THE EFFECTS OF COGNITIVE STRATEGIES ON THE PERFORMANCE OF FEMALE SWIMMERS

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Abstract

The purpose of this thesis was to examine the effects of cognitive strategies on the performance of three female swimmers. The independent variables were the three strategy conditions that were used by the subjects. The major dependent variable was the time taken by each subject to swim the 400 metre effort. Questionnaires also generated information on a number of factors. Treatment conditions were randomly assigned according to a 3 x 3 Latin squares format. An analysis of performance data emphasized the individual nature of athletic performance. Two of the athletes appeared to be able to use cognitive strategies to improve performance, while the other did not demonstrate this ability. Questionnaire data revealed that improved performances did not appear to be related to reduced discomfort or altered pain perception. A Phi Coefficient analysis indicated that expectation to perform well or poorly was not related to actual performance. The ability of the subjects to concentrate on the prepared strategy was generally high. Two of the three subjects swam their best under their preferred condition. Ratings of discomfort and assessment of performances varied with the individuals. The performance of each subject appeared to be affected differently by measured factors with confounding potential.

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CHAPTER I

Introduction

Statement of Purpose

The purpose of this study was to examine the effects of cognitive strategies on performance in female age-group swimmers.

Significance of the Study

With today's advanced state of athletic performance and sophisticated electronic measuring devices, even minute fractions of a second may differentiate a champion from a non-placer. Because of this, any means of improving performance time can be of great value. The difference between a good and great performance may lie entirely within the psychological realm.

Psychological studies have shown cognitive strategies to be successful in increasing tolerance to specific pain (Beers & Karoly, 1979; Chaves & Barber, 1974). Should such strategies also be successful in reducing or delaying the general pain of athletic fatigue, this could prove to be of significant benefit to the sport sciences. Any advances in the understanding of the psychological control of pain have the potential for improving athletic performances.

A few investigators have, in the past, attempted to assess the effectiveness of the use of cognitive strategies in the sporting situation (Crossman, 1977; Selkirk, 1980). Selkirk (1980) examined the effects of cognitive strategies used by runners while performing a maximum endurance treadmill run. While his results did not show a significant difference between the four treatment conditions, Selkirk did find that all conditions employing a cognitive strategy produced greater mean performance times than an unaided condition. One subject was able to increase his performance time by greater than 80% by employing a cognitive strategy. Selkirk's results also showed that the aided conditions had a combined effect which was significantly different from the unaided condition, and that subjects generally performed best under their preferred strategy condition, which was related to familiarity.

The major criticism of Selkirk's design was that the subjects had no opportunity to practise using the cognitive strategies. It was assumed that the subjects had learned how to employ a specific strategy in only one trial. The present study allowed repeated trials in each condition to allow the subjects to become familiar with the strategies and more skilled in employing them.

Previous studies with wrestlers (Crossman, 1977) and endurance runners (Selkirk, 1980) have used running endurance as a dependent variable. This study used swimmers doing a 400 metre maximum effort swim.

Significant findings in this study could have practical implications for sports participants at all levels. The recreational competitor and the elite athlete alike could employ cognitive strategies to improve performances.

Delimitations

This study was delimited to testing three female, club swimmers on a 400 metre maximum effort swim. Two of the swimmers were 12 years of age and one was 13 years of age. They were considered to be good performers in their age groups.

The independent variables were the three cognitive strategies which the swimmers used. These were: a) unaided, b) task specific, and

c) voluntary distraction. These three strategies were selected because of their use in other studies and the results they have generated (Crossman, 1977; Selkirk, 1980).

The dependent variable was the length of time it took each subject to swim a 400 metre maximum effort swim under the varying conditions.

Limitations

For this study the following assumptions were made: a) the subjects were able to understand, plan, and employ the cognitive strategies, b) the strategies were being performed as planned, c) the cognitive strategies being used were relevant for the control of the pain of fatigue, d) the pain of fatigue was a limiting factor in the performance of a 400 metre swim, e) a 400 metre swim was an appropriate distance for employing a cognitive strategy, and f) any improvements in performance were due to the use of the cognitive strategies and not to subject expectancies.

Definitions

Cognitive strategy refers to a consistent perceptual methodology or mental plan employed by an athlete in order to alter or transform the experience of pain from physical fatigue (Selkirk, 1980).

Unaided strategy refers to the uninstructed individual plan, or lack of it, employed by the athlete as a thought control procedure during an athletic feat (Selkirk, 1980).

Task specific strategy refers to the instructed plan which involves total concentration on technique and commands associated with the activity as a thought control procedure during an athletic feat (Selkirk, 1980).

Voluntary distraction strategy refers to the implementation of one of the numerous uninstructed self-chosen plans such as counting backwards, goal-setting, or singing as a thought control procedure during an athletic feat (Selkirk, 1980).

Pain tolerance is the ability to endure the physical and psychological noxious stimuli which result from a maximal athletic performance (Selkirk, 1980).

Performance time refers to the number of seconds that it took a subject to swim 400 metres.

Maximum effort is the highest degree of effort that can be given during the performance of a 400 metre swim.

Club swimmers refers to the three female subjects, two who were 12 years of age and one who was 13 years of age. They were considered to be good performers for their age groups, and competed provincially and nationally.

CHAPTER II

Review of Literature

Cognitive strategies have been proven useful in altering response to experimentally-produced pain (Beers & Karoly, 1979; Chaves & Barber, 1974). This fact has led to the suggestion that cognitive strategies may also be useful in improving athletic performance by altering the reaction to the pain of athletic fatigue. The literature associated with this hypothesis generally falls into one of two broad categories: a) pain, or b) cognitive strategies.

Pain

Numerous articles have been written recognizing various psychological aspects of pain in addition to the physiological aspects. Cautela (1977) stated that the cause of some pain responses seems largely psychological, and that psychological factors affect pain threshold. He expanded on this by saying that conditions or experiences which a subject can label on a pleasant-unpleasant continuum influence the pain response. Murray (1969) described both cognitive and affective aspects of pain, as well as the physiological components. It is apparent that pain reaction is much more complex than a mere physiological response.

Psychological factors can act to influence pain response. Perceived control over noxious stimuli is one of these. Ball and Vogler (1971) stated that most subjects preferred self-shock to random machine-administered shocks. Bowers (1968) found that subjects who were told they could and should avoid electric shocks identified higher levels of shock as painful than did subjects who were told that they had no control over receiving the shocks. Staub, Tursky, and Schwartz (1971) found that self-administration of shocks resulted in increased pain thresholds and tolerance above those of a control group (i.e., experimenter-administered shocks). But when control subjects were able to predict when the shocks would arrive, the threshold and tolerance differences between the two groups were eliminated. The ability to control or predict noxious stimuli acts to increase pain threshold and tolerance.

Knowledge about an aversive situation may enhance pain tolerance. Turk (1978) described a skills-training approach for the control of pain, in which education on the components of the pain experience is an integral part. Staub and Kellett (1972) provided subjects with information on: a) both the pain sensation to be expected and the apparatus which would deliver the shocks, b) the pain sensation only, or c) the apparatus only. A control group received no information at all. They found that the group with both sensation and apparatus information endured more shocks and evaluated more intense shocks as painful than did the other groups. The study concluded that there was an interactive effect from the items of information, and that knowledge of an aversive stimulus may increase pain tolerance.

Response to pain appears to be generalized across the types of pain stimuli used. Clarke and Bindra (1956) found that thresholds for electrical, mechanical, and thermal stimulation were all related. Brown, Fader, and Barber (1973) concluded that responsiveness to pain may generalize across the type of pain. Scott and Barber (1977 b) stated that subjects responded to cold and pressure pain similarly. Davidson and McDougall (1969), however, found no consistent generalization of pain tolerance.

A relationship between pain threshold and pain tolerance is generally accepted. Clarke and Bindra (1956) and Brown et al. (1973) found a correlation between threshold and tolerance. Gelfand (1964), however, stated that the relationship between threshold and tolerance is low, because tolerance has a high psychological component and threshold has a high physiological component.

Anxiety has been shown to alter pain response. Bronzo and Powers (1967) found that anxiety acted to reduce pain threshold. Bowers (1968) concluded that self-control of a pain stimulus probably increases pain threshold by minimizing anxiety.

Personality measures and pain responses appear to be unrelated (Brown et al., 1973; Ellison & Freischlag, 1975), yet much of the reviewed literature categorized two types of subjects according to pain response. The reducers and augmenters (Ryan & Kovacic, 1966; Shephard, 1978) and the catastrophizers and non-catastrophizers (Spanos, Radtke-Bodorik, Ferguson, & Jones, 1979) referred to the two types of subjects who differed in their tendencies to concentrate on the unpleasant aspects of the pain.

Athletes appear to have greater pain acceptance than non-athletes (Ryan & Kovacic, 1966; Walker, 1971). Shephard (1978) stated that top athletes seem to inherit or cultivate exceptional pain tolerance. Contrasting studies (Ellison & Freischlag, 1975; Walker, 1970), however, have found no difference in pain threshold and tolerance between athletes and non-athletes.

The pain that arises from athletic exertion as fatigue approaches is thought to be caused by inadequate blood flow to the working muscles (Lamb, 1978; Shephard, 1969). As a result waste products, especially lactic acid, accumulate and cause pain by stimulating nerve endings in the muscle or connective tissue.

Cautela (1977) described three characteristics of pain: a) a verbal report of pain, b) behaviours such as moaning and grimacing, and c) avoidance of stimuli perceived to be noxious. While the pain of athletic fatigue is unlike the experimentally-produced laboratory pain, it does possess these characteristics as stated by Cautela (1977). It is therefore assumed that the results of pain research are applicable to the understanding of the general discomfort which results from maximum efforts in sporting events.

Cognitive Strategies

Many researchers have demonstrated the effectiveness of cognitive strategies in reducing experimentally-produced pain. Numerous types of strategies have been employed in these studies.

