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EVALUATION OF A COACHING STRATEGY TO REDUCE SWIMMING STROKE ERRORS WITH BEGINNING AGE-GROUP SWIMMERS

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A coaching strategy to decrease errors in swimming strokes with swimmers who had not improved under "standard" coaching procedures was investigated using a multiple baseline design across subjects and swimming strokes. The procedure resulted in a large decrease in errors on swimming strokes during sessions in a training pool. Stimulus generalization of improved performance to normal practice conditions in the regular pool was observed with all but one swimmer. This improvement was maintained during two maintenance phases lasting approximately 2 weeks, as well as under standard coaching conditions during at least a 2-week follow-up. For two swimmers, error rates on one of the strokes showed a gradual increase between the third and fifth week of follow-up, but brief remedial prompting sessions immediately corrected their performance. Some beneficial response generalization to other components of the stroke being trained was observed, but no improvements were found on untrained strokes. The error correction package did not disrupt practice, require excessive amounts of the coach's time, or necessitate the use of cumbersome apparatus. In addition, the coach and the swimmers considered the procedures to be effective, and expressed their willingness to participate in them again in the future.

DESCRIPTORS: swimming, sports skills, behavioral coaching, stimulus generalization, response generalization

During the last decade, behavioral techniques have begun to influence the area of sports and physical education. Books in this area have been published that: (a) describe behavioral principles and techniques for developing new skills and maintaining existing skills at high levels (Martin & Hrycaiko, 1983a; Rushall & Siedentop, 1972); (b) emphasize the importance of positive reinforcement approaches for increasing the probability of children participating in and enjoying sports (Orlick & Botterill, 1975); (c) present a behavioral approach for helping teachers in physical education to improve their teaching skills (Siedentop, 1976); (d) offer an inciteful and theoretical behavioral analysis of athletic behavior in terms of Skinnerian operant conditioning (Dickinson, 1977); (e) describe behavioral strategies for the psychological preparation of the advanced athlete for serious competition (Orlick, 1980; Rushall, 1979); and (f) present an easy-to-follow behavioral approach for improving one's golf game (Simek & O'Brien, 1981).

We express our appreciation to Don Wells, Head Coach, and the coaches and swimmers of the Manitoba Marlin Swim Club for their excellent cooperation during this research. A special thanks to Roger LePage, the coach who conducted the standard coaching and the error correction procedures, for cheerfully supporting this research and making many excellent suggestions throughout the project. We are also grateful to Coach Diane Backman for administering the social validation interviews to the subjects. A longer version of the study was submitted by the first author as a thesis in partial fulfillment of the requirements for the Ph.D. degree in the Department of Psychology, University of Manitoba. For copies of assessment materials used, additional information, or reprints, write to Sandra Koop, Services for the Handicapped, 1st floor Sun Centre Building, 530-8 Street South, Lethbridge, Alberta, Canada, T1J 2J8, or Garry L. Martin, Psychology, 129 St. Paul's College, University of Manitoba, Winnipeg, Manitoba, Canada, R3T 2M6.

Many of the published articles in the area of behavior modification in sports and physical education consist of program descriptions or recommendations for coaches, but do not describe empirical research (Koop, Note 1). Of the research that has been conducted, studies have demonstrated the effectiveness of certain behavioral techniques for developing athletic skills or decreasing errors; maintaining or motivating athletic behavior; altering private thoughts to enhance performance of skilled athletes in competition; and assessing and modifying the behavior of the coach (Donahue, Gillis, & King, 1980; Hrycaika & Martin 1983).

This study focused on techniques for decreasing persistent errors of beginning swimmers. In previous research, Allison and Ayllon (1980) developed an error correction procedure and assessed its effectiveness relative to "standard coaching" across three sports (football, gymnastics, and tennis), various age-groups, and both sexes. When an error occurred, the coach would shout "freeze," and the athlete was expected to hold whatever position she or he might be in at that point. While the athlete remained "frozen," the coach gave explicit verbal feedback regarding the error and modeled the correct behavior. Finally, the athlete imitated the correct position. This procedure was repeated for a block of 10 trials. Results showed this coaching package to be immediately effective in increasing the correct execution of skills in all three sports up to 10 times that observed under standard coaching conditions. Several concerns, however, should be noted. First, the response definitions used were quite complex, requiring the coach to evaluate many behavioral components rapidly during each brief trial. Second, although standard coaching was briefly described, no observational data were taken to quantify its characteristics. The comparison condition for the experimental coaching package, therefore, remains unknown. Third, maintenance was limited in that many athletes exhibited poor performance when the standard coaching procedures were reimplemented. Fourth, considering that data were collected only when the coach was attending to the athletes, it is reasonable to assume that errors increased during experimental phases when the coach was attending to other players (based on the limited maintenance when the standard coaching procedure was reimplemented). Fifth, in many sports, it is virtually impossible to require athletes to "freeze" when an error is committed. In fact, it is difficult to imagine how athletes were able to do so during a gymnastics routine. Finally, although no formal social validation measures were conducted, Allison and Ayllon reported compaints by some athletes that the "freeze" position was aversive.

Considering these factors, the purpose of this study was to investigate an alternative error correction package that would be applicable to beginning swimmers. Age-group swimming is an area of amateur sport that has experienced considerable growth over the last couple of decades (McPherson, Marteniuk, Tihanyi, Rushall, & Clark, 1980). An error correction package for decreasing errors in components of swimming strokes (backstroke, breast stroke, and freestyle) was examined with five beginning age-group swimmers. Stimulus generalization to another setting, response generalization to other components both within and across strokes, and maintenance over time were also studied. Moreover, the social validity of the target behaviors, procedures, and results was evaluated.

