

## Research Quarterly for Exercise and Sport

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/urqe20>

### The Effect of Contextual Variety on the Practice, Retention, and Transfer of an Applied Motor Skill

Craig A. Wrisberg<sup>a</sup> & Zhan Liu<sup>a</sup>

<sup>a</sup> Department of Human Performance and Sport Studies , University of Tennessee , Knoxville , USA

Published online: 08 Feb 2013.

To cite this article: Craig A. Wrisberg & Zhan Liu (1991) The Effect of Contextual Variety on the Practice, Retention, and Transfer of an Applied Motor Skill, *Research Quarterly for Exercise and Sport*, 62:4, 406-412, DOI: [10.1080/02701367.1991.10607541](https://doi.org/10.1080/02701367.1991.10607541)

To link to this article: <http://dx.doi.org/10.1080/02701367.1991.10607541>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

## The Effect of Contextual Variety on the Practice, Retention, and Transfer of an Applied Motor Skill

Craig A. Wrisberg and Zhan Liu

*Laboratory research in motor learning has consistently demonstrated higher retention and/or transfer when practice occurs under conditions of high contextual variety (e.g., Lee & Magill, 1983; Newell & Shapiro, 1976; Shea & Morgan, 1979;). In the present study, an attempt was made to determine whether a contextual variety effect could be demonstrated in a standard physical education instructional setting. During practice trials on the long and short badminton serves, male and female subjects performed under either blocked (i.e., all trials of one serve followed by all trials of the other) or varied (i.e., alternating trials of long and short serves) conditions. Retention and transfer tests (i.e., using the service area opposite that employed during the practice phase) were administered at the end of the badminton unit. Although little difference was observed in the performance of the two groups during practice, alternating-trial subjects demonstrated significantly higher retention of the short serve and significantly higher transfer of both serves than blocked-trial subjects. The performance of male and female subjects was not differentially influenced by practice structure conditions. It was concluded that a practice schedule that requires performers to change their plan of action from trial to trial may facilitate the retention and transfer of motor skills in applied instructional settings.*

**Key words:** badminton, contextual interference, gender, motor learning, physical education, practice, retention, skill acquisition, transfer

For years, physical education teachers and coaches have attempted to develop practice schedules that promote the acquisition, retention, and transfer of motor skills. Recently, motor learning researchers have shown renewed interest in the topic of practice structure. Spearheaded by the work of Schmidt (1975) and later by that of John Shea and his colleagues (Shea & Morgan, 1979; Shea & Zimny, 1983), a number of investigators have conducted experiments comparing practice schedules in which subjects attempt a variety of movements with formats involving repeated attempts of the same movement, either within or between learning sessions (Carson & Wiegand, 1979; Del Rey, 1982; Del Rey, Whitehurst, Wughalter, & Barnwell, 1983; Del Rey, Wughalter, & Whitehurst, 1982; Gerson & Thomas, 1977; Lee & Magill, 1983; Moxley, 1979; Newell & Shapiro, 1976; Shea & Kohl, 1990, 1991; Shea, Kohl, & Indermill, 1990; Whitehurst & Del Rey, 1983; Wrisberg & Ragsdale, 1979). The results of most of these studies have revealed

higher retention and/or transfer performance for subjects receiving acquisition schedules in which different movements are attempted from trial to trial than for those in which repeated practice with one movement is completed before practice with another is undertaken.

Theoretical explanations for this trend have primarily centered on the notions of elaboration (Shea & Morgan, 1979; Shea & Zimny, 1983) and action plan reconstruction (Lee & Magill, 1985). Proponents of the elaboration view contend that trial to trial changes in the practice of a variety of movements promote (a) the maintenance of multiple items in working memory, (b) interitem elaboration and/or distinctive processing, and (c) the development of a stronger and more flexible memory representation. Reconstruction theorists, however, contend that varied practice facilitates learning and memory because at least partial forgetting of each movement variation occurs when other variations are practiced in between. Thus, each time a particular variation is attempted, more effortful processing is needed to reconstruct the response requirements of that movement. Conversely, repeated practice of the same variation is reasoned to be less beneficial because between-trial forgetting is less likely and therefore subjects can bypass the reconstruction process on all but the first trial in a block (see Magill & Hall, 1990, for a more complete discussion of the theoretical explanations).

