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Contextual Interference Effects in Learning Three Badminton Serves

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This study investigated the generalizability of results of contextual interference effects by extending previous laboratory research to a field setting. Thirty female subjects (N = 30) learned three badminton serves in either a blocked (low interference), serial (mixed interference), or random (high interference) practice schedule. The subjects practiced the serves three days a week for three weeks. On the day following the completion of practice the subjects were given a retention and transfer test. Results replicated previous findings of contextual interference research by showing a significant group by block interaction between acquisition trials, retention, and transfer. The random group performed better on both retention and transfer than the blocked group. The significant trial block by contextual interference interaction also supports the generalizability of contextual interference effects, as posited by Shea and Morgan (1979), to the teaching of motor skills.

Key words: contextual interference, badminton, acquisition, retention, transfer.

A common conclusion of motor learning research stresses the possible application of the data to an educational setting (e.g., Shea & Morgan, 1979). Generalizability is indeed one of the goals of science, yet very few studies have confirmed that experimentally contrived results are reproducible in a "real world" setting (Whiting, 1982). The difficulty in controlling the multitude of variables and the inability to adequately attribute the variance to specific factors explains, in part, the absence of such studies. However, the need for generalizability still remains, as Knapp (1963) succinctly pointed out by concluding that much of current motor learning findings, which are based mainly on verbal and fine motor skills, "may not be applicable to the activities involving the big-muscle groups of the body" (p. i).

Generalizability of results from motor learning research encompasses a wide spectrum of application concerns. One of these application areas is instructional strategies. Variables such as knowledge of results (KR), attention, practice scheduling, and mental practice have provided data which textbook writers have felt justified in generalizing to practical learning situations (e.g., Magill, 1985; Schmidt, 1982). Despite this mass of empirical findings, teacher education literature (e.g., Bucher & Koenig, 1983) refers to a "gap" between theory and application. Stallings (1982) suggested motor learning research could help bridge this gap, "if we continue to (1) refine our theoretical models, (2) validate them in the practical situation, and (3) translate them into instructional procedures applicable to the practitioner" (p. 194).

In line with these suggestions, human behavior may be studied in the laboratory, but as the significance of the treatment differences are recognized, the scope of the experiment can be enlarged to include field experimentation. Within this transition meaningful results can be derived despite the fewer methodological constraints (Thomas, 1980). Speculations made as to the effect of various treatments on human learning are tested in a setting that is as realistic as possible. These findings give pertinent information to the researcher about the powerful effect of context and other real world variables on the learning processes of the individual. These results also present to the practitioner more translatable information than might be derived from laboratory data.

In the experiment presented in this paper, the call for testing theoretical speculations in a practical situation was heeded. An area of investigation in motor learning that fit nicely into this step-by-step approach was contextual interference. This phenomenon has replicated laboratory significance as well as purported generalizable results. In addition, contextual interference has dealt with the manipulation of practice with the intent to improve retention and transfer. Discussions of practice, retention, and transfer are all viable concerns for the practitioner in developing effective learning environments.

The conceptualization of contextual interference was originally proposed by Battig (1966) within the realm of verbal learning. At first he defined contextual interference as functional interference that produces improvement in memory. The locus of the interference was found "in the task itself and particularly in the inter-item similarities or inconsistencies" (Battig, 1979, p. 32). Later he broadened the concept of interference to include

altering the intertask context to produce contextual variety (Battig, 1979). The additional processing induced by contextual interference leads to more effective memory of the original learning situation as well as that of a transfer task.

Contextual interference was first studied in a motor skill paradigm by Shea and Morgan (1979). They studied the motor skill acquisition of three simple movement patterns using a barrier knock-down task. Contextual variety alone was sufficient to facilitate retention and transfer performance. Subjects practiced the patterns in either a blocked (low-interference) or random (high-interference) practice schedule. The blocked group practiced one pattern entirely before practicing the next movement, while the random group practiced all three patterns in a random fashion. This study as well as many since that time (for a review see Lee & Magill, 1983; Shea & Zimny, 1983) shows the decided advantage of the random over blocked presentation in motor skill retention and transfer.