METHOD

Swimmers

Three female and two male swimmers, ranging from 7 to 12 years of age, who were members of the Manitoba Marlin Swim Club and who typically attended three weekly practices, participated in the study. With the exception of Swimmer 1, all had been swimming competitively for at least one year. All five swimmers had been identified by their primary coach as exhibiting persistent errors in two or more swimming strokes.

Setting

Practices were held in a university swimming pool which was divided by a bulkhead into one large and one small section. The more advanced swimmers typically used the large area, with the smaller one being reserved for the newest swimmers. Between two and four coaches and 20 to 40 swimmers were usually present at any given practice.

Personnel

Behavioral observations were taken by 12 university students (all with formal swimming experience) and the authors. The students had chosen this option to fulfill a practicum requirement for an undergraduate psychology course. Their training was conducted in two phases. First, they attended an orientation session during which data collection procedures were explained. They reviewed the correct form for three competitive swimming strokes (backstroke, breast stroke, and freestyle) and watched a 10-min film in which Olympic swimmers demonstrated each stroke (Counsilman, Note 2). Second, each student collected data on nonexperimental swimmers until a minimum interobserver reliability level of 80% was obtained for at least three consecutive trials on each stroke.

The error correction procedure was implemented primarily by one of the coaches who had been with the Marlin team for 6 years, and who generally worked with first- and second-year swimmers. At times, however, it was necessary for the coach to be absent or to be occupied with advanced swimmers. Two swimmers were therefore trained on one stroke by one of the (female) students (who was also a part-time swimming instructor), and one swimmer was partially trained by the second author. The word "trainer" will refer to the individuals who implemented the procedure. Specific trainer(s) for each swimmer are identified in Table 1. Different trainers were used primarily in an attempt to reduce disruptions to the learning process, which may have resulted from lengthy time periods between sessions, due to the coach's absences. This procedural variation, however, also permitted a systematic replication of the error correction strategy when implemented by individuals who differed on variables such as age, sex, and degree of coaching experience. All trainers practiced the error correction procedure using nonexperimental swimmers until both trainer and authors agreed that the procedures were being implemented correctly.

Identification of Target Behaviors

Serious swimming stroke errors were identified as follows: (a) a list of possible errors was compiled for each stroke, based on popular swimming instruction books (e.g., Counsilman, 1979); (b) these lists were distributed to four Marlin coaches, who independently rank-ordered the errors according to their relative importance in detracting from swimming speed; (c) the lists were then further refined by deleting errors on which coaches strongly disagreed, as well as errors that were unanimously considered unimportant. The final lists contained 9 errors for the freestyle, 7 for the backstroke, and 11 for the breast stroke. Freestyle was selected as the first target stroke because it was most frequently practiced, and is hereafter referred to as "Stroke A." Five swimmers were identified who exhibited at least one serious error on Stroke A as well as on either the backstroke or breast stroke. This second target stroke is hereafter referred to as "Stroke B." The specific target behaviors (errors) identified for each swimmer on both strokes are shown in Table 1.

Most observations during baseline, training, maintenance, and follow-up were taken only on these selected behaviors. However, intermittent probe observations on all the potential errors identified above were also conducted for each target stroke. This was done during baseline and after training to assess whether response generalization of improved performance occurred to other components of the same stroke. Probe observations were conducted in the same manner as regular observations, as described next.

Table 1

Descriptions of target behaviors identified for each swimmer, and individuals who conducted training sessions.

Swimmer	*Stroke*	*Error Number*	*Description of Error*	*Trainer*
S1	A (freestyle)	5	Inappropriate arm recovery: Low elbow and straight arm, with arm swinging wide on both left and right arm recoveries.	coach
S1	B (backstroke)	6	Incorrect pull: Straight arm pull through water exhibited on both arms.	university student
S2	A (freestyle)	3	Short stroke: Arms did not reach full extent before entering water, or push back past hips in water.	coach
S2	B (breast stroke)	7	Poor glide: Swimmer did not stretch body out completely during glide.	no training given
S3	A (freestyle)	7	Cross over hand entry: When hands enter water, they cross well over midline of swimmer's body.	university student
		1	Low head: Head extremely low in water, such that entire face is completely submerged.	university student
S3	B (backstroke)	6	Incorrect pull: Straight arm pull through water exhibited on both arms.	no training given
S4	A (freestyle)	7	Cross over hand entry: When hands enter water, they cross well over midline of swimmer's body.	coach
S4	B (backstroke)	7	Lateral arm recovery: During arm recovery, both arms swing to side (rather than straight up and back, brushing swimmer's ear).	coach + second author
S5	A (freestyle)	5	Inappropriate arm recovery: Low elbow and straight arm, with arm swinging wide on both right and left arm recoveries.	no training given
S5	B (backstroke)	2	Shoulders too flat: Swimmer's body remained flat during each arm recovery (rather than rolling 45° to side).	no training given

Behavioral Recording and Reliability Procedures

Each swimmer was observed from either the side or the front, depending on which location best facilitated observation of the specified target behavior. When recording from the side, the observer walked along the pool deck beside the swimmer for at least part of the observational distance. For frontal observations the observer

stood on the bulkhead at the end of the swimmer's lane.