Although the results of laboratory studies exploring practice structure appear to have relevance for the teacher/coach, little research has yet to be performed in

---

Craig A. Wrisberg is a professor and Zhan Liu is a doctoral student in the Department of Human Performance and Sport Studies at the University of Tennessee, Knoxville.

Submitted: March 18, 1991  
Revision accepted: August 1, 1991

applied contexts or with common motor skills. An exception is a study by Goode and Magill (1986) in which the badminton service was employed as the experimental task. During acquisition trials (three days a week for three weeks), subjects attempted (from the right court) three different serves (short, drive, and long) under one of three practice conditions. On each day, blocked-practice subjects performed 36 trials with one of the three serves while serial- and random-practice subjects received an equal number of trials (i.e., 12) with each serve. In the serial condition, serves were performed in a predictable and repeating order (e.g., short, long, drive, short, long, drive, etc.), whereas in the random condition serves were performed in a random order with no version attempted more than twice in succession. Thus, all subjects received the same number of acquisition trials with each serve (i.e., 108) but under different practice structures. On the day following the acquisition phase, all subjects received six retention trials with each of the three serves in a random sequence followed by a transfer test involving another random sequence of 18 trials from the opposite (i.e., left) service court. Although no differences were found between groups on any of the serves during the acquisition phase, the random condition demonstrated significantly higher retention and transfer of the short service than did the blocked condition (Note 1). Thus, it was concluded that the implementation of a practice structure characterized by contextual variety may in some instances have a positive effect on the retention and transfer performance of an applied sport skill.

Although the Goode and Magill (1986) study was an important attempt to establish the ecological validity of the practice variety phenomenon, the experiment was conducted under controlled conditions typically not present in a physical education class. For example, subjects were tested individually rather than in a group setting, received instruction only with respect to the three serves, and were screened for previous racquet sport experience. Before practitioners can be expected to implement the findings of motor learning research in regular class settings, experimental effects need to be demonstrated in naturally occurring instructional contexts. With respect to the issue of current pedagogical attitudes about practice structure, Goode and Magill have observed that contemporary teacher instruction texts (e.g., Harrison, 1983; Rink, 1985) continue to emphasize motor skill acquisition sessions that are more blocked than varied in nature. Thus, the primary purpose of the present study was to determine the effect of contextual variety on the practice, retention, and transfer of the long and short badminton service in a standard college physical education class.

A secondary purpose addressed the possibility that male and female subjects may be differentially influenced by practice structure manipulations. In at least two previous studies, varied conditions have been found to

benefit the transfer performance of (a) females more than males (Wrisberg & Ragsdale, 1979), and (b) females with a greater amount of prior open skill experience than females with only average levels of prior experience (Del Rey et al., 1982). In both experiments, an open skill (i.e., coincident timing) was used as the criterion task (see Poulton, 1957, for a more detailed discussion of open and closed skills). It remains to be determined whether a Practice Structure  $\times$  Gender interaction exists for closed skills. Thus, in the present study similar proportions of males and females were assigned to each practice-structure condition.

## Method

### Subjects

The subjects were male ( $n = 32$ ) and female ( $n = 20$ ) students from two elementary badminton classes at the University of Tennessee, Knoxville. All subjects volunteered to take part in the experiment, and none received payment or class credit for their participation. Informed consent was obtained from the subjects prior to initiation of the study.

### Tasks

The badminton tasks of interest in this study were the clear (or long) service and the short service. All serves were practiced and tested on a regulation court. Subjects used regulation racquets and plastic (Carlton blue stripe) shuttlecocks.

A modification of the French Short Serve Test (French & Statler, 1949) was used to assess short serve performance. A rope was extended between two portable standards 50 cm above the height of the net. Four concentric scoring areas, each 20-cm wide, were drawn on opaque sheets of paper, which were placed on the floor in the service court. The first scoring zone began at the intersection of the center line and the short service line and extended 55 cm from the intersection. The outside boundaries of the remaining zones were 75, 95, and 115 cm from the intersection. Point values assigned to the four zones (beginning with the one closest to the intersection) were five, four, three, and two, respectively. Serves landing outside the 115-cm arc but within the doubles service court area received a score of one, and those landing outside the doubles service area received a score of zero. Serves landing on the line between two scoring zones were awarded the higher point value. Any serve passing above the rope resulted in a one-point deduction. Reliability of the French Short Serve Test has been established using odd-even and Spearman Brown methods with coefficients ranging from .51 to .89 (Johnson & Nelson, 1974).