Blitz and Dinnerstein (1971) had subjects immerse their hands in ice water. They found that pain thresholds were increased by having subjects a) concentrate on the cold aspect and ignore the pain sensations, or b) imagine the cold water to be cool and pleasant. Kanfer and Goldfoot (1966) reported that pain tolerance varied with the following treatment conditions: (from high to low effectiveness) a) subjects viewed and described slides, b) subjects used clocks to set goals, c) subjects expected severe pain, d) control group, and e) subjects verbalized aloud momentary experiences. Barber and Cooper (1972) found that subjects could reduce the pain sensations by listening to a story or adding aloud. Relevant cognitive strategies (imagining a situation inconsistent with pain) were reported to be more effective in increasing pain thresholds than irrelevant cognitive strategies (imagining a situation unrelated to pain) by Spanos, Horton, and Chaves (1975). Westcott and Horan (1977) found anger imagery to be effective in increasing pain tolerance in female subjects. Jaremko (1978) used three treatment groups: a) reversal (imagining cold water as refreshing), b) rationalization, and c) irrelevant distraction, and reported all three as being effective in increasing pain tolerance. In another cold water test Beers and Karoly (1979) found four treatments to be effective in increasing both pain thresholds and tolerance. Of these treatments a rational thinking strategy (task-related and positive self-statements) and a compatible imagery strategy (imagining a pleasant cold scene) were reported to be the best for pain reduction.

Scott and Barber (1977 a) reported that subjects could make greater increases in pain tolerance by employing multiple strategies. They concluded that single strategy effects were not as significant as those realized by combining strategies.

One problem encountered in some of these studies was the absence of 'pure' treatment and control groups. Barber and Cooper (1972), Kanfer and Goldfoot (1966), and Scott and Barber (1977 b) all reported that subjects generated their own thoughts and images in order to control pain if they were not assigned strategies, or if their assigned strategies were ineffective.

How cognitive strategies work to reduce the pain experience is unclear, but a number of factors have been suggested as contributing to this phenomenon.

The importance of an expectation factor in affecting a pain response is uncertain. Chaves and Barber (1974), in a study designed to assess the effects of expectation, concluded that expectation alone will decrease pain, but not as significantly as when a cognitive strategy is employed. Scott and Barber (1977 a) suggested increased pain tolerance may be due to expectations arising from instructions. Spanos et al. (1975) concluded that only overt behaviour (the response to pain), and not the actual pain experience, is affected by expectation. Beers (1976) and Beers and Karoly (1979) reported that expectancy alone was not significant in reducing pain.

The role of imaginal ability in reducing pain is also unclear. Beers and Karoly (1979) found that individual differences in imaginal ability were unrelated to changes in pain coping, while Anderson (1975) reported that subjects with high imaginal scores tolerated pain longer than those with low scores.

The attenuation of pain which occurs with the use of cognitive strategies may result from the distraction or redirection of attention away from the painful stimulus. Kanfer and Seidner (1973) found that subjects who were presented with slides to view while being subjected to a painful stimulus had increased pain tolerance. They concluded that this was due to the concentration on the slides instead of the task. Scott and Barber (1977 a) reported that distraction results from trying to use a strategy. Brucato (1978) concluded that there is an attention explanation of the psychological control of pain. Blitz and Dinnerstein (1971) proposed that the wide individual variation in pain coping may be due to the subject's skill in focussing attention, and that training may be required for this skill.

The subject's degree of involvement in the cognitive strategy being used may be a significant factor. Spanos et al. (1975) hypothesized that involvement in a strategy affects the actual pain experience. Jaremko (1978) reported that the amount of involvement in a strategy affects changes in pain tolerance.

The degree of subject participation in planning and controlling a cognitive strategy may be another factor affecting pain reduction (Gelfand, 1964). Kanfer and Seidner (1973) found that subjects who controlled the presentation of slides to be viewed during a painful situation demonstrated greater pain tolerance than subjects to whom the slide presentation was controlled by the experimenter.

Hypnosis has been used alone and in conjunction with cognitive strategies to reduce pain. It has generally been found that pain reduction is not related to hypnosis (Spanos et al., 1979) and that cognitive strategies alone are as effective in attentuating pain (Barber & Hahn, 1962).

The use of cognitive strategies by athletes is a fairly recent area of interest. Morgan (1978) found that long-distance runners and marathoners at different levels of ability use completely different types of strategies. Non-elite endurance athletes dissociate from their task in order to reduce anxiety and discomfort. Non-elite athletes use strategies such as 'reliving' their educational experiences or 'building' houses. Elite athletes, however, associate with their pain. The cognitive processes of elite athletes during their entire athletic performances are directed towards monitoring body signals in order to be able to adjust the pace and avoid trouble. Elite athletes may be able to use associative strategies due to their superior physiologies (Morgan, 1978).

Other athletes and coaches support the idea of using associative strategies in order to cope with pain (Sheehan, 1978; Watts, 1978). Beers (1976), in a laboratory study, also concluded that selective attention to specific aspects of the pain experience is better than distraction.

It appears that athletes must learn how to use cognitive strategies. Rushall (1979) presented data showing that one athlete took three days and five trials to learn a rehearsal task so that its use was effective. Selkirk (1980) stated that the ultimate success of cognitive strategies may depend on familiarity with the strategy content, and recommended that athletes practise using strategies.

Controlled experiments to assess the effects of cognitive strategies on athletic performance are limited. Crossman (1977) and Selkirk (1980) were unable to find significance, but did find that strategy conditions produced longer mean performance times on maximal runs than did an unaided condition. Selkirk (1980) also found that the combined effects of strategies differed from an unaided condition, and that subjects performed best under a preferred condition, which was related to familiarity.

The reviewed literature described many types of cognitive strategies and factors which may be involved in reducing the experiences of pain. It seems reasonable to assume that coaches and athletes may be able to use this knowledge to devise strategies for coping with the pain of athletic fatigue. If performances can be improved by using cognitive strategies this will be a great advancement in the field of sport psychology.

CHAPTER III

Methods and Procedures

Experimental Aims

The aims ofthis experiment were threefold: a) to determine if the use of cognitive strategies resulted in improved performance times, b) to determine if the different strategy conditions produced differential results in performance times, and c) to determine if learning, with respect to the development and usage of the cognitive strategies, did occur over the course of the study.

Research Design

This study employed a single subject alternating treatments design (Barlow & Hayes, 1979). This design was utilized to avoid the problems which arise from inter-subject variability and from generalizing results from a group average to an individual. Replications of this procedure may allow for future generalizations. Three subjects were involved in this experiment.

This experimental design consisted of two stages. A baseline stage was conducted to establish a stable performance record for each subject. During the experimental stage the subjects used two more treatment conditions. One condition was employed per session. A 3 x 3 Latin square was used to randomly assign treatment conditions. This was done so as to balance any possible sequencing effects.

Independent and Dependent Variables

The independent variables were the three treatment conditions under which the subjects performed. These were: a) an unaided condition,

b) a task specific strategy, and c) a voluntary distraction strategy. During the unaided condition the subject performed while thinking as she usually did during a swim. This condition was meant to be representative of 'normal' conditions. In the task specific strategy condition, the subject concentrated on the specific techniques and appropriate commands of swimming, in order to focus on the task and possibly distract herself from the pain of fatigue. In the voluntary distraction strategy condition the subject concentrated on ideas of her own planning. These three conditions were selected because of their use in previous studies on cognitive strategies, from which the present experiment was adapted.

The major dependent variable was the time taken for each subject to perform a 400 metre maximum effort swim, under the varying treatment conditions.

Questionnaires were completed by the subjects following each trial and at the conclusion of the experiment (see Appendix A). The questionnaires produced information on the following: a) the degree of discomfort experienced by the subject, b) the subject's expectancy regarding performance, c) the subject's assessment of performance time, d) the percentage of time that the subject was able to concentrate on the prepared strategy, e) the subject's preference and estimate of the effectiveness of each treatment condition, and f) a description of the factors that might have affected performance times.

Subjects

The subjects were selected from the Thunder Bay Thunderbolts Swim Club on the basis of suitability, availability, and interest. Factors considered when determining the suitability of a subject included past performance and practise attendance habits. The three female swimmers were ranked in the top 10 in Canada in their age-groups. Table 1 presents data on the subjects.

Subject	Age	Height	Weight	Event
1	13	160 cm	48.5 kg	Freestyle
2	12	159 cm	45.6 kg	Indiv. Medley
3	12	156 cm	48.1 kg	Freestyle

Table 1. Subject data.

Controls

Extraneous variables with the potential for confounding results were controlled for in a number of ways.

A pre-treatment baseline was established for each subject as a means of determining the constancy of extraneous effects over a number of trials. The unaided condition served this purpose. This period also allowed the subjects to familiarize themselves with the testing procedure.

Test performances were conducted Monday through Thursday each week, at the same time each day, when the swimmers were available for testing. Subject absences delayed the testing schedule.

Each subject was allotted sufficient time for strategy preparation, and swam a self-developed, standardized 10-minute warm-up.

The presentation of treatment conditions was randomized according to a Latin sqaures format. Starts were staggered to reduce the probability of intersubject pacing. This was necessary because of the limited allotted to testing. Subjects were instructed not to look at clocks and timers and no performance feedback was given. Subjects were reminded before each swim that this was a maximum effort performance.

Standardized recording sheets (see Appendix B) were used to minimize the chance of recording errors. The pool temperature was noted daily, but was beyond the control of the experimenter.

Experimental Procedure

This experiment proceeded in three stages: a) pilot study, b) baseline stage, and c) experimental stage.

Pilot study. A pilot study to establish baseline for one subject was conducted over a two-week period prior to the actual baseline stage. This was done in order to establish a consistent experimental procedure, and to see if stability of performance could be achieved.

Baseline stage. Each subject swam at least seven trials in an attempt to stabilize performance for the determination of baseline. For each trial the subject swam a 400 metre maximum effort swim, following a standardized warm-up. Baseline was considered stable when variations in performance time developed consistent patterns or when four consecutive performance times varied only ± 1 second. The determination of stability varied with each individual.

Starting instructions for baseline and experimental stages were "On your mark -- Go". Subjects started from the raised edge of the pool. Performance time was measured with a digital stopwatch from the word "Go". Performances were always done in the same pool lane. Data was recorded on the standardized recording sheet.

Experimental stage. The experimental stage was comprised of three parts: a) instruction, b) testing, and c) evaluation.

A. Instruction

Immediately following the establishment of baseline the subject was given a standardized instruction sheet describing the nature of the experiment (see Appendix C). These instructions introduced the concept of cognitive strategies and described the three treatment conditions which the swimmers employed.