A "stroke" was defined as both right- and left-arm recoveries for freestyle and backstroke, or one complete pull with both arms for the breast stroke. Each trial consisted of 10 consecutive strokes. The observer counted the number of errors on the target behavior that were made during 10 strokes and recorded this number immediately following each trial.

Reliability checks were conducted by having a second observer who, independently and simultaneously with the primary observer, recorded errors made by the same swimmer. The percent interobserver reliability was calculated for each trial by dividing the total number of agreements that an error did or did not occur by the total number of agreements plus disagreements, and multiplying this result by 100.

Procedural compliance data were taken during each training session. A checklist was constructed to prompt the trainer when carrying out the procedures. In addition, an observer was always present who, using the same checklist, independently recorded whether the trainer actually engaged in each specified training behavior. The total number of possible trainer behaviors could vary among sessions, depending on the number of errors committed by a particular swimmer during a training session. A percent compliance score was calculated from the observer's data by dividing the total number of correct trainer behaviors emitted by the total number possible for that session, and multiplying this result by 100.

Error Correction Procedure

The error correction procedure consisted of two distinct phases: a *training* phase, in which sessions were conducted in the small (training) pool and a *maintenance* phase, in which specific interventions occurred under normal practice conditions in the large (practice) pool.

Training. The training phase included the following components:

1. *Preliminary description of a correctly performed component.* Large checklists containing drawings and instructions for correct behaviors on each stroke were placed against the wall by the training pool. During each training session the trainer would refer to the appropriate checklist to identify the correct behavior that the swimmer had recently emitted, and then praise this correct performance.

2. *Out-of-pool intervention for an incorrect component.* The trainer next identified the target behavior, provided explicit instructions as to how it should be performed, and modeled the incorrect behavior exhibited by the swimmer and then the correct form of the behavior. The trainer also provided concise verbal self-prompts for the correct behavior (e.g., "hands in front"), and repeated these while modeling the behavior. The swimmer then role played both incorrect and correct forms of the behavior after which the trainer questioned, "Can you feel the difference?" A negative reply resulted in additional instructions and modeling. If the swimmer replied, "yes," however, she or he role played the correct form of the behavior several times while repeating the self-prompt, until the trainer was satisfied that the swimmer was exhibiting correct performance.

3. *In-pool practice of correct component.* The swimmer then attempted to swim the stroke correctly for two trial lengths in the training pool to enable the trainer to observe. Further prompts could be given following these two laps at the trainer's discretion. The swimmer then swam six consecutive laps (a total distance of 91.2 m), after receiving instructions to repeat covertly the designated self-prompt once per stroke. The swimmer was also informed as to the consequences of incorrect and correct performance, as described next.

4. *In-pool consequences of incorrect performance.* The trainer walked beside the swimmer during the six-lap swim. Each time an error on the target behavior occurred, the trainer immediately tapped the swimmer once on the shoulder with the padded end of a 1.3-m stick. If three errors occurred during one lap, the swimmer was

stopped at the end and given further instructional feedback before continuing with the next lap. If the swimmer failed to perform the required six laps in 15 min, training was terminated for that session and the swimmer was asked to rejoin the others.

5. *In-pool consequences of correct performance.* The results of correct performance (defined as two or fewer errors on the target behavior per lap) were as follows: (a) *Individual laps.* When the swimmer touched the end of the pool, the trainer shouted "Good!" (or made a similar positive comment) following each correctly swum lap; (b) *Completion of six laps.* The trainer provided verbal approval and feedback regarding the swimmer's performance such as, "That's great! You're really getting that arm right—I only had to stop you once. Super!" The swimmer was also prompted to continue to practice the correct behavior and the self-prompt during regular practice sessions.

During the training phase, data on the target behavior were also recorded while the swimmer swam in the practice pool, to see if any stimulus generalization had occurred. However, no programmed feedback or prompts were given except in the training pool sessions.

Training was terminated for each swimmer after his or her average error rate on the target behavior had decreased to 20% or less over three consecutive sessions in the training pool.

Maintenance. After the training criterion was met, specific maintenance procedures were implemented in the practice pool, as described next.

1. *Maintenance Phase 1.* This phase lasted for three consecutive practice sessions after training criterion was reached, and consisted of two components: (a) *Initial prompt.* At the start of each practice the trainer would give a brief prompt to the swimmer to perform the newly trained behavior correctly during that practice session; (b) *Feedback.* At least two instances of feedback regarding performance on the target behavior were given by the trainer while the swimmer was swimming that stroke during regular practice. Feedback could consist of a brief positive comment if performance was good, or more specific descriptive feedback if errors were occurring.

2. *Maintenance Phase 2.* For three sessions following Maintenance Phase 1, only the initial prompt (as described above) was deliberately programmed.

During both maintenance phases the trainer was cued by the first author to administer the procedures. This was done at the coach's request because he stated that he might forget to carry out the procedures. At no time throughout the entire experiment (including baseline) was the coach discouraged from providing feedback or prompts to any of the swimmers. Rather, the coach was encouraged to interact "normally" with the swimmers throughout the experiment.

Follow-up. During the follow-up phase the coach was no longer cued by the author to provide prompts or feedback to the swimmers, and the other two trainers no longer interacted with their particular swimmers. As stated above, however, the coach was not discouraged from interacting with any swimmer.