Performance of the long serve was evaluated using the Poole Long Serve Test (cited in Johnson & Nelson, 1974). Four lines were created (using yarn and masking tape) to form the scoring zones. The first was placed 5 cm behind and parallel to the back boundary line, and the second was placed 40 cm inside the first. The remaining two lines were located parallel to and 40 and 80 cm, respectively, inside the back doubles service boundary. Point values corresponding to the resulting four 40-cm wide zones were five, four, three, and two, respectively, beginning with the deepest zone. Serves landing outside the zones but within the singles service court received a score of one, those landing on a line between two zones received the higher point value, and those landing outside the singles service area received a score of zero. Any serve passing lower than the judged height of an opponent standing with racquet extended near the front of the service area resulted in a one-point deduction. Reliability of the Poole Long Serve Test has been previously established (see Johnson & Nelson, 1974) using the test-retest method ( $r = .81$ ).

### Procedures

Classes were held on a Monday, Wednesday, Friday schedule and lasted 50 min each. The experiment was conducted midway through a seven-week unit. At that time all of the fundamental shots of badminton, including the long and short serve, as well as the rules of singles and doubles play, had been introduced, and students had the opportunity to practice the various shots and to participate in both types of games.

Following a presentation by one of the principal investigators of the requirements of the study, volunteers were asked to sign consent forms. A pretest of long and short serve performance was then administered. Subjects attempted six trials of each type serve in a blocked fashion with the order of presentation of the blocks counterbalanced among subjects. The results of the pretest were used to form two groups with statistically equivalent scores on the two serves. The resulting groups also contained equal proportions of male ( $n = 16$ ) and female ( $n = 10$ ) students.

The experiment consisted of two phases, a practice phase and a test phase. The practice phase covered five class periods in which subjects performed nine short serves and nine long serves. On each day subjects in the blocked condition attempted all of their trials with one type of serve before practicing the other. The ordering of trial blocks was counterbalanced among subjects. Subjects in the varied (i.e., alternating) condition practiced all serves in an alternating fashion (e.g., long, short, long, short, etc.), with sequence order counterbalanced among subjects. All practice trials occurred at the beginning of each class period and were followed by participation in singles or doubles tournament play. Subjects worked in

pairs, with one person attempting the serves while a partner (a) called out the type of serve to be performed, (b) verbally reported the score for each serve, and (c) recorded the score on the server's data sheet. When servers had completed their practice trials, they switched roles with recorders.

During the test phase subjects performed 12 long serves and 12 short serves in an alternating fashion with sequence order counterbalanced among subjects in each group. The first 12 trials (6 of each type of serve) constituted a retention test and involved the same service area used for the practice phase (i.e., the deuce court). The second 12 trials represented a transfer test and involved the opposite service area (i.e., the ad court). Testing was conducted in a conventional fashion, with the experimental investigators and course instructor administering the test and recording all results. As is the case in most skills test settings, students were allowed to warm up and then either attempt their round of serves or watch/wait while others were being tested. After completing the test, students engaged in tournament play. No verbal feedback was given to subjects during the test phase.

### Results

As mentioned earlier, the results of the pretest were used as a basis for assigning subjects to the two experimental conditions. This was done to ensure that the groups possessed similar levels of serving skill at the beginning of the practice phase. A Groups  $\times$  Gender MANOVA (Wilks'  $\lambda$ ) was then conducted on the pretest data (see Table 1) using long and short serve performance (total score for each) as dependent variables. As expected no significant main or interaction effects were found ( $ps > .30$ ).

#### Practice Phase

Performance during the practice phase (see Table 2) was analyzed with a Groups  $\times$  Gender  $\times$  Days MANOVA with repeated measures on the last factor (see Schutz &

**Table 1.** Means and standard deviations for pretest performance of male and female subjects in each group

Serve	Group	Gender	<i>M</i>	<i>SD</i>
Long	Blocked	Female	15.1	6.9
		Male	16.8	5.3
	Alternating	Female	14.1	5.2
		Male	15.3	5.0
Short	Blocked	Female	12.1	5.6
		Male	11.1	4.3
	Alternating	Female	13.6	3.9
		Male	12.8	5.6

Gessaroli, 1987). Because preliminary analyses revealed only mild violations of the sphericity assumption (H-F Epsilons: long serve = .99, short serve = .95), separate MANOVAs were performed on each serve with the total score for each day used as the dependent measure.

