

Procedures

The duration of the study was five weeks, and participants attended eight sessions within this period. In the first session, the experimenter explained the procedures of the study and how the sessions would be conducted. Accompanied with verbal explanations, a national-level field hockey player demonstrated the way to execute the Indian dribble, push pass and hit. Following that, the pre-test commenced that consisted of three blocks of five trials for each skill. Only the scores of the last block of five trials were used as pre-test scores. At the end of the pre-test, the participants were randomly assigned to one of five practice orders. The five orders were the blocked (n = 11), serial (n = 12), randomized-blocks (n = 11), block-random (n = 11) and random (n = 10).

During the acquisition phase, participants undertook two practice sessions each week for three consecutive weeks. At the first practice session, all participants were once again shown the techniques for the Indian dribble, push pass, and hit. After the demonstration, a sheet containing the number of trials and practice order of skills was provided to participants according to group assignment. The practice order of the three skills was counterbalanced across participants and practice sessions.

All skills were practiced in an isolated, closed skill manner. In total, all participants practiced 45 trials in each practice session, with 15 practice trials for each skill completed. Participants in the blocked group completed 15 practice trials for one skill before moving on to the other skills. Those in the serial group practiced blocks of 5 repetitions of each skill with the sequence repeated in the same order three times, while participants in the randomized-blocks group practiced blocks of 5 repetitions of each skill arranged in a quasi-random order. The block-random group initially rehearsed 10 trials of each skill in an order similar to the blocked group but then practiced in a quasi-random order for the remaining 15 practice trials. The random group practiced the three different skills in a quasi-random order with the same skill performed not more than twice in a row. Throughout the practice trials, no feedback was provided to the participants.

A research assistant was assigned to each practice area to monitor the session and assist with the flow of the practice and to clear the area of any hockey balls that got in the way. During practice sessions one, two, four and five, participants were cleared to leave the experiment area after returning the completed practice sheets. However, on practice sessions three and six, an acquisition test consisting of five trials of each skill was administered. A retention test took place one week after the final practice session. The acquisition and retention tests followed the same format as the pre-test.

Statistical analyses

The scores for the Indian dribble, push pass and hit were analyzed using a 5 Group (blocked, serial, randomized-blocks, block-random, random) x 4 Time period (pre-test, acquisition test 1, acquisition test 2, retention test) split plot analysis of variance (SPANOVA). Both the performance outcome scores and the movement form scores were analyzed in this way. Where necessary, corrections were made using a Huynh-Feldt adjustment and the level of significance was set at alpha < .05. Separate analyses were performed for each skill with all significant effects from the SPANOVA analyzed by follow-up ANOVA or paired-samples t-test. Strength of association were calculated using partial omega squared (ω^2) and based on criteria that $\omega^2 = 0.01$ is a small association, $\omega^2 = 0.059$ is a medium association and $\omega^2 = 0.138$ or larger is a large association (Kirk, 1995). Effect sizes for significant interactions were calculated using Hedges' g and based on criteria that 0.2 is small, 0.5 is medium and 0.8 is large (Stuttgen and Schwarz, 2010). Bonferroni adjustments were used for the post hoc comparisons.

Results

Means and standard deviations for the Indian dribble, push pass and hit across all groups are presented in Tables 1, 2 and 3, respectively.

Pre-test

No between group differences were observed on the pre-test scores for any of the performance outcome scores. Among the movement form scores, between group

Table 1. Indian dribble ball control and movement form means and standard deviations across four time periods for all treatment groups.

Indian Dribble	Pre-Test		Acquisition 1		Acquisition 2		Retention	
	M	(SD)	M	(SD)	M	(SD)	M	(SD)
Ball control								
Blocked	10.90	(2.59)	13.00	(2.83)	14.45	(3.05)	15.18	(2.71)
Serial	8.83	(2.37)	11.58	(2.84)	13.33	(3.11)	12.58	(2.91)
Randomized- blocks	9.18	(2.64)	13.55	(2.38)	16.73	(3.98)	15.82	(2.93)
Block-random	8.55	(1.86)	11.90	(2.74)	13.55	(3.67)	14.45	(3.96)
Random	9.00	(1.15)	12.90	(2.51)	13.90	(1.73)	14.70	(1.83)
Movement form								
Blocked	3.05	(.61)	3.95	(.90)	3.30	(.71)	3.23	(1.13)
Serial	1.67	(1.13)	3.21	(1.23)	2.88	(1.07)	2.75	(.72)
Randomized-blocks	2.32	(.78)	3.59	(1.26)	3.68	(.81)	3.36	(.90)
Block-random	2.36	(.92)	3.86	(.60)	3.55	(.85)	3.14	(1.00)
Random	2.15	(.71)	3.80	(.59)	3.55	(.86)	3.20	(.67)