Remedial prompting. If error rates did not remain low during follow-up, a brief remedial prompting session by the practice pool was given. The swimmer stood beside the pool while the trainer quickly described and modeled incorrect then the correct behavior. The swimmer then role played the correct behavior several times while repeating the self-prompts, before returning to the large pool with a final prompt to 'swim that way all the time."

Description of Standard Coaching

Baseline data collection on swimming stroke errors occurred under "standard coaching" conditions. During these practices the target swimmers swam in a lane with other children while under the supervision of the coach. The error correction package was therefore evaluated by comparing swimmers' performances throughout its implementation to their performances under standard coaching. To provide a quantitative

description of standard coaching, the coach permitted observers to record data on the frequency and types of his interaction with each of the five swimmers. If any of the other coaches interacted with a swimmer, the interaction was also recorded. These observations were taken throughout each of 10 morning sessions from Weeks 9 to 13 of the study. During this time the experimental conditions across swimmers varied from baseline to follow-up. The observer sat beside the practice pool and recorded all verbal interactions between the coach and any swimmer. In addition, all comments were placed into one of the following categories:

1. *Positive feedback for desirable behavior:* (a) *General.* This consisted of positive remarks that did not specifically identify a feature of the swimmer's stroke (e.g., "good, you're working hard"). (b) *Specific.* This consisted of positive remarks that identified improved performance on a specific component of a stroke (e.g., "good kick").

2. *Negative feedback for undesirable behavior:* (a) *General.* This consisted of negative remarks that did not specifically identify a feature of the swimmer's stroke (e.g., "that was lousy"). (b) *Specific.* This consisted of comments that identified a specific component of a stroke that was being performed incorrectly (e.g., "your head is too low").

3. *Other:* This category consisted of any other types of interactions (e.g., general instructions to swim laps) that did not fall into the above four categories.

Reliability checks were conducted on 30% of all observational sessions by having a second observer independently and simultaneously record and evaluate coach-subject interactions. Reliability assessments were conducted for both the content and the type of interaction. An agreement on the content of the interaction was defined as two recorded comments that were: (a) similar in wording and meaning; (b) recorded as being spoken by, and directed to the same individuals; and (c) recorded as occurring within a 1-min interval of each other. If disagreement occurred on any of these components, that total comment was defined as a disagreement. Reliability checks on the type of interaction (e.g., positive, negative) were calculated only for those comments on which agreement was reached regarding the content, as defined above). Percent interobserver reliability for both content and type of interaction was calculated by dividing the total number of agreements per session by the total number of agreements plus disagreements, and multiplying this result by 100.

Experimental Design

A multiple baseline design across subjects, with a follow-up component was used. In addition, with Swimmers 1 and 4, a multiple baseline design across Strokes A and B was conducted. That is, after each had received training on Stroke A, the error correction procedure was also applied to Stroke B. For Swimmers 2 and 3, Stroke B served only as a control behavior to assess whether response generalization to different strokes occurred. No training on either stroke was given to Swimmer 5. The selection of Swimmer 5 as a control subject, as well as the order in which swimmers received training, was determined both by the coach and by extraneous factors such as the availability of the swimmers (e.g., some were unavailable over Christmas vacation).

Social Validation

As described previously, the target behaviors were validated in terms of standard swimming books and an assessment of their importance by the coaches of the swimming club. The acceptability of the procedures and the importance of the results were evaluated via questionnaires. At the termination of the research the coach was asked to complete a questionnaire to determine the degree to which he considered the error

correction package to be effective, useful, easy to implement, and so on. In addition, each of the four swimmers who experienced this training was interviewed to evaluate the degree to which he or she liked the procedures or found them useful. One Marlin coach was selected to conduct all interviews because she was familiar to the swimmers and, although she may have seen parts of training sessions while coaching her own swimmers, the experimental procedures were never discussed with her.

RESULTS

Reliability

Reliability measures on the error data for Strokes A and B were taken on 44% of all trials, and assessed the target behaviors of all swimmers during all phases of the experiment. The average interobserver reliability rating across swimmers was 96%, with a range of 86% to 100%. Compliance scores were taken on 100% of all training sessions, and yielded an average compliance rating of 96%, and a range from 78% to 100%.

Training Time

Four of the six trained strokes reached criterion in the minimum number of three sessions with the remaining two requiring four and seven sessions, respectively. The average training session length for individual swimmers varied from 6.3 to 10.0 min, with an overall mean of 7.9 min. On only one occasion was a training session terminated because the 15-min limit had expired. The average total training time for individual swimmers varied from 19.0 to 52.0 min, with an overall mean of 31.7 min.

Effects of the Error Correction Procedure during the Training Phase

In the training pool. As Figure 1 illustrates, the error correction procedure effectively reduced errors on target Stroke A during training sessions with all swimmers, relative to their baseline performances under standard coaching