Inspection of Figure 1 indicates that improvements in the performance of both serves occurred over practice, with consistently higher scores being produced on the long serve than on the short serve. Tests for within-subject effects revealed a significant effect of days for both the long serve,  $F(4, 45) = 23.33, p < .01$ , and the short serve,  $F(4, 45) = 26.24, p < .01$ . A follow-up analysis of the days effects was conducted using the Ryan-Einot-Gabriel-Welsch multiple range test. In the case of the long serve, performance on Day 5 ( $M = 31.0, SD = 5.6$ ) was significantly ( $p < .05$ ) higher than that on Days 1 ( $M = 24.0, SD = 6.4$ ), 2 ( $M = 24.6, SD = 5.8$ ), and 3 ( $M = 26.7, SD = 6.9$ ), and performance on Day 4 ( $M = 28.7, SD = 6.0$ ) was significantly higher than that on Days 1 and 2. For the short serve, performance on Day 5 ( $M = 25.8, SD = 4.7$ ) was significantly higher than that on all other days, performance on Day 4 ( $M = 23.0, SD = 4.9$ ) was significantly higher than that on Days 1 ( $M = 19.0, SD = 5.7$ ) and 2 ( $M = 19.9, SD = 5.7$ ), and performance on Day 3 ( $M = 21.8, SD = 6.1$ ) was significantly higher than that on Day 1.

The only significant interaction of days with either of the between-subjects variables was a Groups x Days interaction for the short serve,  $F(4, 45) = 2.74, p < .05$ . Subsequent simple main effects analysis revealed that the performance of the blocked condition was significantly higher than that of the alternating condition on both Day 4 ( $M = 24.4, SD = 4.96; M = 21.6, SD = 4.51$ , respectively) and Day 5 ( $M = 27.3, SD = 4.48; M = 24.4, SD = 4.46$ , respectively).

Analyses of between-subjects effects produced only a significant main effect of gender for the long serve,  $F(1, 48) = 6.95, p < .01, w^2 = .12$  (Tolson, 1980). Inspec-

tion of the means for this effect indicated that the score for males ( $M = 28.3, SD = 6.4$ ) was significantly higher than that for females ( $M = 24.9, SD = 6.5$ ).

### Test Phase

**Retention.** To assess the effects of practice condition on the retention of the long and short serves, a Groups x Gender MANOVA was performed on the total test scores for the two serves (see Table 3). The only hypothesis to be rejected was that of no overall groups effect,  $F(2, 47) = 6.99, p < .01$ . Follow-up ANOVA procedures revealed that the retention performance of the alternating group ( $M = 19.3, SD = 3.9$ ) was significantly higher than that of the blocked group ( $M = 14.3, SD = 5.0$ ) on the short serve only,  $F(1, 48) = 14.23, p < .01, w^2 = .23$ . Although the same trend in mean scores was found for the long serve, the difference between groups was not significant.

**Transfer.** Following the retention test, subjects were asked to perform the two serves using the service area opposite that employed during the practice phase and on the retention test. The results of the Groups x Gender MANOVA on transfer performance (see Table 3) revealed only a significant overall groups effect,  $F(2, 47) = 7.57, p < .01$ . A follow-up ANOVA indicated that the performance of the alternating condition was significantly higher than that of the blocked condition for both the long ( $M = 21.5, SD = 3.7; M = 16.9, SD = 4.4$ ) and short ( $M = 18.1, SD = 4.3; M = 14.8, SD = 4.7$ ) serves,  $F(1, 48) = 14.33, p < .01, w^2 = .23$ , and  $F(1, 48) = 5.51, p < .05, w^2 = .11$ , respectively. As was the case in the practice phase, subjects produced higher scores on the long serve than on the short serve.