differences were evident only for the Indian Dribble, F(4, 50) = 3.37, p = 0.009. In view of this finding, as suggested by Twisk (2003), movement form analyses for the Indian dribble were conducted using pre-test scores entered as a covariate.

Acquisition and retention

Indian dribble: For ball control, there was a significant main effect for time, F(3, 150) = 132.56, p < 0.001, partial ω^2 = 0.64, with the pre-test scores generally lower than scores on the acquisition and retention tests. The main effect for group was not significant, F(4, 50) =1.58, p = 0.19, but the interaction effect was significant, F(12,150) = 2.36, p = 0.008, partial ω^2 = 0.07. Follow-up paired-samples t-test indicated that performance in acquisition test 2 was better than the pre-test for blocked, t(10) = -8.59, p < .001, d = 1.21, 95% CI [-6.06, -1.03], serial, t(11) = -5.61, p < 0.001, d = 1.57, [-6.06, -1.03], randomized-blocks, t(10) = -7.09, p = 0.05, d = 2.14, [-6.06, -1.03], block-random, t(10) = -5.94, p = 0.05, d = 1.65, [-6.06, -1.03], and random groups, t(9) = -6.94, p = 0.05, d = 3.19, [-6.06, -1.03]. In addition, follow-up paired-samples t-test revealed that performance in retention was also better than the pre-test for blocked, t(10) = -11.14, p < 0.001, d = 1.55, 95% CI [-6.63, -1.91], serial, t(11) = -5.22, p < 0.001, d = 1.37, [-6.00, -1.51], randomized-blocks, t(10) = -11.51, p < .001, d = 2.29, [-9.11, -4.16], block-random, t(10) = -6.50, p < 0.001, d = 1.84, [-8.66, -3.16], and random groups, t(9) = -9.26, p < 0.001, d = 3.57, [-7.14, -4.26].

For movement form, there was a significant main effect for time, F(3,147) = 28.99, p < 0.001, partial ω^2 = 0.60, with scores during acquisition and retention better than during pre-test as revealed in the post hoc analysis. There did not appear to be any significant effect for group, F(4, 49) = 0.73, p = 0.57, nor was the interaction significant, F(12,147) = 0.66, p = 0.79.

Push pass: For accuracy, there were no significant effects for time, F(3,150) = 1.72, p = 0.16, group, F(4,50) = 0.24, p = 0.91, or for the time x group interaction, F(3,150) = .67, p = 0.77. However, for speed, there was a significant main effect for time, F(3,134) = 10.42, p < 0.001, partial ω^2 = 0.11, as well as a significant interaction effect, F(11,134) = 2.29, p = 0.014, partial ω^2 = 0.07. Follow-up paired-samples t-test indicated that speed performance during pre-test was poorer than during acquisition test 2 for the blocked, t(10) = -4.69, p = 0.001, d = 1.17, 95% CI [-12.32, -1.94] and random groups, t(9) =

Table 2. Push pass accuracy, speed and movement form means and standard deviations across four time periods for all treatment groups.