The subjects then formulated a task specific and voluntary distraction strategy for use in the experiment. This was done with the aid of sheets suggesting key words or ideas around which the cognitive strategies could be devised (see Appendix D). Experimenter assistance was also available.

B. Testing

Upon arrival at the pool, subjects were instructed as to which treatment condition they would be using that day. The subject swimming in the unaided condition went directly to the pool and did the standardized warm-up. Following a brief rest the maximum effort swim was performed.

The subjects in the task specific and voluntary distraction strategy conditions were allowed as much time as they wanted to study their planned strategies. When they were prepared, they went to the pool and did their warm-ups. During their brief rests between the warm-up and maximum effort swim, the subjects were given the opportunity to review their planned strategies. Following this, the maximum effort swims were performed.

C. Evaluation

Immediately following the 400 metre swim, the subjects were given a chance to modify the strategy that was used, for use in future efforts.

After each trial all subjects completed a posttest questionnaire. Following the final trial of the experiment all subjects completed a postexperiment questionnaire (see Appendix A).

Testing continued until stability was reached for each treatment condition, or until it became obvious that stability could not be achieved. Criteria for stability were the same as in the baseline stage -- consistent patterns of variation in performance times or four consecutive performance times varying only ± one second. If, after 23 times, stability was not demonstrated for each treatment condition, it was concluded that stability could not be achieved, and testing was terminated.

Apparatus

Digital stopwatches (Siliconix ET 105) were used for timing the 400 metre maximum effort swims. A Taylor etched-stem thermometer was used to measure pool temperature.

Data Analyses

The performance time for each 400 metre swim was recorded in seconds. Fractions of a second were rounded off to the nearest second because of the manual timing employed.

Five graphs were produced for each subject. These were as follows: a) performance time according to treatment condition, b) performance time according to the day of the week on which the swim was done, c) percentage concentration according to treatment condition, d) estimated discomfort according to treatment conditions, and e) performance time according to pool temperature. A visual analysis for trends within and between the graphs was conducted to determine significance. In the absence of obvious visual trends, if necessary, an analysis of overlapping points would have been conducted (Hersen & Barlow, 1976). An overlap of 40% would have been considered non-significant. This form of analysis was used as a method to assess practical significance. Differences need to be obvious to be of importance to coaches.

Performance improvements for treatments would have been calculated by expressing the mean performance time for each treatment condition as a percentage of the mean of the unaided condition. This would have been calculated when stable data had been demonstrated and would have included only those data.

The data from the posttest and postexperiment questionnaires were tabulated in order to determine trends for: a) the subject's preference of treatment conditions, b) the subject's estimate of the effectiveness of the treatment conditions for improving performance, c) the subject's interpretation of discomfort as being painful, d) the subject's assessment of sufficiency of sleep the night before the performance, e) the subject's assessment of the appropriateness of her eating habits, and f) the subject's identification of factors which prevented her from performing her best.

Anytime a subject indicated on the posttest questionnaire, that she was ill when swimming, the performance time for this trial was examined in order to determine if the illness did have an affect on the performance. A time more than three seconds slower than the slowest trial when illness was not a factor, was considered to be a rogue score. These scores were recorded, but were disregarded in the data analyses.

A Phi Coefficient analysis (Champion, 1970) was conducted to test for association between: a) the subject's expectancy concerning performance and her actual performance, and b) the subject's assessment of performance (with respect to her previous trial) and her actual performance.

CHAPTER IV

Subject 1 -- Results and Discussion

Results

Pilot study. This subject was involved in the pilot study which was conducted over a two-week period prior to the baseline stage. Figure 1 illustrates the results of the pilot study.

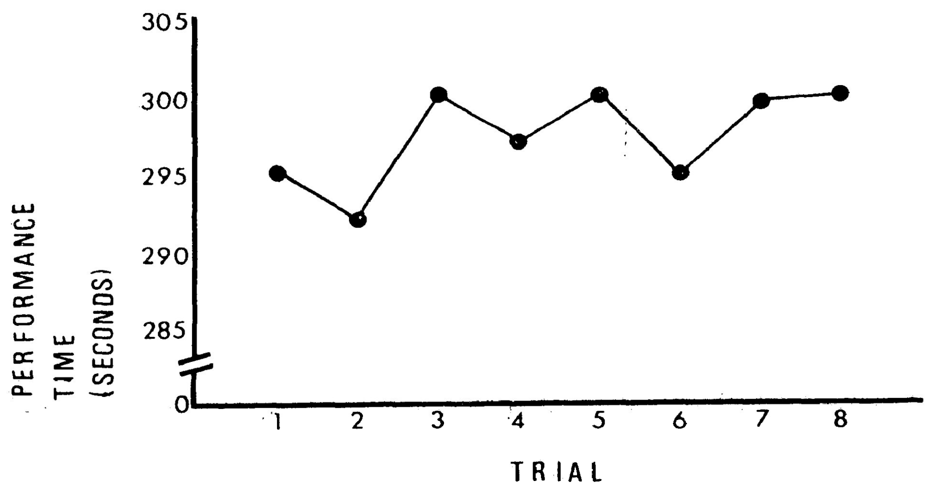

FIGURE 1. PERFORMANCE TIMES DURING PILOT STUDY.

A relatively stable performance pattern was achieved over the eight trials. The range of performance times was 8 seconds.

Experimental results. Figure 2 illustrates the performance record of this subject over the course of the experiment. Baseline was considered to be stable after 10 trials using the unaided condition. The performance times in all three conditions overlapped considerably, but the voluntary distraction times appeared to be slightly poorer than the times of the other two conditions. The performances in the experimental unaided condition tended to be poorer than those which were established in the

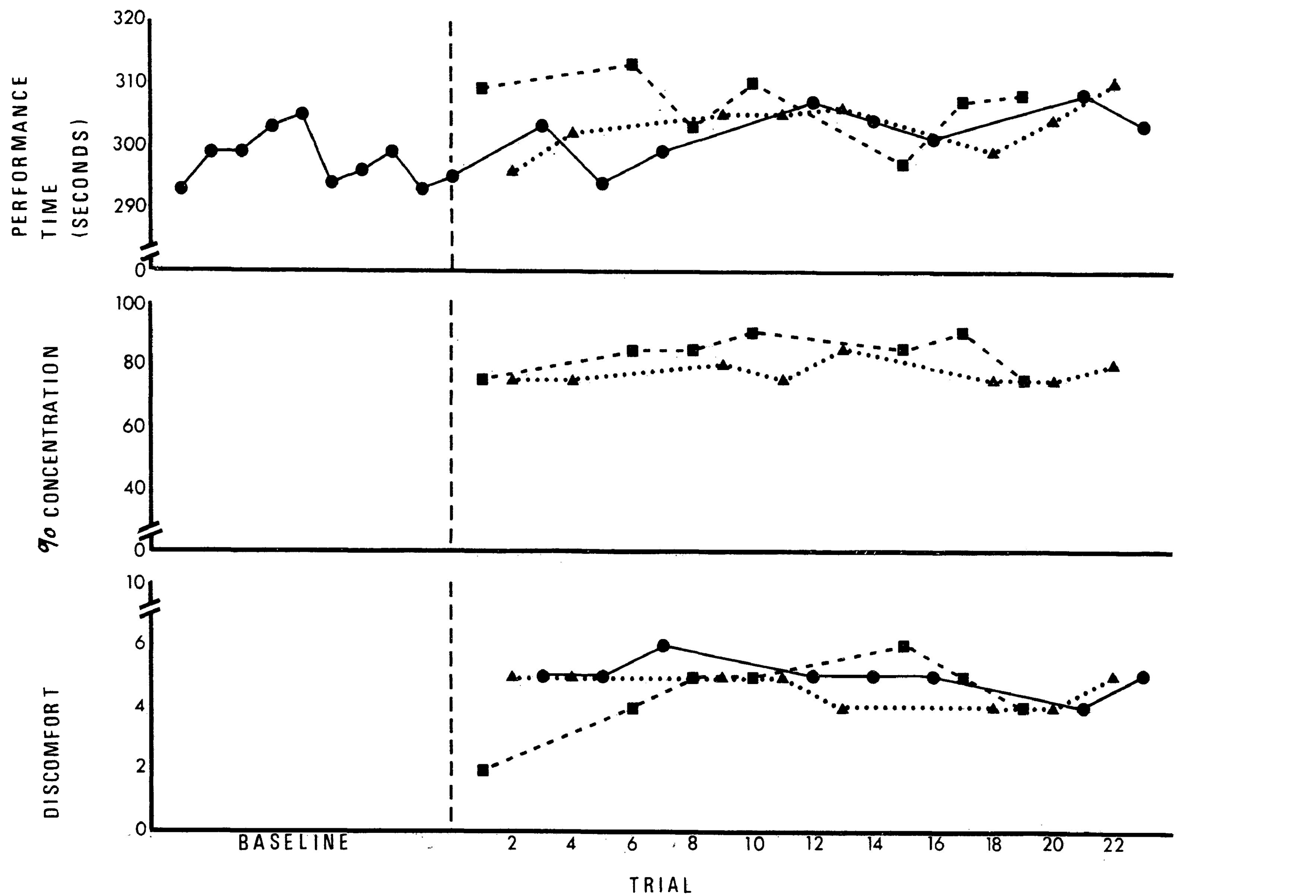

FIGURE 2. SUBJECT'S PERFORMANCE TIMES AND RATINGS OF PERCENTAGE CONCENTRATION AND DISCOMFORT.

baseline stage. Seven of the eight points recorded in the experimental unaided condition were higher than the mean of the baseline unaided performance ($\bar{X}$ = 298 sec.).

The experimental unaided condition performances tended to get poorer over the course of the study. Swims in the task specific condition also appeared to get slightly worse over the course of the experiment, but performances in the voluntary distraction condition did not show this decrement. No condition achieved stability over the course of the study.

The posttest questionnaire asked the subject to rate the percentage of time that she was able to concentrate on her prepared strategy. Figure 2 illustrates these data. This subject found it slightly easier to concentrate on the voluntary distraction strategies than on the task specific strategies.