### Discussion

Although considerable evidence from laboratory studies has suggested support for the notion that contextual variety during skill acquisition enhances the retention and/or transfer of motor skills (Carson & Wiegand, 1979; Del Rey, 1982; Del Rey et al., 1982, 1983; Gerson & Thomas, 1977; Lee & Magill, 1983; Moxley, 1979; Newell & Shapiro, 1976; Shea & Kohl, 1990, 1991; Shea et al., 1990; Shea & Morgan, 1979; Shea & Zimny, 1983; Whitehurst & Del Rey, 1983; Wrisberg & Ragsdale, 1979), little work has been done to determine the generalizability of those results to intact teaching/learning environments. The present study was conducted within the setting of a college physical education class to determine whether contextual variety influenced the practice, retention, and/or transfer of badminton serving skills. A secondary purpose was to assess the relative impact of practice structure on the performance of male and female subjects. Such a possibility had been suggested

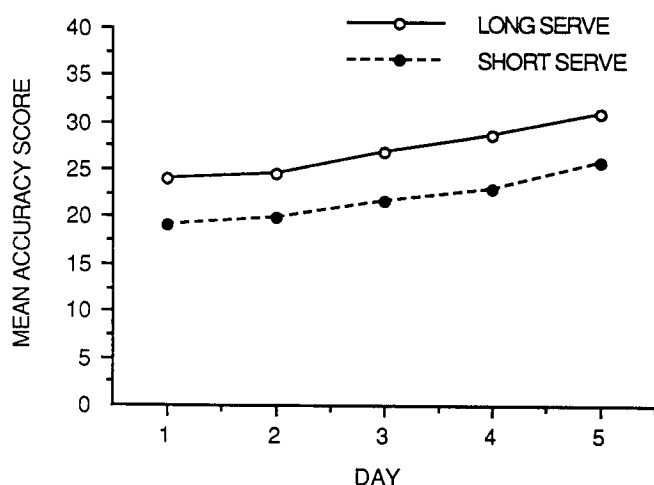


Figure 1. Mean accuracy scores for the two serves over the five days of practice.

**Table 2.** Means and standard deviations for practice performance of male and female subjects in each group on each day

Serve	Group	Gender	Day 1		Day 2		Day 3		Day 4		Day 5	
			<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Long	Blocked	Female	21.9	6.7	24.9	3.0	26.3	6.7	27.6	6.7	30.5	7.5
		Male	25.1	6.0	24.5	6.4	28.2	6.1	29.9	4.6	31.3	4.5
	Alternating	Female	20.7	6.1	22.8	7.1	22.3	6.0	25.2	4.8	27.2	5.6
		Male	26.3	6.0	25.6	5.9	28.3	7.4	30.4	6.9	33.3	4.4
Short	Blocked	Female	17.2	6.2	18.1	6.3	23.0	6.0	24.8	6.0	27.4	4.1
		Male	20.3	4.5	20.4	5.1	21.1	5.4	24.2	4.4	27.3	4.8
	Alternating	Female	20.2	6.9	20.5	6.9	22.3	7.8	20.7	5.8	23.8	4.8
		Male	18.1	5.6	20.3	5.3	21.4	6.1	22.1	3.6	24.8	4.4

from the results of two earlier studies that revealed the performance of female subjects was particularly sensitive to practice structure manipulations (Del Rey et al., 1982; Wrisberg & Ragsdale, 1979).

During the practice phase of the present study, significant improvements in the performance of both the long and short badminton serves occurred for both the alternating-trials and blocked-trials groups. The only significant effect involving groups was a Groups  $\times$  Days interaction for the short serve in which the performance of blocked-practice subjects was found to be higher than that of alternating-practice subjects on the last two days of practice. Although this effect is in the direction predicted by contextual interference theory, the general absence of group differences found during the practice phase coincides more with the results of other research using applied tasks/settings (Goode & Magill, 1986; Wrisberg, 1991). It should also be noted that while group differences were obtained during acquisition trials in initial research on the contextual variety effect (e.g., Shea & Morgan, 1979; Shea & Zimny, 1983), they have not been replicated in more recent studies (e.g., Wright, 1991). Taken together, the existing evidence suggests that the prediction of superior acquisition performance by blocked-practice subjects proposed by Battig (1966, 1979) for the verbal domain may not be appropriate for the learning of motor tasks.