Push Pass	Pre-Test		Acquisition 1		Acquisition 2		Retention	
	M	(SD)	M	(SD)	M	(SD)	M	(SD)
Accuracy								
Blocked	4.91	(1.22)	5.81	(1.25)	5.18	(1.72)	5.91	(1.70)
Serial	5.42	(1.56)	4.83	(1.59	5.67	(2.15)	5.58	(.90)
Randomized- blocks	4.55	(1.51)	5.09	(1.97)	5.55	(1.92)	5.82	(1.89)
Block-random	5.00	(2.00)	5.45	(2.16)	5.09	(1.38)	5.64	(1.57)
Random	5.30	(2.31)	6.30	(1.57)	5.60	(1.90)	5.50	(2.01)
Speed (km/h)								
Blocked	24.55	(5.40)	31.80	(7.44)	31.67	(6.25)	29.93	(4.85)
Serial	25.50	(3.91)	25.80	(5.63)	28.33	(6.23)	26.00	(5.73)
Randomized- blocks	27.20	(8.15)	27.47	(10.46)	29.05	(7.75)	27.87	(8.02)
Block-random	24.43	(8.12)	25.31	(4.43)	26.05	(6.49)	25.89	(6.11)
Random	25.75	(4.14)	26.90	(5.34)	27.84	(5.60)	25.88	(3.95)
Movement form								
Blocked	5.45	(1.15)	5.50	(.55)	5.34	(.69)	5.82	(.64)
Serial	4.33	(1.05)	4.25	(1.41)	4.67	(1.05)	4.88	(.96)
Randomized-blocks	4.59	(1.43)	5.05	(.99)	5.55	(.47)	5.36	(.95)
Block-random	4.55	(1.25)	5.36	(.45)	5.14	(.71)	5.18	(.72)
Random	4.70	(1.69)	5.80	(.71)	5.20	(.54)	5.25	(.82)

Table 3. Hit accuracy, speed and movement form means and standard deviations across four time periods for all treatment groups.

Hit	Pre-Test		Acquisition 1		Acquisition 2		Retention	
	M	(SD)	M	(SD)	M	(SD)	M	(SD)
Accuracy								
Blocked	60.00	(29.66)	43.64	(21.57)	60.00	(23.66)	72.72	(22.40)
Serial	76.67	(20.60)	60.00	(24.12)	62.50	(18.15)	70.00	(30.15)
Randomized- blocks	63.64	(15.02)	58.18	(24.42)	72.73	(20.05)	69.10	(22.56)
Block-random	67.27	(13.48)	61.36	(28.64)	56.36	(23.35)	60.00	(26.83)
Random	58.00	(27.41)	64.00	(26.33)	58.00	(30.48)	62.00	(28.98)
Speed (km/h)								
Blocked	39.55	(12.16)	48.45	(12.07)	49.00	(13.57)	50.36	(15.06)
Serial	37.33	(12.46)	42.00	(13.62)	40.75	(13.72)	41.17	(16.12)
Randomized- blocks	37.64	(14.49)	38.73	(13.90)	42.73	(18.14)	41.82	(19.22)
Block-random	36.18	(14.11)	45.64	(9.44)	38.82	(12.58)	42.45	(15.55)
Random	39.40	(14.10)	43.50	(8.42)	39.10	(8.21)	43.70	(11.54)
Movement form								
Blocked	5.23	(.47)	5.50	(.32)	5.73	(.26)	5.59	(.38)
Serial	4.25	(.84)	4.92	(.56)	5.35	(.61)	5.13	(.93)
Randomized-blocks	4.68	(.68)	5.14	(.50)	5.48	(.39)	5.73	(.56)
Block-random	4.82	(.84)	5.27	(.52	5.45	(.57)	5.36	(.60)
Random	4.40	(1.17)	5.35	(.63	5.40	(.46)	5.35	(.41)

-2.66, p = 0.026, d = 0.41, [-6.72, 2.53], but the other groups did not change significantly over time. In addition, only the blocked group had better retention scores compared to the pre-test, t(10) = -4.80, p = 0.001, d = 1.01, 95% CI [-9.94, -0.82].

For movement form, there was a significant effect for both main factors of time, $F(3,127) = 7.40$, $p < 0.001$, partial $\omega^2 = 0.11$, and group, $F(4,50) = 2.60$, $p = 0.047$, partial $\omega^2 = 0.13$. Post hoc comparisons indicated that the pre-test scores across the groups were poorer than all the other tests. In addition, the blocked group performed significantly better than the serial group. No significant interaction effects were found, $F(10,127) = 1.74$, $p = 0.07$.