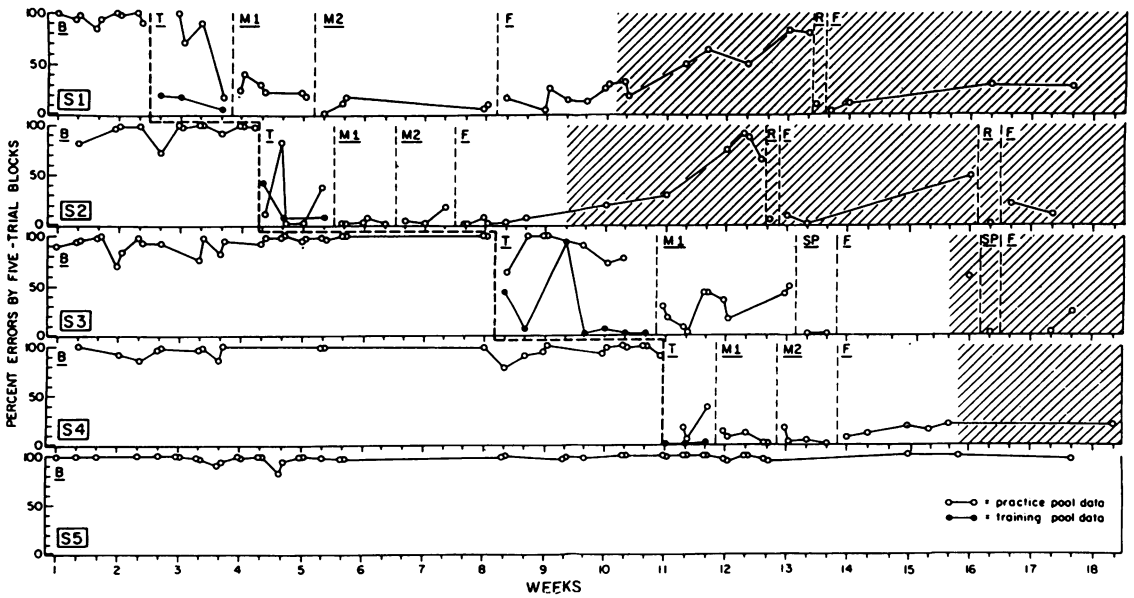

Fig. 1. Percentage of errors in five-trial blocks, made on target behaviors of Stroke A (freestyle) by swimmers during all experimental phases (B = baseline, T = training, M1 = first maintenance phase, M2 = second maintenance phase, F = follow-up, R = remedial prompting, SP = special procedure used with Swimmer 3). Shaded area depicts data collected after the first 2-week follow-up for each swimmer.

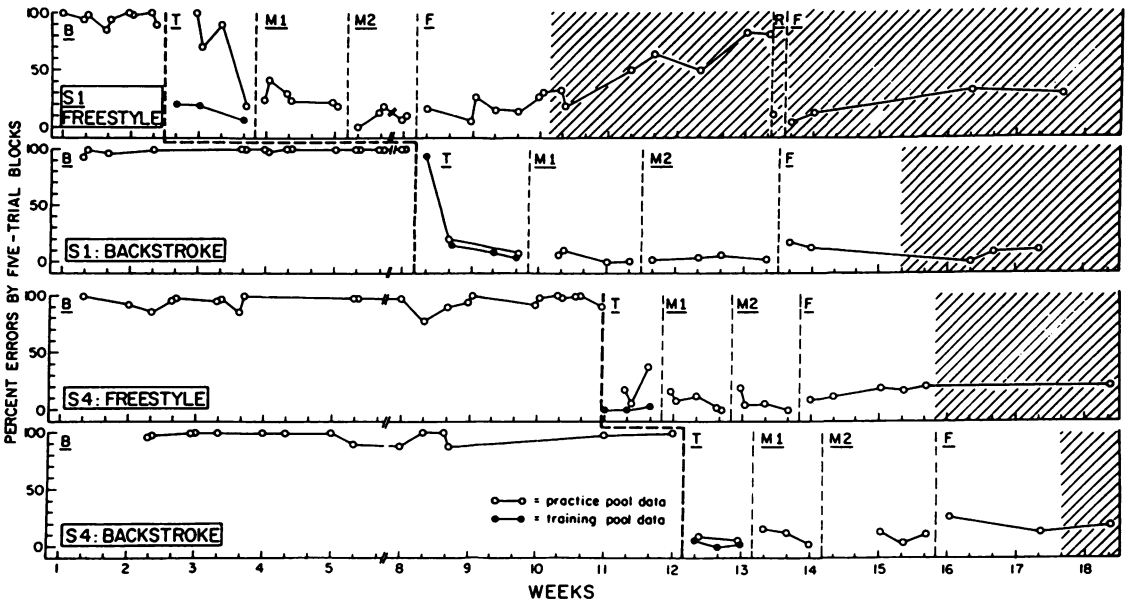

Fig. 2. Percentage of errors in five-trial blocks, made on target behaviors of Strokes A and B (freestyle and backstroke), by Swimmers 1 and 4 during all experimental phases (B = baseline, T = training, M1 = first maintenance phase, M2 = second maintenance phase, F = follow-up, R = remedial prompting. Shaded area depicts data on each target behavior collected after the first 2-week follow-up for each swimmer.

conditions. These results were also replicated in the multiple baseline design across strokes with Swimmer 1 and Swimmer 4 (see Figure 2).

In the practice pool. By the end of the training phase, all swimmers had exhibited substantial stimulus generalization of improved performance to regular practice conditions, with the exception of Swimmer 3 on Stroke A (see Figures 1 and 2), even though a formalized intervention had yet to be implemented in this situation.

Effects of the Error Correction Procedure during the Maintenance Phases

Maintenance Phase 1. With the implementation of the first maintenance phase, generalized performance improvements for three of the four trained swimmers on five of the six trained strokes were maintained. In addition, the only swimmer who did not exhibit stimulus generalization during training (i.e., Swimmer 3) showed large performance improvements in the practice pool during this phase.