In contrast to the relative lack of group differences found during the practice phase of the present study, the results of skills tests conducted on the final day of class revealed a clear superiority for the alternating-practice condition. This was reflected in significantly higher retention scores for the short serve as well as higher transfer scores for both serves when subjects were switched to a situation involving the use of the service area opposite that employed during the practice phase and on the retention test. Because the general goal of practice is to prepare performers for competition situations and because the game of badminton favors participants who vary their serves from point to point, an alternating-trial context was selected for the retention and transfer tests. Therefore, it might be argued that at least some of the

**Table 3.** Means and standard deviations on retention and transfer tests for male and female subjects in each group

Serve	Group	Gender	<i>M</i>	<i>SD</i>
<i>Retention Test</i>				
Long	Blocked	Female	17.7	4.6
		Male	19.3	4.5
	Alternating	Female	19.9	3.3
		Male	21.1	4.5
Short	Blocked	Female	14.6	5.0
		Male	14.1	5.1
	Alternating	Female	19.0	5.0
		Male	19.6	3.3
<i>Transfer Test</i>				
Long	Blocked	Female	16.7	4.1
		Male	17.0	4.8
	Alternating	Female	19.7	3.5
		Male	22.7	3.4
Short	Blocked	Female	15.3	5.9
		Male	14.4	4.0
	Alternating	Female	17.0	3.9
		Male	18.8	4.5

difference in the performance of the two groups was because testing occurred in a familiar context for the alternating-trial condition but in an unfamiliar one for the blocked-trial condition (see Lee, 1988 for a more detailed discussion of this issue). However, two lines of evidence mediate against the conclusion that the extent of similarity of practice/test context was the primary explanation for group differences. Earlier research by Shea and Morgan (1979) revealed that the retention and transfer performance of varied groups was superior to that of blocked groups in *both* blocked and random contexts. Moreover, in a study similar to the present one (Wrisberg, 1991), higher retention of badminton serving skill was found for varied-practice subjects than for blocked-practice subjects when testing was conducted in a blocked context. Thus, it is likely the benefits derived from practicing serves in a nonrepeated fashion in the present study owed to something besides similarity of practice-test context.

Analysis of the performance of males and females in the two groups during each phase revealed few differences. In fact, the only significant gender effect was obtained during the practice phase for the long serve where the score of females collapsed across days was lower than that of males. No gender differences were obtained during the retention or transfer phases of performance. Thus, the present findings suggest little support for the notion that contextual variety during the practice of a motor task influences the retention or transfer performance of adult female subjects differently than that of adult males (Note 2). These results conflict with those of Wrisberg and Ragsdale (1979), who found significant differences in the transfer performance of varied- and blocked-practice females but not males. It is possible that the differential pattern of findings in that study and the present one was due in part to the type of skill (i.e., closed vs. open) utilized. Obviously, further work is required to determine the circumstances under which a Practice Structure x Gender interaction may be expected to exist in the practice, retention, and transfer of motor skills.

In conclusion, the results of the present study suggest that the contextual variety effect, which has been reported in laboratory studies using novel tasks, is also generalizable to a standard physical education instructional setting. While corroboration of these findings in other applied situations is necessary, they appear to offer interesting possibilities for teachers/practitioners concerned with optimizing the benefits of practice periods.