Hit: A significant main effect of time was not found for accuracy, $F(3,150) = 1.61$, $p = 0.18$ but one was present for speed, $F(3,137) = 5.70$, $p = 0.001$, partial $\omega^2 = 0.06$. Collectively, the speed performance for all groups had increased significantly in acquisition test 1 and in the retention test as compared to the pre-test. Neither the main effect for group nor the time x group interaction was significant for hit accuracy or hit speed, indicating that there were no differences between the experimental groups in either acquisition or retention.

For movement form, there was a significant main effect for time, $F(3, 122) = 29.90$, $p < 0.001$, partial $\omega^2 = 0.28$, and group, $F(4,50) = 2.68$, $p = 0.042$, partial $\omega^2 = 0.16$, but none were found for the interaction, $F(10, 122) = 1.17$, $p = 0.32$. All groups had significantly better performance in the acquisition and retention tests compared to the pre-test. A post hoc analysis for the group factor found that the blocked group had better performance than the serial group.

Discussion

The aim of this study was to investigate the influence of practice schedules with a range of CI on the acquisition and learning of three basic field hockey skills (i.e., Indian dribble, push pass, and hit) among pre-university students with no prior background in the sport. The results showed that there was a significant practice effect for ball control and speed performance outcome measures as well as for all movement form measures. Accuracy of the hit and push pass did not improve. Independent of practice conditions, a significant improvement was found when scores from the final acquisition and retention tests were compared with the pre-test, with a medium to large practical significance across time revealed. This means that the amount of practice were adequate for all five practice conditions to show improvements in the three skills in acquisition and learning of field hockey skills.

While the duration of practice, the number of sessions and trials of this study were sufficient to substantiate an improvement and learning of skills in terms of ball control, speed and movement form, the lack of improvement in the accuracy measures across time could be attributed to speed-accuracy trade-offs (i.e., the tendency to substitute accuracy for speed or vice versa in their movements; Fitts, 1954). In this study, participants were instructed to carry out the pushing and hitting skill "as accurately and as fast as possible". It appears that the speed component of the tests may have been given priority over the accuracy component.

Despite improvements in some aspects of each of the hockey skills, no significant differences were found between the five practice groups which had different combinations of high and low interference. This was the case for both rate of acquisition and the degree of retention. Several other studies using sports skills such as golf (Brady, 1997; Porter and Magill, 2004), volleyball (French et al., 1990; Meira and Tani, 2003; Jones and French, 2007; Zetou et al., 2007) and Ultimate® frisbee (Landin et al., 2003) have also failed to find differences between groups as a function of varying degrees of interference. In their review, Magill and Hall (1990) had proposed that for the CI effect to be present, tasks of different generalized motor programs (GMP) need to be practiced together. Yet, with the exception of the study by Porter and Magill (2004), the common denominator in these studies that showed no CI effect, was that the skills prac-

ticed consisted of tasks of different GMP.

It is interesting to note that significant differences were not found even in the Indian dribble despite sharing similar motor tasks characteristics as mentioned in Barreiros et al. (2007). They suggested that the CI effect appeared to be more evident in motor tasks that had a longer overall duration of movement and were made up of different components. The Indian dribble, being a continuous skill and which consisted of a series of movements, similarly had a longer timeframe between the start and end of a movement. The continuous nature also meant that participants had more practice on each trial in terms of duration and number of repetitions as the movement was repeated several times. Participants had the time to make small adjustments to the way they gripped the stick and the position of the body and legs in order to improve ball control.

A possible explanation for the absence of a CI effect was that the level of difficulty of the skills used in this study was high. Difficulty or complexity may be categorized in a number of ways, including degrees of freedom and Guadagnoli and Lee's (2004) challenge point notion of functional and nominal task difficulty. Nominal task difficulty is fixed and may be relatively high in the Indian dribble as it is not typically found in any other physical activity or sport. The functional task difficulty relative to the participants' skill and environment is also considered to be high for the Indian dribble, push pass and hit as more than 95% of the participants were leading a sedentary lifestyle (as reported in a sport experience information form). It is possible that the high nominal and functional task difficulty, as well as the substantial number of degrees of freedom from the three different skills, did not permit participants in the random condition to cope with the interference from both task and practice schedule.