Figure 2 also illustrates the subject's rating of discomfort for each trial. The discomfort ratings for all three conditions overlapped repeatedly. The discomfort ratings for the task specific strategy trials were the most constant, with a range of 4 to 5. The unaided condition produced slightly more variable discomfort ratings, ranging from 4 to 6. The discomfort ratings for the voluntary distraction strategy condition were the most variant, with scores ranging from 2 to 6. The low score of 2 appeared only once, following the first experimental trial.

There did not appear to be a relationship between discomfort rating and swim performance for any of the conditions. Percentage concentration on the strategies also did not appear to be associated with the discomfort ratings.

Figure 3 presents the swim performance times according to pool temperature. Performance times were similar for all temperatures, which ranged from 82^{o} F to 86^{o} F.

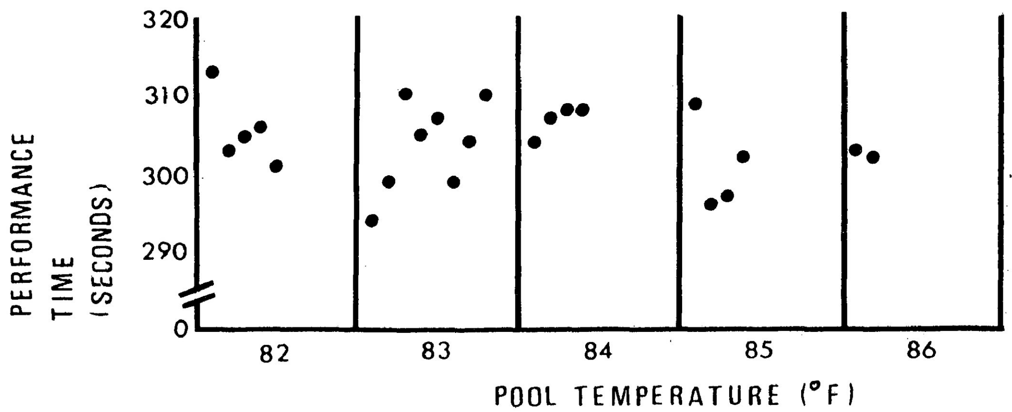

FIGURE 3. PERFORMANCE TIME ACCORDING TO POOL TEMPERATURE.

Figure 4 illustrates the relationship of swim performance to the day of the week on which the swim was performed. Swim times on Tuesday showed the least variability, while those on Thursday showed the most. Although the differences appeared to be small, the mean swim performance times did increase slightly each day from Monday ($\bar{X}$ = 302.5 sec.) to Thursday ($\bar{X}$ = 305.3 sec.).

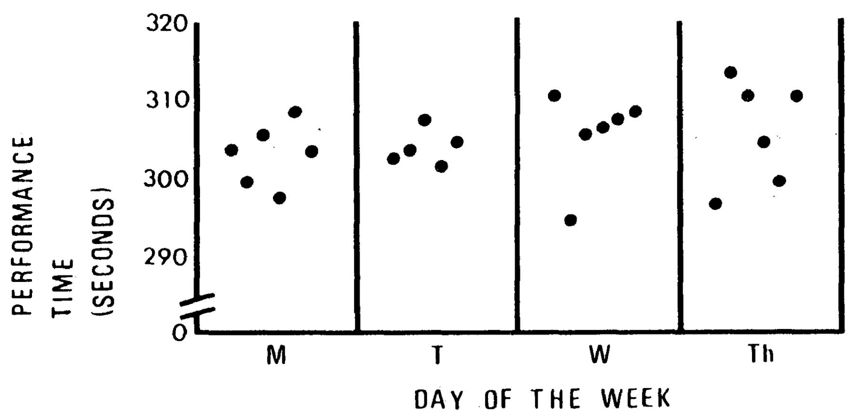

FIGURE 4. PERFORMANCE TIME ACCORDING TO DAY OF THE WEEK.

Appendix E contains the posttest and postexperiment questionnaire results for Subject 1.

A Phi Coefficient analysis was conducted to test the association between the subject's expectancy (whether she expected to swim better than on the previous trial) and actual performance. A r_θ value of .293 was determined. This yielded a χ^2 value of 1.89, which, with one degree of freedom, is nonsignificant.

A Phi Coefficient analysis was also conducted to test for association between the subject's assessment of performance (whether she thought she swam better than on the previous trial) and the actual performance. A r_θ value of .378 yielded a nonsignificant χ^2 value of 3.143.

On 9 occasions the subject considered the discomfort of the swim performance to be painful, while on 14 occasions she did not. Of the 9 performances which were considered painful, 2 were in the voluntary distraction strategy condition, 3 were in the unaided condition, and 4 were in the task specific strategy condition. A comparison of the mean performance times for the painful and non-painful days revealed little difference (painful, $\bar{X}$ = 303.6 sec.; non-painful, $\bar{X}$ = 304.4 sec.).

For 15 trials this subject felt she did not get enough sleep the previous night, while for the other 8 trials she responded that she did have enough sleep the night before. A comparison of mean performance times for these days revealed only a slight difference (enough sleep, $\bar{X}$ = 303.8 sec.; not enough sleep, $\bar{X}$ = 304.2 sec.).

On no occasion did this subject feel that she had eaten too much or too little before her swim performance.

The subject considered that there were factors preventing her best performance on 12 trials. These factors included: a) tired (6 times,

b) sore muscles (9 times), and c) sore knee (one time). On some occasions more than one factor was cited. On 11 trials the subject considered there to be nothing preventing her from swimming her best. The mean performance time on days when the subject considered there to be factors preventing her best performance was 306.2 seconds. This compares to a mean performance time of 301.8 seconds on days when these factors were not present.

The postexperiment questionnaire revealed that this subject preferred to swim using the unaided condition. She also assessed the unaided condition to be the most effective in improving swim performance. The task specific strategy condition was ranked second best for improving performance, and the voluntary distraction strategy condition was ranked third.

Discussion

The results for this subject suggested that the use of cognitive strategies did not improve performance.

The achievement of stability in both the pilot study and the baseline stage of the experiment indicated a constancy of extraneous effects over a number of trials during these periods.

The considerable overlap of performance times in all three conditions suggested that the independent variables (the treatment conditions) did not control the dependent variable (swim performance). Performance times appeared to have been affected by extraneous variables.

The fact that performance times in the experimental unaided condition increased from the baseline results also suggested intervention by extraneous variables. Had there been no outside influences, the experimental unaided condition times should have maintained the original baseline level. The inability to achieve stability of performance in treatment conditions also indicated changing influence by extraneous variables.

The subject's ability to concentrate on the voluntary distraction strategies for longer periods than the task specific strategies may have been due to content of these plans. This subject appeared to favour thinking about topics which were unrelated to the act of swimming.

The overlapping discomfort ratings for the three conditions indicated that no one condition was better than the others for reducing discomfort. The only discomfort rating which did not lie between 4 and 6 on the scale, occurred on the very first swim in the experimental stage (a rating of 2 under the voluntary distraction strategy condition). This fact suggested that this response may have been largely due to the subject's inexperience in rating her discomfort.

The lack of association between discomfort rating and performance times suggested that perhaps, for this subject, discomfort was not an important factor in the performance of a 400 metre swim. The absence of a relationship between discomfort ratings and percentage concentration indicated that this subject was not able to control discomfort through concentration on a prepared strategy.

A number of factors were examined because of their potential to influence swim performance. Many of these did not appear to have acted as confounding extraneous variables for this subject. Pool temperature did not seem to have affected swim performance, as swim times at the more extreme temperatures did not differ from those at the moderate temperatures. The subject's expectancy concerning performance was not related to her actual performance, so this was not likely a factor. This subject did not demonstrate the ability to accurately assess her swim performance with respect to the previous trial. Whether or not the subject considered the discomfort of the maximal effort to be painful did not differentiate performance times. Pain was also associated with all three treatment conditions. A lack of sleep the night before a maximal effort swim also did not appear to cause poorer performances. Dietary habits did not seem to play a role since on no occasion did the subject feel that she had eaten too much or too little before her timed swim.

The day of the week on which the swim was performed may have had some influence on performance time. The mean performance time (for all swims on a given day of the week) increased by roughly one second each day from Monday to Thursday. This may have reflected accumulated fatigue from the training load. This fatigue built up through the week and was reduced on the weekend when there was a day of rest.

The factors which this subject considered to be preventing her from achieving her best performances appear to have indeed produced poorer performance times. The tiredness and sore muscles and joints may have exerted considerable influence over performance times.

While this subject indicated a preference for the unaided condition, the assessment that it was the best condition for improving performance was not supported by the results. The ranking of the voluntary distraction strategy condition as being the least effective in improving performance time was somewhat supported, in that the times under this condition were slightly slower.

With the exception of the day of the week on which the swim was performed, none of the variables which were examined appeared to be related to swim performance for this subject. It appeared to the experimenter that there were other variables which did affect this subject. The most obvious was boredom with the experiment. This subject repeatedly asked when the study would be finished and often showed reluctance to get in and swim.

In the postexperiment questionnaire this subject also stated that she preferred the unaided condition because she "didn't have to think of any special thing". It is suggested by the experimenter that perhaps this was a less than ideal subject for using cognitive strategies. Concentration on a prepared thought plan was not enjoyable for this subject, and perhaps the use of cognitive strategies simply did not suit her character.

The study was finally terminated with this subject because stability in the conditions was not being achieved, and no obvious differences between treatments was emerging.

CHAPTER V

Subject 2 -- Results and Discussion

Results

The performance record of Subject 2 is illustrated in Figure 5. This subject performed 16 trials using the unaided condition in order to achieve a stable baseline.

The three treatment conditions appeared to have been separating when the experiment, with this subject, was terminated due to an injury. The task specific strategy condition showed the best times, the unaided condition times were next best, and the voluntary distraction strategy times were the poorest. The performance times for the task specific condition were decreasing while the performance times in the voluntary distraction condition were increasing. The performance times for the experimental unaided condition were remaining constant and were maintaining a stable baseline level. The study did not continue long enough to conclude that stability for the conditions was achieved.

The posttest questionnaire data revealed that this subject was able to concentrate on the planned voluntary distraction strategy more easily than the task specific strategy. This is also illustrated in Figure 5.