The locus of contextual variety was investigated by Lee and Magill (1983) in a series of experiments using Shea and Morgan's task. In their second experiment a third group (serial) was added in which subjects practiced the three movement patterns in a predetermined order sequence. Throughout acquisition the subjects continued to practice in that same order. With this additional group Lee and Magill attempted to ascertain the locus of contextual variety. The data followed closely with other contextual interference effects showing the advantage of random over blocked in retention and transfer. Of more interest, the serial group's scores paralleled those of the random group. These results seem to indicate that the primary factor in the advantage gained is not the predictability of the practice schedule but rather the increased spacing of repetitions in the random and serial groups. The repetition effects found in learning these patterns were related to an explanation of these effects proposed by Jacoby (1978) in the verbal domain.

Results of contextual variety research suggest that better learning of a related motor skill will occur when those skills are practiced in a random rather than a blocked arrangement of trials during practice sessions. Accordingly, Shea and Morgan (1979) optimistically generalized that, "the instructor should teach a number of skills during each session for a number of sessions in order to achieve maximum retention and transfer" (p. 187), a suggestion which provides a way to bridge the gap between theory and application. It gives the practitioner a clear-cut method for scheduling effective practice.

It is of interest to see if this suggestion is being used in the teaching of real-world skills. A look at two teacher instruction texts (Harrison, 1983; Rink, 1985) provides evidence of the apparent disregard of the use of contextual interference effects in teacher unit plans. Instead of using the practice advantage found for the random group, practice is constructed in a way that closely simulates a blocked presentation. Although there is variety in the way a skill is taught, most of the practice is delegated to performing one or two skills at the most. For instance in Rink's (1985) sample unit plan for volleyball, the class practiced the set and pass for the first 5 days before the introduction of a new skill. On Day 1 the set was practiced exclusively. The pass was introduced on Day 2 but only at the end of class. A similar strategy is followed by Harrison (1983) in a sample softball lesson plan. In her lesson the class practiced batting for the first half of the session and the other half was spent playing a modified game which emphasized batting.

Neither plan followed the advice of Shea and Morgan (1979) concerning the advantage of random practice. Actually the plans run counter to finding of contextual interference effects. However, it might be expected that a teacher would not adopt such a strategy without some evidence from data outside of a laboratory setting. Without such data the teacher would be taking results generated from the learning of a simple task (knocking down small wooden barriers) and applying these findings, face value, to the learning of a complex activity (e.g., volleyball).

If indeed contextual interference effects are generalizable, then the teacher has a tool for constructing a more effective learning environment. However, Knapp's (1963) warning should not go unheeded. Accordingly, the purpose of this study was to investigate the generalizability of results from contextual interference experiments by extending the Lee and Magill (1983) Experiment 2 to a field setting. Specifically, the subjects were taught three badminton serves in which practice orders were blocked, random, or serial. Throughout the experiment there were several manipulations in order to make the study more applicable to a practical learning situation. For instance, the three serves were chosen because they represent skills that would be taught in a badminton class (Ballou, 1982). Also, the tests used to measure acquisition, retention, and transfer were adaptations of commonly used badminton skill tests. If the contextual interference phenomenon is generalizable to the teaching of a sport skill, then random and serial practice should lead to superior skill retention and transfer than a blocked practice order.

Method

Subjects

The subjects were 30 right-handed female students at Texas Wesleyan College. All students were unpaid volunteers from the general student population. The

participants were not part of an organized badminton class and only received instruction for the serves that were taught. In order to control for prior experience in racket sports, the subjects were screened as to extended experience in badminton, raquet ball, or tennis. Any subject with such experience was eliminated from the experiment. This step is to limit individual differences which might confound the results (Del Rey, Wughalter, & Whitehurst, 1983).

Task

The task was to learn three badminton serves—the short, long, and drive serves. The three serves were practiced on a regulation court with a specific target area designated for each serve. The subjects used a regulation racket and plastic shuttles which were supplied by the experimenter. All serves that were scored were legal according to the rules of badminton. That is, the shuttle had to be contacted below the waist of the server with the racket head clearly below the hand (Poole, 1969).

