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CONTEXTUAL INTERFERENCE EFFECTS WITH SKILLED BASEBALL PLAYERS [1,2]

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Summary.—The learning benefits of contextual interference have been frequently demonstrated in different settings using novice learners. The purpose of the present study was to test such effects with skilled athletic performers. Scheduling differences for biweekly additional ("extra") batting-practice sessions of a collegiate baseball team were examined. 30 players ($ns = 10$) were blocked on skill and then randomly assigned to one of three groups. The random and blocked groups received 2 additional batting-practice sessions each week for 6 wk. (12 sessions), while the control group received no additional practice. The extra sessions consisted of 45 pitches, 15 fastballs, 15 curve-balls, and 15 change-up pitches. The random group received these pitches in a random order, while the blocked group received all 15 of one type, then 15 of the next type, and finally 15 of the last type of pitch in a blocked fashion. All subjects received a pretest of 45 randomly presented pitches of the three varieties. After 6 wk. of extra batting practice, all subjects received two transfer tests, each of 45 trials; one was presented randomly and one blocked. The transfer tests were counterbalanced across subjects. Pretest analysis showed no significant differences among groups. On both the random and blocked transfer tests, however, the random group performed with reliably higher scores than the blocked group, who performed better than the control group. When comparing the pretest to the random transfer test, the random group improved 56.7%, the blocked group 24.8%, and the control group only 6.2%. These findings demonstrate the contextual interference effect to be robust and beneficial even to skilled learners in a complex sport setting.

Recent research in motor learning has yielded several interesting and counterintuitive learning effects in laboratory settings where novices learn relatively simple tasks. The generalizability of these findings to more complex learning environments like the gym and the playing field where learners at various levels of skill practice complex tasks has been questioned (Hoffman, 1989; Locke, 1989). One counterintuitive learning effect often demonstrated in the laboratory is the contextual interference effect (Battig, 1979; see Magill & Hall, 1990, for a review). The benefits due to this effect occur when several motor skills are being learned during the same practice session. If these motor skills are practiced concurrently in a random fashion, performance has been shown to be poorer than when motor tasks are practiced in a blocked fashion. However, when the over-all learning levels are later assessed on retention or transfer tests, those from random conditions perform signifi-

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cantly better than subjects from blocked conditions. These learning benefits were first reported in the motor-learning domain by Shea and Morgan (1979), following many years of experimental work in verbal learning by Battig (1966, 1972, 1979). Interference can be introduced into the practice session several ways. Researchers, following Shea and Morgan (1979), have created interference by manipulating the practice schedule, i.e., contextual variety. That is, a high contextual interference condition involves a random presentation of tasks in learning, e.g., A, B, B, C, A, C, . . . , while a low contextual-interference condition involves a blocked presentation of tasks in learning, e.g., A, A, A . . . B, B, B . . . C, C, C . . . .

The contextual interference effect has been frequently demonstrated in controlled laboratory settings using novice learners (e.g., Gabriele, Hall, & Buckolz, 1987; Jelsma & Pieters, 1989; Lee & Magill, 1983; Lee, Magill, & Weeks, 1985; Poto, 1988). The tasks involved in these experiments are often fairly simple and can be learned in as little as an hour. Several studies have examined the contextual interference effect in a physical education setting (e.g., Goode & Magill, 1986; Wrisberg & Liu, 1991); here the tasks were more complex but again the learners were novices. In fact, Goode and Magill (1986), whose subjects learned three badminton serves, screened potential participants for prior experience in all racquet sports and excluded those with such experience. So, further tests of the generalizability of the contextual interference effect using skilled learners practicing a complex task are appropriate.

It seems likely that, if random practice is beneficial in early learning, it also would help skilled learners; however, it may be more difficult to detect as the potential for measuring improvement diminishes for higher skill. The present purpose was to test the effects of contextual interference with skilled individuals in a sport-skill setting. The population chosen was a junior college baseball team. The tasks were hitting three different types of pitches, fastballs, curveballs, and change-ups. Subjects were assigned to one of three groups randomly; however, they were first blocked by their hitting. The acquisition phase consisted of six weeks of additional batting practice during the fall baseball season. Experimental groups received pitches either in blocked or random fashion, while the control group received no extra batting practice. If interference created by contextual variety enhances learning in this sport-skill setting, random practice should depress acquisition performance compared to blocked practice but facilitate learning as measured by transfer tests. Also, the random and blocked groups should achieve better learning than the control group.