Figure 5 also illustrates the subject's ratings of discomfort for each trial. Discomfort ratings in the task specific strategy condition were somewhat less than in the voluntary distraction condition, but were similar to those for the unaided condition. The voluntary distraction strategy condition produced the highest discomfort ratings. The discomfort ratings did not appear to be related to either performance time or percentage concentration on the strategy, for this subject.

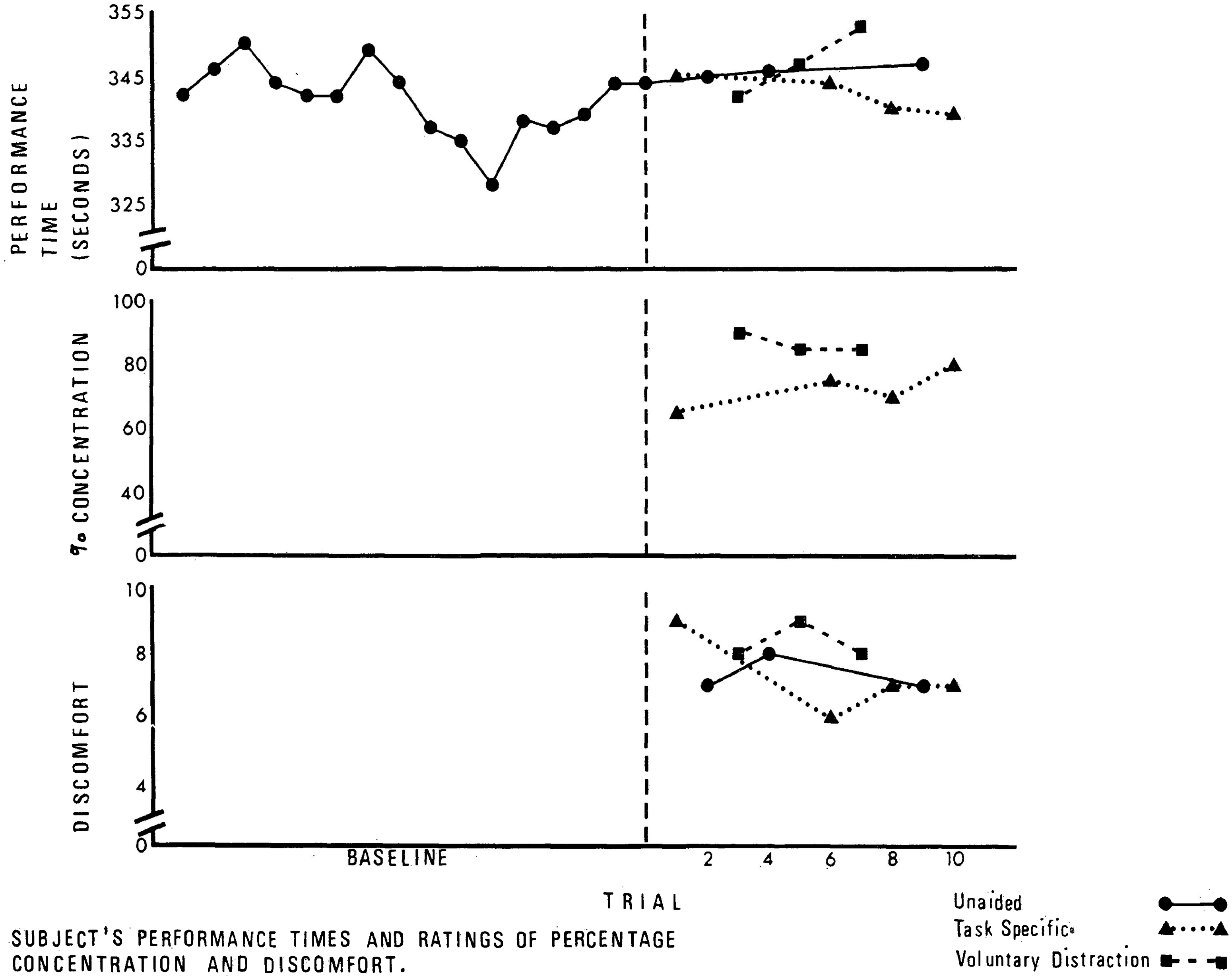

FIGURE 5. SUBJECT'S PERFORMANCE TIMES AND RATINGS OF PERCENTAGE CONCENTRATION AND DISCOMFORT.

Swim performance time according to pool temperature is presented in Figure 6. There was little difference in performance times regardless of pool temperature.

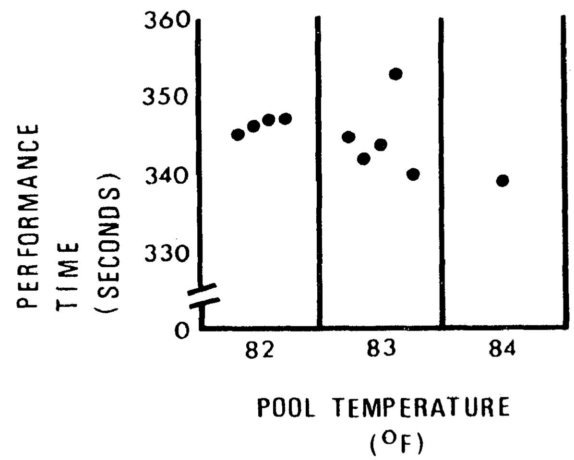

FIGURE 6. PERFORMANCE TIME ACCORDING TO POOL TEMPERATURE.

Figure 7 illustrates the relationship of performance time to the day of the week on which the swim was performed. There was a limited number of trials on each day, and no obvious differences were apparent.

Appendix E contains the posttest and postexperiment results for Subject 2. The association between the subject's expectancy and the actual performance was tested by a Phi Coefficient analysis. A r_0 value of -.408 was determined. This yielded a χ^2 value of 1.66, which with one degree of freedom, is a nonsignificant value.

A Phi Coefficient analysis was also conducted to test for association between the subject's assessment of her performance (in relation to the previous trial) and her actual performance. On all 10 trials the

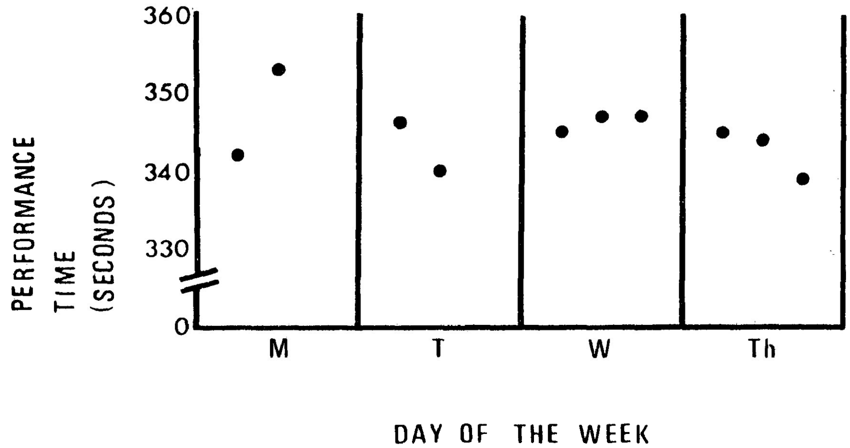

FIGURE 7. PERFORMANCE TIME ACCORDING TO DAY OF THE WEEK.

subject considered the discomfort of the maximal effort to be painful. The subject responded that she had enough sleep the night before every trial, and had not had either too much or too little to eat before any trial. She also felt that a shoulder injury was preventing her best performance on all 10 occasions.

The postexperiment questionnaire revealed that this subject preferred to swim using a task specific strategy, and that she assessed the task specific condition as being the most effective for improving swim performance. The unaided condition was ranked second, and the voluntary distraction strategy condition was assessed to be the least effective for improving performance.

Discussion

These results indicated that a cognitive strategy may be useful for improving swim performance in this subject. Because of the limited number of trials in the strategy conditions, it was difficult to predict what would have happened in future trials.

The separation of the performance times for the three treatment conditions suggested that a task specific strategy may have helped this subject to improve her performance times. It also suggested that a voluntary distraction strategy may have caused this subject's performance times to increase (become worse). From these limited data it appeared that the independent variables may have controlled the dependent variable (performance time) for this subject.

The stability of the baseline was maintained by the experimental unaided condition, after the introduction of the treatments. This suggested that extraneous variables continued to exert a constant effect on the dependent variable. The opportunity to achieve stability of performance in the strategy conditions was eliminated when the study had to be terminated, because of a shoulder injury.

Although this subject found it more difficult to concentrate on the task specific strategy than on the voluntary distraction strategy, her ability to concentrate in the task specific condition appeared to be increasing with the use of the strategy. This suggested that whereas the content of a task specific strategy may not be as interesting or pleasant as the content of a voluntary distraction strategy, it may be possible through practice, to learn to concentrate on technique.

The limited data on discomfort ratings suggested that a task specific strategy was superior to a voluntary distraction strategy for reducing the discomfort which arises from maximal performances, for this subject.

The lack of association between discomfort ratings and performance times suggested that perhaps, for this subject, discomfort was not an important factor in the performance of a 400 metre swim. The absence of a relationship between discomfort ratings and percentage concentration suggested that ability to concentrate on a cognitive strategy was not related to discomfort, for this subject.

Neither pool temperature nor the day of the week on which a swim was performed appeared to have affected the performance times of this subject.

The subject's expectancy concerning performance was not related to her actual performance, so an expectancy factor did not likely contribute to the performance differences between the treatment conditions. This subject was unable to assess her performances with respect to the performance on the previous trial.

This subject considered the discomfort of all trials to be painful. This assessment was largely due to a shoulder injury with which the subject was swimming. Had the subject not been experiencing the acute shoulder pain, the discomfort of the maximal efforts may not have been considered painful. Since all swims were performed in the presence of pain, this factor would not likely serve to differentiate performance times.

The sleeping and eating habits of this subject did not vary greatly before any trial. These factors, therefore, did not likely act differentially to affect performance times. The shoulder injury was present from the time of the introduction of the treatments, so probably also influenced all performances equally.

The subject's preference for the task specific strategy condition, and her assessment that it was the most effective condition for improving performance times appeared to be supported by her performance results.

Her rankings of the unaided condition and the voluntary distraction strategy condition as less effective in improving performance were also supported by her swim times.