Maintenance Phase 2. Only three swimmers experienced the second maintenance phase because Swimmer 3 received a different procedure, which will be discussed later. For these three swimmers error rates on all trained strokes remained low throughout this phase.

Two-Week Follow-up

As depicted in Figures 1 and 2, error rates on all target behaviors for Swimmers 1, 2, and 4 remained low throughout a 2-week follow-up.

Extended Follow-up and Remedial Prompting

As Figure 1 illustrates, Swimmer 4's error rate on Stroke A remained low during a 5-week follow-up. In addition, follow-up data on Stroke B were collected with Swimmer 1 and Swimmer 4, for 4 and 3 weeks, respectively (see Figure 2). Error rates for both swimmers remained low during this time.

Follow-up data on Stroke A were collected for 5 weeks following the termination of Maintenance Phase 2 for Swimmers 1 and 2 (see

Figure 1). Both exhibited a gradual increase in errors after the second week until, by the fifth week, these approached baseline error rates. Remedial prompting at this point produced immediate error reductions for both swimmers. Four weeks later, Swimmer 1's error rate remained low. Remedial prompting was reimplemented with Swimmer 2 after a 3-week follow-up assessment revealed a 50% error rate. At the termination of the study 2 weeks later, his average error rate was below 20%.

Procedural Variations and Results with Swimmer 3

During training. For a number of reasons, the procedures used with Swimmer 3 deviated from those originally planned. First, the target behavior identified for Swimmer 3 on Stroke A (Error 7, see Table 1) was that her hands crossed over the midline of her body when entering the water. When training was implemented on Error 7, however, it became obvious that her head was also much too low in the water (Error 1, see Table 1), and that this was interfering with skill acquisition. Training was therefore also introduced on Error 1 during the fourth session (see Figure 3). The initial out-of-pool prompts were expanded to include both errors (7 and 1), and the number of laps swum was increased to nine. Swimmer 3 was instructed to concentrate on Error 7 for the first three laps, Error 1 for the next three, and on both target behaviors for the final three laps. She met training criterion on both behaviors in seven sessions. As illustrated in Figure 3, stimulus generalization to the practice pool was not evident for either behavior during the training phase.

During maintenance. Although errors on both behaviors decreased relative to baseline rates during Maintenance Phase 1, overall improvement was less and variability was greater than that exhibited by the other swimmers in this phase. Further, Swimmer 3 increasingly appeared to resent being prompted by the trainer in the presence of her peers. As described previously, her trainer was not the regular coach, but a university student (see Table 1). A telephone conversation between the coach and her parents revealed that she had complained to them that a university student, rather than the

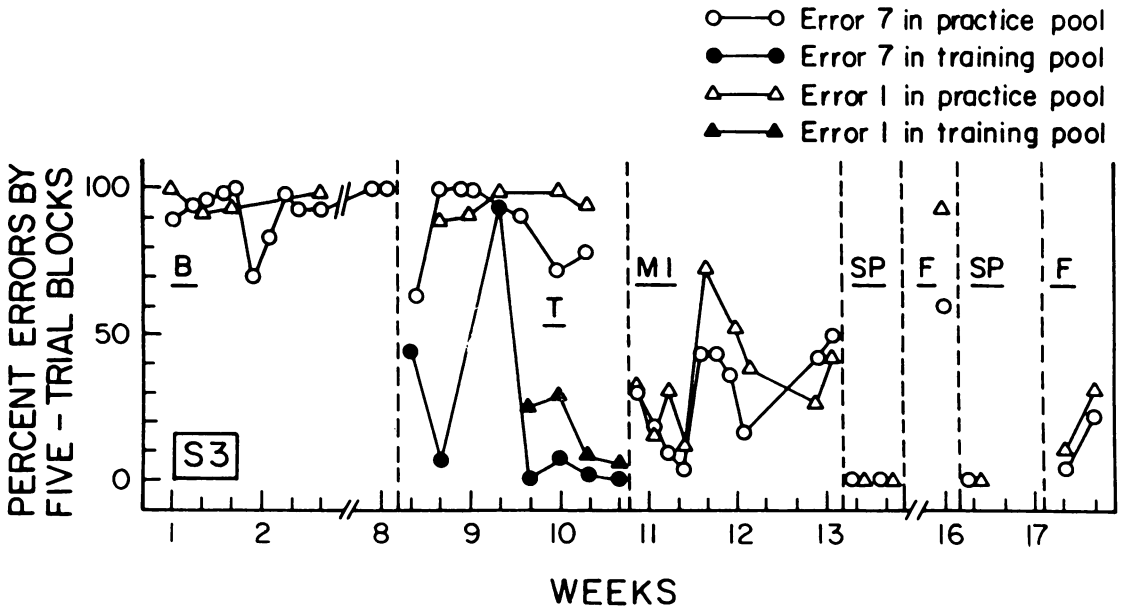

Fig. 3. Percentage of errors in five-trial blocks, made on target behaviors A7 and A1 of Stroke A (freestyle) by Swimmer 3 across all experimental phases (B = baseline, T = training, M1 = first maintenance phase, SP = special training procedure, F = follow-up).

coach, was working with her. For these reasons, a special procedure (described below) was implemented with Swimmer 3.