METHOD

Subjects

The subjects were 30 male baseball players (*n*s = 10) from a junior college baseball team in California. The players ranged in age from 17 to 21 years, with an average of 9.5 years of experience in competitive baseball. Subjects signed their informed consent, and all were naive as to the purpose of the experiment or the differences among the experimental groups.

Task

The task was to hit three different pitches solidly. The pitches were fastballs, curveballs, and change-ups.

Procedure

For the groups assignment procedure, a master list of the 30 players ordered from most skilled to least skilled at hitting was determined using three criteria, the pretest score, current batting averages, and a subjective list prepared by the head coach. The players were then blocked into groups of three and each block of three was randomly assigned to one of the three experimental conditions, random, block, or control groups. The pretest took two days. Each player received 45 fastballs, curveballs, and change-ups according to a predetermined random list. The pitching was done by the same assistant coach on a live playing field for both the pretest and the transfer tests. The response to each pitch was evaluated by two separate judges as a solid hit or not. These two judges were baseball coaches and were used consistently during the entire experimental procedure. Players were instructed to swing at good pitches only, and pitches were recorded only when contact was made. If the subject did not swing or completely missed a particular pitch, the pitcher moved on in the list of random pitches and placed that pitch at the end of the sequence. Immediately following the last pitch for each subject, the judges compared scores for hits in disagreement. If any were found, they were marked on the tally sheets and immediately rethrown. The interreliability correlation of the judges on solid hit vs not a solid hit for the entire experiment was .976. For the acquisition sessions, players worked in pairs and pitched to each other in batting cages. There were 12 acquisition sessions. All subjects participated in 12 other batting-practice sessions, except the control subjects who attended no additional ("extra") batting-practice sessions. The fifth and eighth sessions were recorded as acquisition data. Pitch selection was determined by a list provided at the beginning of each practice session. The random group's list of pitches contained 15 of each type in a random order such that no pitch occurred more than twice in succession, e.g., FB, CU, CU, CB, FB, CB . . . The blocked group's list of pitches consisted of 15 consecutive pitches of each type in repetitive blocks, e.g., FB, FB, FB . . . CU, CU, CU . . . CB, CB, CB . . . . All blocks were counterbalanced over players and days. The control group received regular batting practice but no additional ("extra") batting-practice sessions. The random and blocked groups also received regular batting practice. Additional ("extra") batting-practice sessions were given twice a week for six weeks (12 sessions).

The testing phase included two separate transfer tests, each of 45 pitches, i.e., 15 of each type of pitch. For the random transfer test the pitches were presented in a random sequence. For the blocked transfer test the pitches were presented in blocks of 15. The transfer tests were conducted in exactly the same manner as the pretest with the exception that one was presented in a blocked order.

Results

The dependent measure was the number of solid hits per 45 pitches, e.g., a typical score for a session was 20 solid hits per 45 pitches. Mean performance for each group in each phase of the experiment can be seen in Fig. 1 and Table 1.

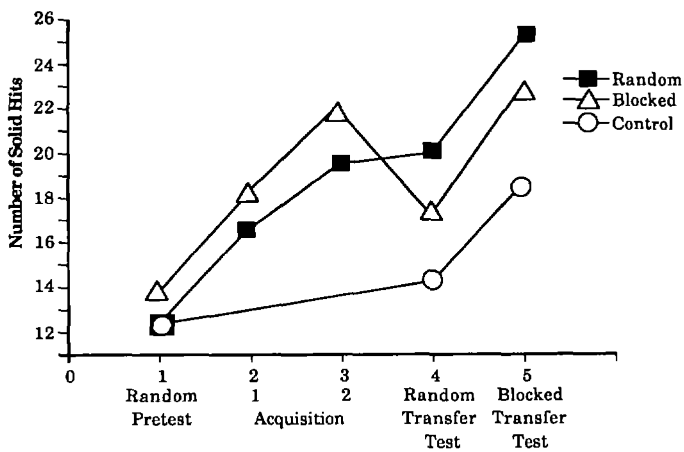

FIG. 1. Mean number of solid hits (per 45 pitches) for each condition

Acquisition Phase

Two sessions in acquisition were recorded, the fifth and the eighth. These data were analyzed using a 2 (conditions) × 2 (sessions) analysis of variance. The control group did not receive batting practice and so had only pretest and transfer test data. Analysis indicated a significant improvement over the two sessions ($F_{1,36} = 10.25$, $p < .05$). The differences were not significant for condition ($F_{1,36} = 2.14$, $p > .05$), although the blocked group ($M = 21.3$) had a higher mean for number of solid hits than the random group ($M = 17.9$). The interaction was not significant ($F_{1,36} = .133$, $p > .05$).