The results obtained from this subject's performance suggested that the use of cognitive strategies may assist to improve the performances of some individuals. Unfortunately, a shoulder injury resulted in early termination of this experiment, thereby limiting prediction of future performances from the results.

CHAPTER IV

Subject 3 -- Results and Discussion

Results

The performance record for Subject 3 is illustrated in Figure 8. The three circled points (Trials 1, 6 and 11) were disregarded when analyzing the results because the subject was ill when she swam these trials. Before she swam on these three occasions it was apparent that there were predetermined factors which would prevent her from swimming well. These three scores were so far out of line with the others (5 to 9 seconds above the next highest scores), that it was decided it would be best to consider them as rogue scores, and disregard them in the data analyses.

Baseline was considered to be stable after seven trials, when the last four performance times demonstrated a 2-second range.

The three treatment conditions overlapped repeatedly, but the unaided condition appeared to generate slightly poorer performance times than the other two conditions. Task specific strategy times tended to be slightly faster than voluntary distraction times, with the exception of the voluntary distraction performance of Trial 20. Over the course of the study performance times in all three conditions tended to improve.

The posttest questionnaire data revealed little difference in this subject's ability to concentrate on task specific or voluntary distraction strategies. Figure 8 illustrates these data. Percentage concentration was more variable for the task specific strategies (range 65% to 96%) than for the voluntary distraction strategies (range 80% to 100%).

Figure 8 also illustrates the subject's ratings of discomfort.

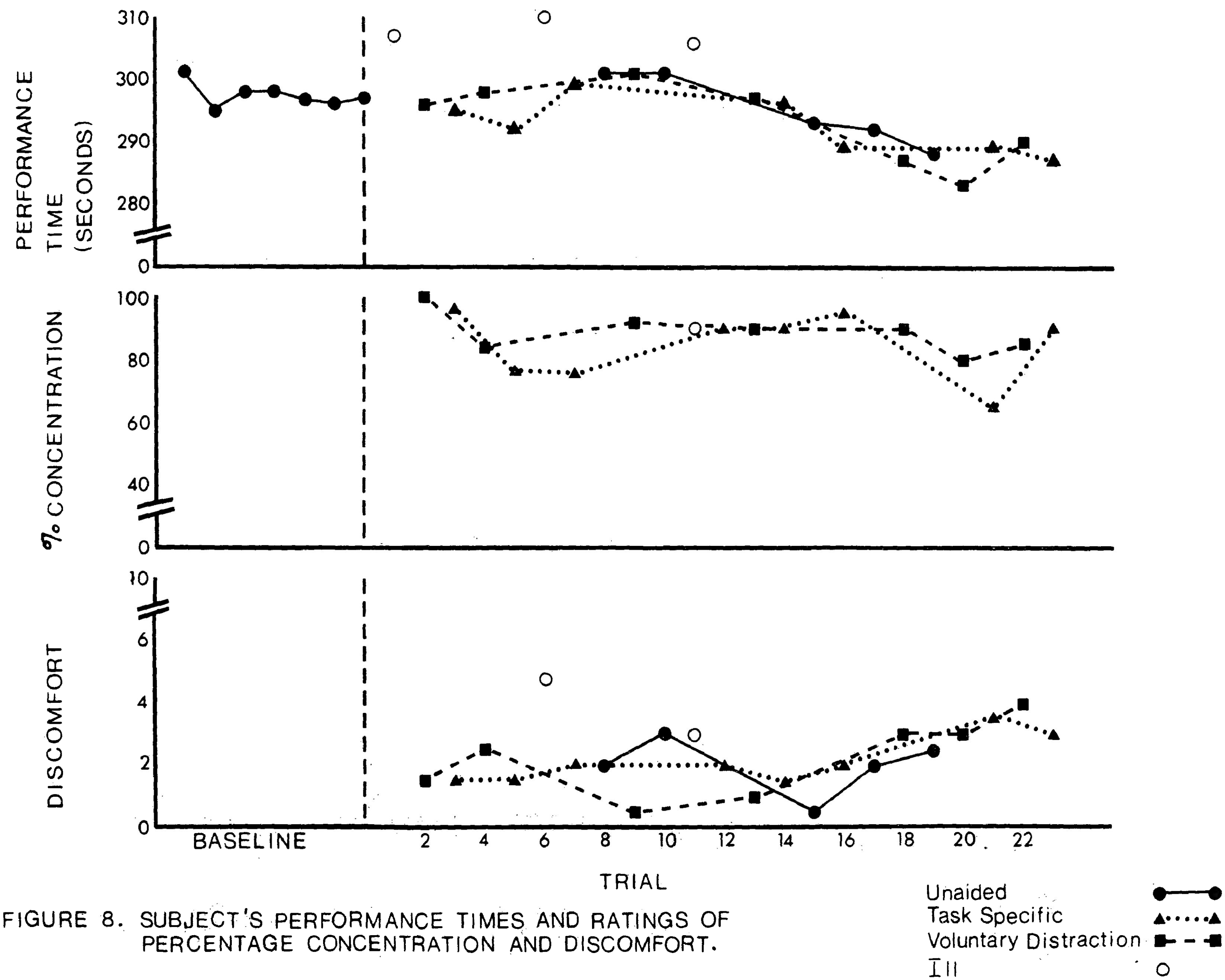

FIGURE 8. SUBJECT'S PERFORMANCE TIMES AND RATINGS OF PERCENTAGE CONCENTRATION AND DISCOMFORT.

The discomfort ratings for all three conditions overlapped considerably. In the latter part of the study (Trial 13 on) the discomfort ratings appeared to be gradually increasing. The highest discomfort rating (4.8) occurred after Trial 6, when the subject was ill.

The discomfort ratings did not appear to be related to concentration ability. The general trend of increasing discomfort ratings after Trial 13 somewhat mirrored the general trend of decreasing performance times from this point on.

Figure 9 presents the swim performance times according to pool temperature. When the three rogue points were ignored, two of the three poorest performances still occurred when the pool temperature was 86°F. Two of the three best swim times occurred when the pool temperature was 84°F.

Figure 10 illustrates the relationship of swim performance to the day of the week on which the swim was performed. When the rogue points were disregarded there appeared to be little difference between performances on any day.

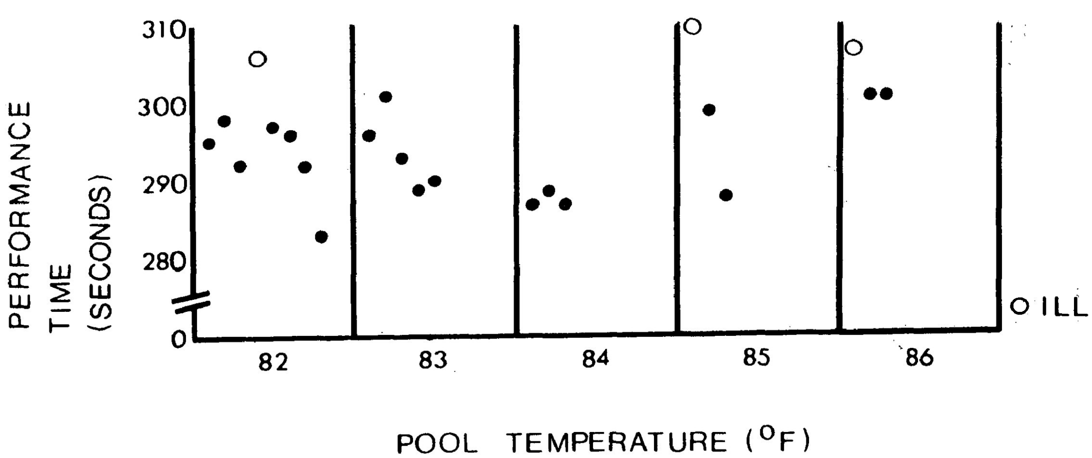

FIGURE 9. PERFORMANCE TIME ACCORDING TO POOL TEMPERATURE.

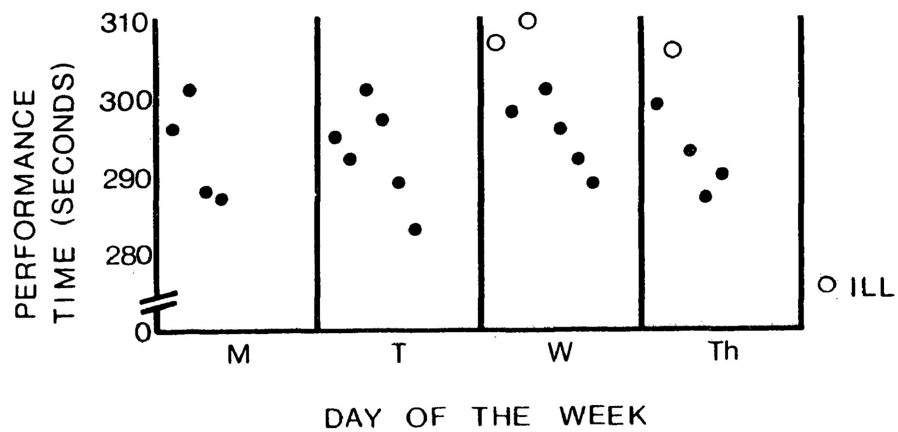

FIGURE 10. PERFORMANCE TIME ACCORDING TO DAY OF THE WEEK.

Appendix E contains the posttest and postexperiment questionnaire results for Subject 3. A Phi Coefficient analysis was conducted to test the association between the subject's expectancy for performance and the actual performance results. A r_0 value of .367 was determined. This yielded a χ^2 value of 2.559, which, with 1 degree of freedom, is nonsignificant.

The association between the subject's assessment of performance and the actual performance was also tested by a Phi Coefficient analysis. A r_0 value of .489 yielded a χ^2 value of 4.541. With 1 degree of freedom, this is significant at the .05 level of significance.

On 17 occasions the subject considered the discomfort of the maximal effort to be painful, while on 5 occasions she did not. Of the 17 performances which were considered to be painful, 4 were in the unaided condition, 7 were in the task specific strategy condition, and 6 were in the voluntary distraction strategy condition. A comparison of mean performance times for painful ($\bar{X}$ = 292.9 sec.) and non-painful days ($\bar{X}$ = 295.3 sec.) revealed a slight difference.