The short serve was practiced and tested using the French Short Serve Test as a model (French & Statler, 1949). A rope was extended between two standards 50 cm above the height of a standard net. In the right service court markings were drawn 5 cm wide in the formof arcs at distances of 55, 75, 95, and 115 cm from the midpoint of the intersection of the center line and the short service line. The different distances were scored 5, 4, 3, 2, and 1 respectively. For a serve to receive a double score the shuttle had to travel between the rope and the net and land in the target area. Any shuttle landing on the line received the higher score. If the shuttle landed outside the target area the subject received a zero for that trial. All illegal serves and serves that hit the rope were retrials.

A form of the Scott and Fox Long Serve Test (Scott & French, 1959) was used for acquisition, retention, and transfer trials for the long serve. On the same court as previously described, an additional rope was extended parallel to the net at a height of 2.6 m and a distance of 4.3 m from the net. The marking and scoring were the same as in the short serve test. The target was placed at the intersection of the right singles sideline and the long service line. To receive a double score the shuttle traveled over the appropriate rope and landed in the target area.

The drive serve target was placed in the right service court at the intersection of the center line and the doubles service line. The dimensions and scoring were the same as for the other two targets. To receive a double score the shuttle passed under the long service rope (Ballou, 1982).

Procedures

The students were randomly assigned to one of three treatment groups; blocked, serial, and random with each group receiving 108 trials for each serve in acquisition for a total of 324 practice trials. Each subject performed 18 total trials for retention and 18 for transfer, with each serve performed on six randomly administered trials.

Acquisition Phase. Before a subject began the acquisition phase, the task was explained. The subject was shown the appropriate grip for each serve and where to stand. She then viewed a film loop (Poole, 1968) of the short and long serves, and then the trials began. The procedure of viewing the film loop was repeated during the first week of testing.

Each subject practiced 3 days a week for 3 weeks in one of the three practice conditions. Each day was considered a session and consisted of 3 blocks of 12 trials for a total of 36 trials per session. The blocked group practiced all 36 trials of one serve per session. The next day they practiced a second serve and the third day the remaining task. The order of practice for the three serves was counterbalanced among group members. As a point of clarification, the structure of the blocked group was slightly different than that of Lee and Magill (1983). In their experiment all trials of one pattern for the blocked group were practiced before attempting the other patterns. The robust nature of the learning pattern of the blocked group should not be influenced by this manipulation for the nonrepetitive practice regime remains intact (Lee & Magill, 1983). The advantage of the present blocked group's schedule is that it follows more closely typically suggested lesson plans for physical education (e.g., Rink, 1985). Even though an entire week might be spent on the learning of one serve, that serve would be practiced again before a retention test would be given. If the original blocked group's protocol had been followed the subject would be tested on a skill last practiced two weeks before the retention test.

The random and serial groups attempted all three serves in one session. The serial group practiced a different serve each trial in a predictable order. For example, a subject would practice the short, long, and drive serve and then repeat this scheduling throughout the rest of the 36 trials. The order of presentation was counterbalanced among group members. The random group attempted the three serves throughout the 36 trials. The serves were practiced in a random fashion with no serve attempted more than two times in succession. Both groups practiced each serve 12 times per session.

The experimenter stood in the left service court adjacent to the target area. The subject stood in the right service court and practiced all serves from the

right court. At the end of each trial the subject was verbally given KR about her score. After 12 serves the subject recovered the shuttles and after a total time of 2 min resumed testing. Each trial lasted approximately 15 s and began on command from the experimenter as to the serve to be attempted. The serves were announced as short serve, long serve, and drive serve.

Retention Phase. A retention test was given on the day following the last session and consisted of six trials of each of the three serves. No KR was given to the subject. There were 18 shuttles available. The experimenter began each trial by calling out the serve to be attempted. The trials were presented in a random fashion so that no serve was attempted twice in succession, the same procedure used by Lee and Magill (1983).

Transfer Phase. The transfer test was given approximately 5 min following the retention phase (the amount of time needed to switch the targets to the left side of the court). All tests for transfer follow the same procedures as in retention. For the transfer phase the serve originated from the left court. The random presentation of trials was followed in an attempt to make the testing more closely parallel the random use of these serves when playing a game, since the ability to transfer practice to a game is one of the primary goals of practice. Also, the testing of a serve from the left side of the court for transfer is directly applicable to the game of badminton.