## References

- Battig, W. F. (1966). Facilitation and interference. In E. A. Bilodeau (Ed.), *Acquisition of skill* (pp. 215-244). New York: Academic Press.
- Battig, W. F. (1979). The flexibility of human memory. In L. S. Cermak & F. I. Craik (Eds.), *Levels of processing in human memory* (pp. 23-44). Hillsdale, NJ: Erlbaum.
- Carson, L. M., & Wiegand, R. L. (1979). Motor schema formation and retention in young children: A test of Schmidt's schema theory. *Journal of Motor Behavior*, 11, 247-251.
- Del Rey, P. (1982). Effects of contextual interference on the memory of older females differing in levels of physical activity. *Perceptual and Motor Skills*, 55, 171-180.
- Del Rey, P., Whitehurst, M., Wughalter, E., & Barnwell, J. (1983). Contextual interference and experience in acquisition and transfer. *Perceptual and Motor Skills*, 57, 241-242.
- Del Rey, P., Wughalter, E. H., & Whitehurst, M. (1982). The effects of contextual interference on females with varied experience in open sport skills. *Research Quarterly for Exercise and Sport*, 53, 108-115.
- French, E., & Statler, E. (1949). Study of skill tests in badminton for college women. *Research Quarterly*, 17, 257-272.
- Gerson, R. F., & Thomas, J. R. (1977). Schema theory and practice variability within a neo-Piagetian framework. *Journal of Motor Behavior*, 9, 127-134.
- Goode, S., & Magill, R. A. (1986). Contextual interference effects in learning three badminton serves. *Research Quarterly for Exercise and Sport*, 57, 308-314.
- Harrison, J. M. (1983). *Instructional strategies for physical education*. Dubuque, IA: W. C. Brown.
- Johnson, B. L., & Nelson, J. K. (1974). *Practical measurements for evaluation in physical education*. Minneapolis, MN: Burgess.
- Lee, T. D. (1988). Transfer-appropriate processing: A framework for conceptualizing practice effects in motor learning. In O. G. Meijer & K. Roth (Eds.), *Complex movement behavior: The motor-action controversy* (pp. 201-215). Amsterdam: North-Holland.
- Lee, T. D., & Magill, R. A. (1983). A locus of contextual interference in motor skill acquisition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 9, 730-746.
- Lee, T. D., & Magill, R. A. (1985). Can forgetting facilitate skill acquisition? In D. Goodman, R. B. Wilberg, & I. M. Franks (Eds.), *Differing perspectives in motor learning, memory, and control* (pp. 3-22). Amsterdam: North-Holland.
- Magill, R. A., & Hall, K. G. (1990). A review of the contextual interference effect in motor skill acquisition. *Human Movement Science*, 9, 241-289.
- Moxley, S. E. (1979). Schema: The variability of practice hypothesis. *Journal of Motor Behavior*, 11, 65-70.
- Newell, K. M., & Shapiro, D. C. (1976). Variability of practice and transfer of training: Some evidence toward a schema view of motor learning. *Journal of Motor Behavior*, 8, 233-243.
- Poulton, E. C. (1957). On prediction in skilled movements. *Psychological Bulletin*, 54, 467-478.
- Rink, J. E. (1985). *Teaching physical education for learning*. St. Louis: Times/Mirror Mosby College Publishing.
- Schmidt, R. A. (1975). A schema theory of discrete motor skill learning. *Psychological Review*, 82, 225-260.
- Schutz, R. W., & Gessaroli, M. E. (1987). The analysis of repeated measures designs involving multiple dependent measures. *Research Quarterly for Exercise and Sport*, 58, 132-149.
- Shea, C. H., & Kohl, R. M. (1990). Specificity and variability of practice. *Research Quarterly for Exercise and Sport*, 61, 169-177.
- Shea, C. H., & Kohl, R. M. (1991). Composition of practice: Influence on the retention of motor skills. *Research Quarterly for Exercise and Sport*, 62, 187-195.
- Shea, C. H., Kohl, R. M., & Indermill, C. (1990). Contextual interference: Contributions of practice. *Acta Psychologica*, 73, 145-157.
- Shea, J. B., & Morgan, R. L. (1979). Contextual interference effects on the acquisition, retention, and transfer of a motor skill. *Journal of Experimental Psychology: Human Learning and Memory*, 5, 179-187.
- Shea, J. B., & Zimny, S. T. (1983). Context effects in memory and learning movement information. In R. A. Magill (Ed.), *Memory and control of action* (pp. 345-366). Amsterdam: North-Holland.
- Tolson, H. (1980). An adjunct to statistical significance:  $w^2$ . *Research Quarterly for Exercise and Sport*, 51, 580-584.
- Whitehurst, M., & Del Rey, P. (1983). Effects of contextual interference, task difficulty, and levels of processing on pursuit tracking. *Perceptual and Motor Skills*, 57, 619-628.
- Wright, D. L. (1991). The role of intertask and intratask processing in acquisition and retention of motor skills. *Journal of Motor Behavior*, 23, 139-145.

- Wrisberg, C. A. (1991). A field test of the effect of contextual variety during skill acquisition. *Journal of Teaching in Physical Education, 11*, 21-30.
- Wrisberg, C. A., & Ragsdale, M. R. (1979). Further tests of Schmidt's schema theory: Development of a schema rule for a coincident timing task. *Journal of Motor Behavior, 11*, 159-166.

## Notes

---

1. It was not reported whether the short serve performance of the serial condition differed significantly from that of either the random or blocked conditions during either the retention or transfer phases.

2. Because the significant gender difference obtained for the long serve during the practice phase was eliminated on the retention and transfer tests, it might, however, be argued that the additional serving practice, regardless of the way it was structured, was more beneficial to female than to male subjects.

## Authors' Notes

---

We extend our appreciation to Kim Bearden for assistance with data collection and to Ed Howley, Ann Reed, and Tinah Utsman for technical support. Address all correspondence and requests for reprints to Craig A. Wrisberg, 344 HPER, The University of Tennessee, Knoxville, TN 37996-2700.