For 12 trials the subject felt that she had enough sleep the night before, while for 10 trials she responded that she did not have enough sleep the previous night. A comparison of mean performance times for these days revealed a small difference (enough sleep, $\bar{X}$ = 292.0 sec.; not enough sleep, $\bar{X}$ = 294.9 sec.).

On 3 occasions the subject responded that she had eaten too much or too little before the performance. On 19 occasions her eating habits were considered to have been appropriate. The mean performance time on days when the subject felt she had not eaten appropriately was 295.5 seconds, compared to a mean time of 293.1 seconds when the eating habits were appropriate.

On three occasions the subject responded that there were factors preventing her best performance. These were on Trials 1, 6, and 11, the three days that the subject was ill. The mean performance time for these three trials was 307.7 seconds, compared to a mean performance time of 293.4 seconds for the other 19 trials.

The postexperiment questionnaire revealed that this subject preferred to swim using a task specific strategy. She assessed the task specific condition to be the most effective for improving performance, the unaided condition to be the next best, and the voluntary distraction condition to be the least effective for improving performance.

Discussion

These results suggested that cognitive strategies may be of slight value for improving performances for this subject.

The rapid achievement of stability in the baseline stage indicated that extraneous variables were exerting a constant influence over these trials.

The repeated overlap of the performance times in the three conditions indicated that the independent variables (the treatment conditions) did not exert complete control over the dependent variable (swim performance). The slight difference between the three conditions, with the unaided times being the poorest and task specific times being marginally fastest, may have resulted from a number of factors, one of which was the treatment condition.

The general trend over the study was that the task specific performance times stayed slightly faster than the voluntary distraction times. This trend was ended with the voluntary distraction performance at Trial 20. It appeared that an extraneous variable intervened between Trial 20 and Trial 21, which resulted in increased performance times. Had there been another task specific trial between Trials 17 and 21, perhaps the trend of task specific times being faster than voluntary distraction times would have continued. That is a limitation of using a randomized treatment assignment.

The fact that performance times in the unaided condition tended to improve over the period of the study suggested the intervention of extraneous variables. With no outside influences the experimental unaided condition should have maintained the baseline level. The improvement of the times in the strategy conditions corresponded to improvements in the unaided condition. This suggested that this subject did not learn to use the strategies more effectively over the course of the experiment, because when the strategy conditions varied in performance, so did the unaided condition. It appeared that the performance times in all three conditions were affected by extraneous variables.

Generally this subject did not appear to find one strategy condition easier to concentrate on than the other. However, the greater variation of concentration in the task specific strategy condition, suggested that, at times, it was difficult to concentrate on.

The overlapping discomfort ratings for the three conditions indicated that no one condition was better than the others for reducing discomfort. The gradually increasing discomfort ratings in the latter part of the study may have been related to the fact that the subject generally was swiming faster. The highest discomfort rating (4.8 on Trial 6) occurred on a day when the subject was ill and felt she did not perform well.

The lack of association between the discomfort ratings and percentage concentration indicated that discomfort was not controlled by concentrating on a strategy.

Although the pool temperature did not range very much (82^{o}F to 86^{o}F), the results suggested that this may have affected some of the performance times. The consistently fast performances at 84^{o}F suggested that, for this subject, this may be near optimal water temperature for maximal effort swims. A pool temperature of 86^{o}F may be too high for the achievement of best performances by this subject.

The day of the week on which the swim was performed did not appear to have affected performance times for this subject.

The subject's expectancy concerning performance was not related to her actual performance, therefore expectancy did not appear to be significant factor in influencing swim times.

This subject was able to accurately assess her performance in terms of the previous trial, so she may have had some form of intrinsic information feedback.

After the majority of the trials (77%) this subject considered her discomfort to be painful. Pain was associated with all three treatment conditions, so no one condition appeared better for controlling pain. Maximal efforts that were considered not to be painful produced a mean performance time nearly 2.5 seconds slower than the mean performance time of the trials which were considered painful. For this subject, perhaps pain is associated with fast performances.

A lack of sleep the night before a performance appeared to be related to performance time for this subject. Performance times following nights of insufficient sleep were nearly 3 seconds slower than those following nights where the subject did get enough sleep.

The appropriateness of the subject's eating habits before a performance may have been related to performance time. But the fact that there were only three occasions when the subject felt that she had eaten inappropriately, limited the ability to compare meaningfully, mean performance times.

The factors identified by the subject as preventing her best performance, did indeed appear to have done that. The mean performance time for the three days that she was ill was more than 14 seconds slower than the mean time for the trials on which the subject was healthy. It was for this reason that these three points were not included in the data analyses.

This subject's preference for the task specific strategy condition, and her assessment that it was the most effective condition for improving performance times, appeared to be somewhat supported by the performance results. Her ranking of the unaided condition to be second best and the voluntary distraction condition to be the least effective in improving performance times, was not supported by the data.

The data for this subject suggested that the use of cognitive strategies may help in improving performance time. Performance times in both the task specific and voluntary distraction conditions appeared to be slightly better than those in the unaided condition, although stability was not achieved for any condition.

The data also indicated that other variables were affecting performance times. Discomfort, pain, pool temperature, amount of sleep, and eating habits all appeared to have potential to affect performances for this subject.

This subject's preference for the task specific strategy condition, and her assessment that it was the most effective condition for improving performance, indicated that there may be value in this subject using a cognitive strategy.

CHAPTER VII

General Discussion

The great differences in the data generated by the three subjects emphasized the individuality involved in athletic performances. While the subjects were quite similar in many respects (age, sex, ability) they did not demonstrate similar performance patterns or similar responses to the measured factors which might have affected performance times. Table 2 shows which factors appeared to have the potential to affect performance times for each subject.

Factor	A	B	C	D	E	F	G	H	I	J	K
Subject 1	N	N	N	N	Y	N	N	N	N	N	Y
Subject 2	Y	N	N	N	N	N	N	N	N	N	N
Subject 3	Y	N	Y	Y	N	N	Y	Y	Y	Y	Y

Key: A - treatment condition
B - % concentration
C - discomfort rating
D - pool temperature
E - day of the week
F - expectancy
G - assessment of performance
H - pain
I - sleep
J - eating habits
K - other factors

Y - Yes: this factor appeared to be related to performance time.
N - No: this factor did not appear to be related to performance time.

Table 2: The potential of factors for affecting performance times.

Performance time, for Subject 1, appeared to be independent of the treatment conditions which were used. Of all the variables which were examined, only the day of the week on which the swim was done appeared to be related to performance time for this subject. Soreness and tiredness (Column K - other factors) also appeared to influence this subject's swim efforts.

For Subject 2, only the treatment conditions which were used appeared to influence performance times. Performances tended to improve with the task specific strategies and to decline with the voluntary distraction condition. None of the other factors which were considered appeared to be related to this subject's swim performances.

A number of factors appeared to have the potential for affecting the performance of Subject 3. While both strategy conditions seemed to be associated with improved performance times, many other variables also seemed to have an affect. These included: a) the amount of discomfort which was experienced, b) whether the discomfort was considered to be painful, c) the temperature of the pool, d) the subject's ability to accurately assess performances, e) the amount of sleep the night before a performance, f) eating habits before a maximum effort, and g) illness (Column K - other factors).

For two of the three subjects, performance did seem to be influenced by the use of strategies. This tended to support the findings of Selkirk (1980) whose endurance runners increased their mean performance times by using cognitive strategies.

The differential effects of the three treatment conditions on performance time varied with each individual. For Subject 1 treatment condition appeared to have no effect, while for Subject 3 both strategy conditions seemed to improve performance. With Subject 2 the task specific condition tended to improve performance from the unaided condition, while the voluntary distraction condition seemed to result in performances poorer than those in the unaided condition.

Rushall (1979) presented data showing how one subject improved performances after repeated trials using a cognitive strategy. However, only one of the three subjects in the present experiment demonstrated an increased effectiveness in using cognitive strategies over the course of the study.

As with Selkirk's (1980) subjects, these swimmers generally indicated that the ability to concentrate on the prepared strategy was high. Two of the three subjects found the voluntary distraction strategies easier to concentrate on than the task specific strategies. This did not surprise the experimenter, as the voluntary distraction strategies were less restrictive, thereby providing the opportunity for greater variety.

Spanos, Horton and Chaves (1975) and Jaremko (1978) reported that the subject's degree of involvement in a strategy affected the pain experience. The present study did not support this fact, in that for no subject, was the estimated percentage concentration on the strategy related to the discomfort ratings.

The discomfort ratings varied greatly among the three subjects. Ratings by Subject 3 were generally low, those by Subject 1 were in the mid-range, and the discomfort ratings of Subject 2 tended to be high.

The use of cognitive strategies did not appear to affect the discomfort ratings for these subjects. This fact tended to conflict with the results of numerous laboratory pain studies (Beers & Karoly, 1979; Blitz & Dinnerstein, 1971; Chaves & Barber, 1974; Kanfer & Goldfoot, 1966). These studies found cognitive strategies to be effective in altering pain responses. The differences may be due to the fact that the laboratory-produced pain was very localized, unlike the usual general discomfort experienced by the swimmers following their performances.

It should be noted that discomfort was not considered to be painful on all occasions. Whether the discomfort was considered to be painful also appeared to be independent of the treatment condition which was used.

Expectancy for performance was not related to actual performance results for the subjects of this study. This finding was similar to that made by Selkirk (1980). Selkirk, however, found that the majority of his subjects were able to accurately assess their performance in terms of previous trials. Only one of the three subjects in this study demonstrated that ability.

Selkirk (1980) stated that his subjects reported a large number of aversive thoughts when running under the unaided condition. In the present study, not one thought about pain or discomfort was reported after these trials. The swimmers often reported that they thought about "nothing", but counting lengths and concentrating on speed were common preoccupations during the unaided condition efforts.

Two of the three subjects in this study preferred the task specific strategy condition and assessed it to be the most effective for improving performance. They both tended to swim their best under this condition. The third subject preferred the unaided condition, but no one treatment appeared to be better than the others for improving her performances. This was unlike Selkirk's (1980) findings, where, although the majority of his subjects preferred the voluntary distraction strategy, few of them recorded their best performances under this condition.