Results

For analysis purposes, the accuracy scores for each of the three serves were averaged across six trials yielding 18 acquisition blocks of practice, one retention block, and one transfer block. The data were analyzed using a multivariate analysis of variance (MANOVA) with the accuracy scores of the three serves as the dependent measures. Separate analyses were performed for acquisition and for retention and transfer with all significance effects from the MANOVA analyzed by follow-up ANOVAs. The retention and transfer analysis included the last block of acquisition, the retention block, and the transfer block. *Post hoc* comparisons were tested using the Newman-Keuls procedure. The level of significance for all analyses was set at alpha = .05. Figure 1, which represents the accuracy scores summed over the three different serves, graphically displays the three practice group's performances for the acquisition, retention, and transfer blocks.

Acquisition Phase

The design for acquisition was a Group x Trial Block (2 × 18) factorial model with repeated measures on the last factor. The MANOVA revealed a main effect for blocks, $F(51,1361) = 4.01$. There were no other significant main effects or interactions. Follow-up ANOVAs showed significant blocks effect for all three serves: long, $F(17,34) = 4.43$; short, $F(17,34) = 3.76$; drive, $F(17,34) = 5.22$.

Retention and Transfer Phase

The last block of acquisition trials, the retention trial block, and the transfer trial blocks were analyzed using a MANOVA and follow-up ANOVAs. The design was a Group x Trial Block (2 × 3) factorial MANOVA with repeated measures on the last factor. There was a significant Block x Group interaction $F(12,138) = 1.98$, $p = .03$. Follow-up ANOVAs revealed a significant block by group interaction for short serve $F(4,54) = 2.51$, $p = .0491$.

Discussion

The purpose of the present experiment was to extend the study of contextual interference effects into a field setting using the Lee and Magill (1983) study as a prototype and by so doing to test the generalizability of contextual interference on a real life skill. The results of this replication generally support past laboratory based studies. The significant interaction found for retention and transfer parallel findings of Shea and Morgan (1979) that random practice facilitates retention and transfer. Theoretically, Battig's (1979) predictions are upheld that the use of contextual variety (random practice) in the ordering of practice enhances retention and transfer. From another perspective, the contextual variety from trial to trial allowed the random group to become context independent and able to transfer to a new task more successfully than the blocked group (Bransford, Franks, Morris, & Stein, 1979).

The results of this experiment also support the advice of Shea and Morgan (1979) concerning how to schedule practice for optimum retention and transfer effects. The results very clearly show the advantage of the random group over the blocked group in the retention and transfer of skills and make a positive statement to the teacher concerning the generalizability of contextual interference effects. Since the skill in this study was one typically taught in physical education classes, the results provide a basis for the teacher to construct an effective practice regime. Accordingly, we can have confidence in recommending that instructors of motor skills can enhance learning by organizing practice following contextual interference guidelines.