Testing Phase

The testing phase consisted of a pretest and two transfer tests. One-way analyses of variance were performed and Newman-Keuls comparisons were used to assess mean differences after a significant *F* value. On the pretest, there were no differences among the three groups ($F_{2,27} = 0.45$, $p > .05$). Significant differences were found for both the randomly presented transfer test ($F_{2,27} = 7.03$, $p < .01$) and the blocked transfer test ($F_{2,27} = 6.25$, $p < .01$). Follow-up Newman-Keuls tests indicated that all three groups were significantly different on each test, that is, the random group performed significantly better than the blocked group, while the blocked group performed better than the control group.

TABLE 1
Group Means and Standard Deviations For Each Phase of the Experiment

Test	Random Group		Blocked Group		Control Group	
	M	*SD*	*M*	*SD*	*M*	*SD*
Random Pretest	12.7	2.7	13.7	2.8	13.7	2.7
Acquisition 1	16.7	2.9	17.9	3.6		
Acquisition 2	19.8	3.0	21.8	4.1		
Random Posttest	19.9	2.8	17.1	3.8	14.6	2.7
Blocked Posttest	25.3	3.5	22.3	2.4	18.5	2.7

To assess relative improvement in skill by all groups, a comparison of the percentage of improvement from the random pretest to the random transfer test was calculated. This statistic showed the random group improved 56.7%, the blocked group 24.8%, and the control group only 6.2%.

Discussion

The purpose of this experiment was to test the generalizability of the effects of contextual interference for skilled players in a sport setting. Specifically, this experiment tested the effects of different practice schedules on biweekly additional ("extra") batting-practice sessions for a junior college baseball team. Different amounts of learning (or improvement) were attained in the different experimental conditions. A high contextual interference practice schedule, i.e., random presentation of pitches, led to greater improvement in hitting three different types of pitches than a low contextual-interference practice schedule, i.e., blocked presentation of pitches. Also, either of these additional ("extra") batting-practice schedules led to greater improvement than regular batting practice (i.e., control-group comparisons). These findings validate and support the generalizability of the laboratory demonstrations of the contextual interference effect (Del Rey, 1989; Gabriele, *et al.*, 1987; Jelsma & Pieters, 1989; Lee & Magill, 1983; Lee, *et al.*, 1985; Poto, 1988; Shea & Morgan, 1979).

The learning benefits found here are noteworthy when considering subjects' skill. Previous experiments on contextual interference have been done early in learning where the potential for learning effects are quite large. In this setting, where potential for showing improvement is diminished, significant differences were found for practice schedule in additional ("extra") batting-practice sessions. Also, these differences were found even though all subjects received regular batting practice. Indeed, these data indicate how robust the contextual interference effect is, suggesting that it is not simply an early learning or laboratory-based learning phenomenon.

Random practice seems particularly appropriate for batting practice. The decision-making process when one is at the plate in a game includes identifying the type of pitch before applying the appropriate motor response. In random practice the learner does this processing repeatedly. The concept of transfer of appropriate processing emphasizes that the value of any practice condition can only be considered in the context of the transfer test used to evaluate learning (Lee, 1988). The actual test situation for batting is in a game where the batter has no advance knowledge of the type of pitch. Thus, a large part of being successful in this situation is learning to identify and reconstruct quickly and appropriately the action needed for each type of pitch. Random practice should facilitate this process.

The practical applications here are straightforward, particularly for the skill of batting. Additional ("extra") batting practice is a viable means of enhancing ability to hit a pitched ball soundly, and improvement in this skill is facilitated when this practice is presented randomly. It is assumed that a random presentation of tasks would be equally beneficial to skilled athletes in other sport settings. For example, the random practice of chipping a golf ball different distances, e.g., 20, 40, 60, or 80 yards, should facilitate golfers' short game, or the random practice of tennis forehands, backhands, and lobs should improve tennis players' skills more readily than blocked practice of the same skills.

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