Examination of previous studies comparing low, moderate and high interference practice schedules reveals that a number of different moderate interference schedules have been used. More specifically, moderate interference protocols have included alternating (Landin, et al., 2003; Wrisberg and Liu, 1991), blocked followed by random practice (French et al., 1990; Jarus and Goverover, 1999; Wegman, 1999), increasing interference (Porter and Magill, 2004; Porter and Magill, 2010; Porter and Saemi, 2010), randomized-blocks (Jones and French, 2007), serial (Bortoli, et al., 1992; Goode and Magill, 1986; Keller et al., 2006; Landin and Hebert, 1997), and serial-with-high-interference (Bortoli, et al., 1992). In addition to having different types of moderate protocols, the number of repetitions for block conditions and changes for random conditions were also different across studies for the same type of moderate interference. It was therefore difficult to establish which moderate interference procedures were superior to others because they were not compared against each other. One exception was by Al-Ameer and Toole (1993) who compared two moderate interference conditions and found that the serial group outperformed the serial-with-high-interference group, but this study was conducted in a laboratory setting.

In the present study, three moderate interference protocols (serial, randomized-blocks and block-random) were compared against one another. The randomized-block group had a blocked component of five repetitions as well as a random component, which resulted in eight changes of skill. The block-random group had a blocked component of eight repetitions with either 14 or 15 changes of skill while the serial group had the same number of repetitions and changes as the randomized-blocks protocol but these changes were predictable. Based on the findings, it appears that these combinations of blocked and random practice were neither better nor worse than low or high interference practice schedules. Thus, we were unable to resolve the issues pertaining to the CI effect of learning sport skills in applied settings. It is possible that the same explanation of task difficulty may apply to these three moderate interference practice schedules as there were varying degrees of randomness in each of the moderate interference schedules.

Although practice condition effects were not found, the rate of change in the five groups appeared to be somewhat different. More specifically, the blocked group tended to outperform the random group in all performance outcome measures and in movement form measures for both push pass and hit during the acquisition phase. The interference from the random schedule coupled with the complexity of task may have been too difficult for the subjects to deal with but the degree of interference just from the task itself may have been enough for the blocked group to improve and learn. At the same time, there were also smaller improvements in the moderate groups compared to the blocked group and this could be attributed to the design of the practice area. There was a separate station for each of the three skills at different locations on the practice area. This meant that the more random the condition, the more time and effort was spent in practice. It was observed that participants in groups with random conditions had at times showed signs of fatigue towards the end of the practice sessions as they moved from one station to another to execute the skills that were to be practiced. It is possible that the increased amount of time and effort spent in practice could have affected learning of new skills in the groups with random conditions.

Finally, given the uptrend in performance during acquisition, it may be argued that the number of practice trials may have been too few to elicit the CI effect despite being sufficient to substantiate an improvement in the skills across time. In previous studies, the number of practice trials ranged from 30 to 1800 (Barreiros et al., 2007). In this study, participants completed 270 trials by the end of practice. There was one study that had used the same number of practice trials (i.e., 270) and double the number of trials (i.e., 540 trials) to investigate if additional practice trials were necessary to elicit the CI effect (Sekiya et al., 1996). The results supported the rationale for using 270 trials as the authors found no differences between the two amounts of practice and suggested that both number of trials were adequate to allow the CI effect to emerge.

Conclusion

In summary, the findings of the present study failed to support the CI effect for the learning of hockey skills by beginners in a field setting. Thus, it appears that either low (blocked), moderate (mixed) or high (random) interference practice schedules can be used effectively when conducting a multiple skill practice session with these types of learners. Further research can be carried out using the same moderate interference practice schedules on multiple tasks with high degrees of similarity to investigate if parameter modifications could influence the CI effect when using sport skills. In addition, the number of repetition and changes of a mixed interference schedule could also be further explored. Finally, considering that more time and effort is spent in practice involving random practice schedules, it may be feasible to explore other forms of practice that represent random conditions instead of practicing the skills in isolation.

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Key points

- The contextual interference effect did not surface when using sport skills.
- There appears to be no difference between blocked and random practice schedules in the learning of field hockey skills.
- Low (blocked), moderate (mixed) or high (random) interference practice schedules can be used effectively when conducting a multiple skill practice session for beginners.

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