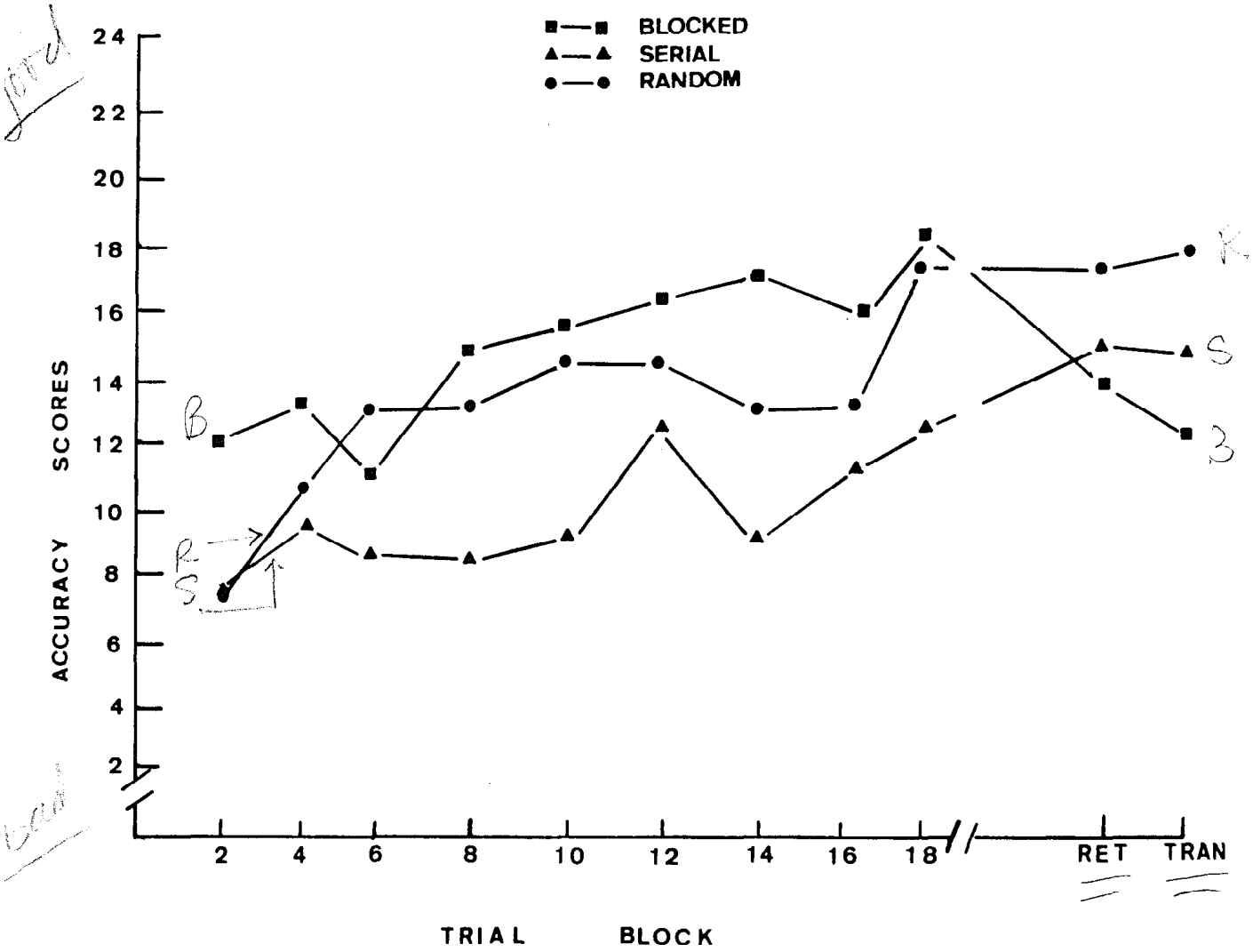

Figure 1—Accuracy scores summed across the three serves for acquisition, retention, and transfer of the three contextual interference groups.

Also of importance to the teacher is the apparent grouping of the three serves. Despite the different beginning and ending scores of each serve, the learning pattern was the same, as evidenced by the significant block effect. The use of contextual interference would have been of little benefit to the teacher if each serve needed to be practiced with a different schedule. The practice scheduling effects appear to be general and can be applied to a complete unit plan, not just an isolated skill.

Some of the differences found between the blocked and random groups could be attributed to the change in context from acquisition to retention and transfer. Previous findings indicate that practice schedule has a more powerful effect on learning than does changing the test context (Shea & Morgan, 1979). More importantly, an *a priori* decision was made to structure the test conditions for retention and transfer ina random format to enhance generalizability. Fundamental to this experiment was the ability to generalize the data to a real world setting. The general goal of practice is to transfer to a game. A game situation varies from event to event, making random testing the best condition to appraise the effectiveness of practice.

While the retention and transfer effects parallel previous contextual interference studies, results in the acquisition phase fall short when compared to previous findings. The lack of a group effect or a group by block interaction, as found by Lee and Magill (1983), was an obvious departure from other studies (Shea & Morgan, 1979; Del Rey, Wughalter & Whitehurst, 1982). There are several reasons for these findings, but first it is informative to review some of the constraints of the present experiment. The purpose of the study was to replicate a laboratory experiment and yet place the paradigm within appropriate teacher-education parameters. Such a manipulation required compromises which weakened the chance for across-the-board statistical replications. Two of the areas that incorporated some of the compromises were the scor-

ing system used and the structure of the practice for the blocked group.

The scoring system employed for practice and testing was an adaptation of the established skills test for badminton. Although such procedures appeared more applicable there was a lack of sensitivity inherent in the system. If a subject did not hit the shuttle into the target area, she received a score of 0. Early in acquisition the subjects scored a 0 on more than half of the trials. In Lee and Magill's (1983) and Shea and Morgan's (1979) studies the dependent measures were time (in milliseconds) which produced more discriminating results. This lack of sensitivity would tend to negate any group effects, leaving only the possibility of a significant block effect. For future investigations this problem could possibly be solved if, instead of scoring only good serves, the trials that recieved "0" could also be assigned scores representative of their location to the appropriate target.