Special procedure. The university-student trainer's involvement was terminated and, because the regular coach was going to be away for a week, the new procedure was implemented by the second author. He explained to Swimmer 3 that the coach had asked him to work with her on her freestyle during the coach's absence Her goal was to earn 10 points per practice in as few laps as possible. Points were distributed contingent on performance per lap as follows: (a) a "pretty good" lap (i.e., three or four errors on either target behavior) earned one point; and (b) a "very good" lap (i.e., two or fewer errors on either behavior) earned two points. The second author stood at the end of the lane and raised either one or two fingers after each lap, depending on how many points Swimmer 3 had earned. He was aided by a second observer who assessed performance on Error 1 from the side, and signaled to him the number of points Swimmer 3 had earned for that behavior. When the coach returned, he was informed as to how many laps it took her to earn 10 points during two practices.

Results. This manipulation was immediately effective in eliminating errors on both behaviors, as shown in Figure 3. It was reimplemented approximately 2 weeks later for one session when a follow-up assessment revealed that error rates on both behaviors were again high. Two additional follow-up observations showed error rates to be well below baseline levels.

Probe Data on Response Generaliaztion

Data from probe observations (of all identified potential errors) were averaged and a total percent errors score on each stroke was obtained for each swimmer. Because errors on target behaviors were expected to decrease following intervention, these averages were calculated excluding target behavior data. This provided an unbiased measure of the extent to which improved performance generalized to untrained components of the same stroke. As Figure 4 illustrates, strokes that received training on one

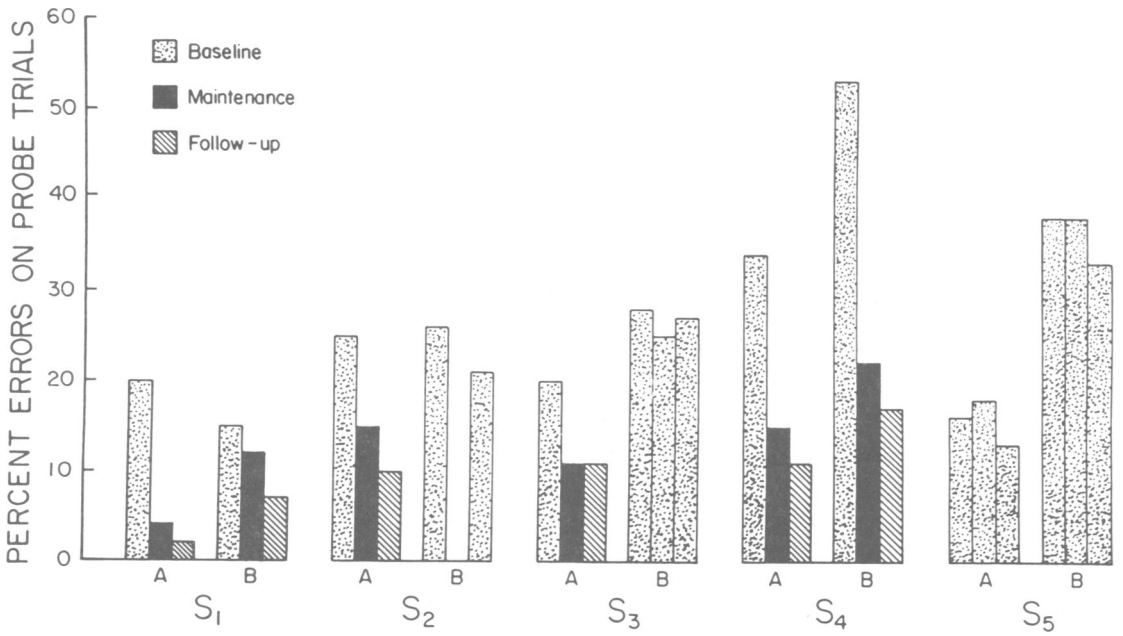

Fig. 4. Percentage of errors from probe trials of all identified potential errors for Strokes A and B, excluding errors on target behaviors, for all swimmers during various experimental phases. (Note: Probe trials on strokes that did not receive training are depicted as baseline data).

component exhibited substantial overall error decreases on untrained components of that stroke as well as during subsequent assessments. In contrast, overall error rates on untrained (control) strokes showed little or no improvement over time.

Data on Standard Coaching Procedure

Interobserver reliability checks were conducted on 30% of all observational sessions. The average reliability rating regarding the content of the interactions was 86%, ranging from 60% to 100%; whereas the average rating for type of interaction was 83%, ranging from 67% to 100%. All swimmers received some general positive feedback, with averages ranging from 0.1 to 0.5 instances per practice; and four swimmers received some general negative feedback, ranging from 0.3 to 1.1 instances per practice. Two swimmers received some specific positive feedback, and this was for target behaviors identified for this experiment. These occurred on an average of less than once per practice. No instances of response-specific negative feedback were observed. "Other" types of interactions ranged from 0.3 to 2.5 occurrences per practice across the five swimmers.

Social Validation

One section of the social validation questionnaire completed by the coach required that he rate the error correction procedure using a 7-point scale on characteristics such as its disruptiveness to regular practice, ease of application, effectiveness, and popularity with swimmers. He gave it 44 (of a possible 49) points, and also commented that all procedural components were useful, that none should be eliminated or changed, and that he would like to continue using this strategy in the future. During their individual interviews the four swimmers stated that they liked the training procedure, and that the immediate feedback while swimming was very helpful. In addition, all swimmers rated the overall helpfulness of the training procedure as 10 (on a scale of 10), and all stated that they would like to receive similar training on other problem strokes.

DISCUSSION

This research demonstrated that the error correction package resulted in a decrease in errors on swimming strokes to a low rate during training sessions, stimulus generalization to regular practice with three of four swimmers, and maintenance of improved performance with minimal prompting and feedback under normal practice conditions. The use of the multiple baseline design across strokes allows these reductions to be attributed to the error correction procedure, rather than to concurrent increases in trainer attention. That is, for each swimmer performance improvements were specific to the stroke being trained. Control strokes improved only when they were also targeted for training. Although response generalization across strokes did not occur, the probe data illustrated that training one component of a particular stroke had beneficial effects on other components of the same stroke.

In addition to improvements during training and maintenance phases, error rates remained low under standard coaching conditions during at least a 2-week follow-up. Swimmers 1 and 2, however, exhibited a gradual increase in error rates on Stroke A some time after 2 weeks. Observations of coach-swimmer interactions were conducted during Weeks 9 to 13 of the experiment, and therefore occurred simultaneously with a large part of the follow-up phases for these two swimmers (see Figure 1). An analysis of this interaction data revealed that Swimmer 1 received no feedback from the coach related to the target behavior during eight observational sessions, whereas Swimmer 2 received less than one instance of response-specific feedback per session (mean = 0.4). Thus, in terms of coach feedback, these swimmers experienced an approximation of extinction. Behaviors that have

not reached a level of acquisition high enough to be maintained by existing reinforcement contingencies in the natural environment will show performance decrements unless additional sources of reinforcement are supplied.

The observed performance deterioration with some swimmers emphasizes the need for intermittent assessment of target behaviors to ensure that they continue to be exhibited in their correct form. Although remedial prompting sessions were demonstrably effective at reinstating correct performance, a preventive coaching approach may be more desirable. The fact that error rates did remain low during at least a 2-week follow-up suggests that very little additional prompting or feedback, perhaps on an increasingly intermittent schedule, would be sufficient to maintain correct performance at a high rate.

The performance of Swimmer 3 warrants additional discussion. First, she apparently found it somewhat aversive to be trained by a university student. This was an unexpected development because other swimmers who were not trained by the coach seemed to enjoy working with their trainers. Also, when questioned later about the procedures, Swimmer 3 responded quite positively. A second reason may be that "swimming correctly" was not under the control of any natural contingencies of reinforcement for her. Informal observations, as well as comments from the coach, suggested that she enjoyed swimming practices and competitions mainly because these provided opportunities to interact socially with her peers and the coaches. By contrast, she appeared to be relatively unconcerned with her actual swimming performance. This implies that for some athletes it may be necessary to program strong reinforcement contingencies to maintain correct performance. Most coaches, however, are likely to set a higher priority on working with individuals for whom correct performance is already rewarding.

Although the coach and the swimmers considered the procedures to be effective in improving swimming performance, it would be desirable to determine if the reduction in errors in swimming strokes actually resulted in increased swimming speed, such as might be evidenced at swimming meets. Surprisingly, we could find no experiments examining swimming speeds as a function of characteristics of a swimming stroke. In spite of the lack of research on this topic, we found complete agreement on the importance of the target behaviors in various books on swimming (cf. Colwin, 1977; Counsilman, 1979; Ryan, 1978). It appears that recommendations by experts concerning optimal form for swimming strokes are based on a photographic analysis of swimming form shown by world champions, such as Mark Spitz. Although research is clearly needed in this area, it is also faced with many difficulties. Swimming speed at meets, as a dependent variable, is subject to a wide variety of influences such as the prior conditioning program of the swimmer, the presence or absence of a taper period before a meet, the order of events swum in a particular meet, time between events, and the speed of individuals swimming in adjacent lanes. The influence of all of these and other factors are likely to be exaggerated with younger swimmers. Research is also difficult due to the low frequency with which swimming meets occur. With respect to the current study, the entire period of data collection (from the beginning of baseline to the end of follow-up) covered approximately 4 months. During that time, 15 first- and second-year swimmers with the club (including the experimental swimmers and within the age range of them) swam a 50-m freestyle event in three separate meets. Excluding the experimental swimmers, the first- and second-year swimmers in the club who swam the 50-m freestyle in those three meets averaged 81% best times from one meet to the next. However, a comparison of the last 50-m time in a meet immediately before treatment to the first 50-m time in a meet immediately after treatment revealed 100% best times in the four experimental swimmers. The average decrease in swimming speed of the four experi-

mental swimmers was approximately the same as the average decrease by the other first- and second-year swimmers who got best times. Although these results are encouraging, additional research is needed to demonstrate convincingly that the reduction of specific errors in swimming strokes will result in consistent and significant increased swimming speeds.

The generality of these results is limited by the fact that all experimental swimmers were relatively new and young swimmers. The effectiveness of these procedures with older or more experienced swimmers remains to be demonstrated. A procedural limitation was the necessity for someone to supervise the other swimmers while the coach was conducting training sessions in the small pool. In addition, the coach required reminders to administer the programmed feedback prompts during the maintenance phase. Successful adoption of these procedures may, therefore, necessitate the development of a practical prompting system for the coach. Finally, it should be emphasized that the techniques used in the error correction package are not unique or novel. Coaches do use instructions, modeling, positive reinforcement, and other behavior modification procedures. As recommended by Martin and Hrycaiko (1983b), however an improvement in the consistency with which behavioral procedures are applied along with the use of detailed data systems to evaluate thoroughly the effectiveness of those procedures will help coaches to arrange athletic environments that will maximally facilitate the development of individual athletes.

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