The lack of sensitivity in the scoring system probably affected retention, although not as much as in acquisition. During retention the subjects performed the task accurately enough to produce trends in the data. Close perusal of Figure 1 indicates a very similar trend to that found by Lee and Magill. The individual serves also show the random group to be higher on retention than the blocked. Most likely the effects of the scoring system are lessening in retention for the predicted trends are becoming more evident, but still the combination of scoring system, task difficulty, individual differences, and other uncontrolled variables may tend to hide statistical differences.

Between the last block of acquisition and the retention trials there is a large decrement in the scores of the blocked group. But remember that the blocked group was changed in this experiment to more closely follow classroom procedures. The blocked group's results from other contextual interference experiments indicate the difference between acquisition and retention may have even been greater if the original blocked schedule had been followed.

A final point worth noting is the performance of the serial group, which did not follow the results reported by Lee and Magill (1983), in which the serial group paralleled results of the random group. While interesting, this result does not damage the conclusions possible from this experiment as the purpose was to examine contextual interference effects on a real-life skill. The serial group was added to Lee and Magill's (1983) study only to extract the locus of contextual variety effects. It is more conducive to the present context (especially when one considers the empirical support of contextual interference effects) to limit discussion to the differences and similarities between the random and blocked practice condition. However, it is interesting to note that on both retention and transfer the serial group improved its score and in both cases scored higher than the blocked group. Such scores may indicate the practice advantage for retention and transfer as found in the random group, although there is presently no apparent explanation for the depressed scores for the serial group in acquisition.

References

Ballou, R. (1982). *Teaching badminton.* Minneapolis: Burgess.

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.

Bransford, J. D., Franks, J. J., Morris, C. D., & Stein, B. S. (1979). Some general constraints on learning and memory research. In L. S. Cermak & F. I. Craik (Eds.), *Levels of processing in human memory* (pp. 331–354). Hillsdale, NJ: Erlbaum.

Bucher, C. A., & Koenig, C. R. (1983). *Methods and materials for secondary school physical education.* (6th ed) St. Louis: C. V. Mosby.

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,* 257–272.

French, E., & Statler, E. (1949). Study of skill tests in badminton for college women. *Research Quarterly, 17,* 257–272.

Harrison, J. M. (1983). *Instructional strategies for physical education.* Dubuque, IA: Wm. C. Brown.

Jacoby, L. L. (1978). On interpreting the effects of repetition: Solving a problem versus remembering a solution. *Journal of Verbal Learning and Verbal Behavior, 17,* 649–677.

Knapp, B. (1963). *Skill in sport: The attainment of proficiency.* London: Routledge & Kegan Paul.

Lee, T. D., & Magill, R. A. (1983). A locus of contextual interference in motor skill acquisition. *Journal of Experimental Psychology: Learning, Memory & Cognition, 9,* 730–746.

Magill, R. A. (1985). *Motor learning: Concepts and applications* (2nd Ed.). Dubuque, IA: Wm. C. Brown.

Poole, J. (1969). *Badminton.* Pacific Palisades, CA: Goodyear Publishing Co.

Rink, J. E. (1985). *Teaching physical education for learning.* St. Louis: Times Mirror/Mosby College Publishing.

Schmidt, R. A. (1982). *Motor control and learning: A behavioral emphasis.* Champaign, IL: Human Kinetics.

Scott, M. G., & French, E. (1959). *Measurement and evaluation in physical education.* Dubuque, IA: Wm. C. Brown Co.

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.

Stallings, L. M. (1982). *Motor learning from theory to practice.* St. Louis: C. V. Mosby.

Thomas, J. R. (1980). Half a cheer for Rainer and Daryl. *Journal of Sport Psychology, 2,* 266–267.

Whiting, H. T. A. (1982). Skill in sport: A descriptive and prescriptive appraisal. In J. H. Salmela, J. T. Partinton, & T. Orlick (Eds.), *New paths of sport learning and excellence.* Ottawa: The Coaching of Canada.

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