The findings of this study indicated that the successful use of cognitive strategies for improving performance may be a highly individualistic phenomenon. While the use of strategies did not appear to be related to reduced discomfort ratings or altered pain perception, it did seem to be related to improved performance times for two of the three subjects. It appears that while some athletes may derive little or no benefit from the use of cognitive strategies, other individuals may be able to use them successfully to improve performance.

The type of strategy which is most effective may also be a highly individual factor. These data suggested that perhaps task specific strategies may hold the greatest potential for improving performance, but it could be worthwhile for a serious athlete to experiment with different types of strategies.

The necessity of an individual approach toward preparation for athletic competition was emphasized by the results of this experiment. Coaches who deal with a number of athletes, even though they may appear to be a fairly homogeneous group, should experiment to discover which conditions are optimal for each individual.

CHAPTER VIII

Summary, Conclusions, and Recommendations

Summary

This thesis examined the effects of cognitive strategies on the swim performance of three female swimmers from the Thunder Bay Thunderbolts Swim Club.

A pilot study was conducted with one subject in order to establish a consistent experimental procedure and to see if stable performance could be achieved. Following this, all three subjects swam repeated 400 metre swim trials until a stable baseline record was determined for each. The subjects then formulated task specific and voluntary distraction strategies, which were randomly alternated with an unaided condition, for use in the experimental trials. Performance times were recorded for each 400 metre swim under the varying strategy conditions. Subjects swam four times each week, and continued until stability of performance was achieved, or until it became obvious that stability could not be accomplished.

The independent variables were the three treatment conditions. The major dependent variable was the time taken to swim the 400 metre effort. Posttest and postexperiment questionnaires produced information on the following: a) the degree of discomfort experienced by the subject, b) the subject's interpretation of discomfort as being painful, c) the subject's expectancy regarding performance, d) the subject's assessment of performance time, e) the percentage of time that the subject was able to concentrate on the prepared strategy, f) the subject's preference and estimate of effectiveness of each treatment condition, and g) a description of factors which may have affected performance times.

Data were graphed and tabulated, so that a visual analysis for trends could be conducted to determine significance. A Phi Coefficient analysis was conducted to test for association between: a) the subject's expectancy and her actual performance, and b) the subject's assessment of performance and her actual performance.

Conclusions

The results of this study emphasized the individual nature of athletic performance. The widely varying data produced by the three subjects revealed several things.

1. Some athletes appeared to be able to use cognitive strategies to improve performance.

2. A task specific strategy appeared to have the greatest potential for improving performance, but this may be dependent on the individual athlete.

2. While the use of cognitive strategies was related to improved performances for some athletes, this did not appear to be due to reduced discomfort or altered pain perception.

4. Expectation to perform well or poorly was not related to actual performance.

5. The ability of the subjects to concentrate on the prepared strategy was generally high.

6. Two of the three subjects swam their best under their preferred condition and estimated it to be the most effective for improving performance.

7. Discomfort ratings and the ability to accurately assess performances varied with the individuals.

8. The performance of each subject appeared to be affected differently by factors with confounding potential.

The results of this study indicated that an individualized planned cognitive strategy may enable some athletes to improve performances.

Recommendations

1. This study should be repeated with certain modifications.

2. Future researchers should consider breaking down performance times, and recording split times, as well as the overall result. Cognitive strategies may affect the nature of the performance, if not the overall time.

3. Questionnaire items concerning expectancy about a performance and factors which may prevent a best performance should be asked before the trial. A brief pretest questionnaire would serve this purpose in future studies.

4. Coaches should instruct their athletes in the formulation and implementation of cognitive strategies. A task specific strategy, where the major focus is technique, should be given due consideration.

5. Coaches should experiment to discover which strategy conditions are optimal for each individual athlete.

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APPENDIX A

Examples of Posttest Questionnaires

1) unaided - first trial
2) unaided - later trials
3) strategy - first trial
4) strategy - later trials

Example of Postexperiment Questionnaire

POSTTEST QUESTIONNAIRE (1)

Instructions: Please read and circle your response.

1. Did you: a) get enough sleep last night? YES NO

   b) eat too much or too little before this trial? YES NO

2. Rate yourself on the following scale as to the degree of discomfort you experienced during your swim.

0	1	2	3	4	5	6	7	8	9	10

No Discomfort — Slight Discomfort — Moderate Discomfort — Severe Discomfort — Very Severe Discomfort

3. Would you say your discomfort was painful? YES NO

4. Was there anything preventing you from performing your best today? YES NO
   If answer is "YES" please explain.

5. What were you thinking of during your swim today?

Name:________________________________

POSTTEST QUESTIONNAIRE (2)

Instructions: Please read and circle your response.

1. Did you: a) get enough sleep last night? YES NO

   b) eat too much or too little before this trial? YES NO

2. Rate yourself on the following scale as to the degree of discomfort you experienced during your swim today.

0	1	2	3	4	5	6	7	8	9	10

No Discomfort	Slight Discomfort	Moderate Discomfort	Severe Discomfort	Very Severe Discomfort

3. Would you say your discomfort was painful? YES NO

4. Did you expect to do better today than on your previous swim(s)? YES NO

   Do you feel that you did do better today than on your previous swim(s)? YES NO

5. Was there anything preventing you from performing your best today? YES NO
   If answer is "YES" please explain.

6. What were you thinking about during your swim today?

Name:_______________ __ __ ____________

POSTTEST QUESTIONNAIRE (3)

Instructions: Please read and circle your response.

1. Did you: a) get enough sleep last night? YES NO

   b) eat too much or too little before this trial? YES NO

2. Rate yourself on the following scale as to the percent of time you were able to think of the content that you prepared.

   0% — 25% — 50% — 75% — 100%

3. Rate yourself on the following scale as to the degree of discomfort you experienced during your swim today.

   0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

No Discomfort	Slight Discomfort	Moderate Discomfort	Severe Discomfort	Very Severe Discomfort

4. Would you say your discomfort was painful? YES NO

5. Was there anything preventing you from performing your best day? YES NO
   If answer is "YES" please explain.

Name: ______________________________

POSTTEST QUESTIONNAIRE (4)

Instructions: Please read and circle your response.

1. Did you: a) get enough sleep last night? YES NO

   b) eat too much or too little before this trial? YES NO

2. Rate yourself on the following scale as to the percent of the time you were able to think of the content that you prepared.

   0% — 25% — 50% — 75% — 100%

3. Rate yourself on the following scale as to the degree of discomfort you experienced during your swim today?

0	1	2	3	4	5	6	7	8	9	10
No Discomfort	Slight Discomfort		Moderate Discomfort			Severe Discomfort			Very Severe Discomfort	

4. Would you say your discomfort was painful? YES NO

5. Did you expect to do better today than on your previous swim(s)? YES NO

   Do you feel that you did do better today than on your previous swim(s)? YES NO

6. Was there anything preventing you from performing your best today? YES NO
   If answer is "YES" please explain.

Name: ______________________________

POSTEXPERIMENT QUESTIONNAIRE

Name: ____________________

Instructions: Please answer the following questions carefully. Take some time to think over your answers.

During your 400 metre maximum effort swims you were asked to think of different things while you swam. You were instructed to:

A. Perform your warm-up, and following a brief rest, begin your 400 metre swim. (Unaided)

B. Perform your warm-up, and following a brief rest, begin your 400 metre swim. During this swim concentrate entirely on your swimming technique and 'power' words. (Task Specific)

C. Perform your warm-up, and following a brief rest, begin your 400 metre swim. During this swim think of things that will take your mind away from your swimming, but do not concentrate on your swimming technique. (Voluntary Distraction)

1. Which of the three conditions did you prefer? Why?

2. Which of the three conditions did you feel was the best for improving your swim time?

3. List in order from most effective (1) to least effective (3) the conditions that improved your performance.

   ( ) Unaided ( ) Task Specific ( ) Voluntary Distraction

4. Write down anything that you feel would be of value for me to know regarding your participation in this experiment.

APPENDIX B

Sample Sheet for Recording
Performance Information

Name:____________________

Event:____________________

Date	Pool Temp.	Strategy	Prep. Time	400m Time	Est. % Concen.	Discom-fort	Expec-tation	Comments

APPENDIX C

Sample Instruction Sheet

INSTRUCTIONS

During the next few weeks you will be asked to swim a 400 metre maximum effort using one of three different thought strategies. These will be called:

1) unaided condition
2) task specific strategy
3) voluntary distraction strategy.

1) Unaided condition: In the unaided condition you will perform your standard 10-minute warm-up. Following a brief rest you will start your 400 metre swim.

2) Task specific strategy: In the task specific strategy condition you will perform your standard 10-minute warm-up. Following a brief rest you will start your 400 metre swim. During this swim you will focus your attention and concentrate entirely on your swimming technique. As you swim always think of your technique. For your entire swim concentrate on your arm action, head position, body alignment, breathing and kicking action. Remember, you are to think only of your technique. Concentrate, at all times, on rhythm, arm action, breathing and any other features of your technique with which you are familiar.

3) Voluntary distraction strategy: In the voluntary distraction strategy condition you will perform your standard 10-minute warm-up. Following a brief rest you will start your 400 metre swim. During this swim you will think of things that will take your mind away from your swimming. Please do not concentrate on your technique as in the task specific situation. Think of anything you wish that will distract you from your swimming. You may sing, count, recite poetry, or think of anything you wish, except your swimming.

APPENDIX D

Examples of Sheets Containing
Key Words and Ideas for Use in
Formulating Cognitive Strategies

1) Task Specific Strategy
2) Voluntary Distraction Strategy

TASK SPECIFIC STRATEGY

Instructions: Using the following words and any others you can think of, write down statements you will concentrate on during your swim.

Key Words:		
	start	hand, arm, shoulder positions
	turns	streamlining
	arm action	head position
	stroke length	kicking
	breathing	rhythm

Note: Plan enough content to fill the entire swim. Ideas can be repeated.

VOLUNTARY DISTRACTION STRATEGY

Instructions: Using the following ideas or any others you can think of, write down statements you will concentrate on during your swim.

Ideas:

singing	recite poetry
counting	skiing
games	T.V.

Note: Plan enough content to fill the entire swim. Ideas can be repeated. Do not concentrate on your swimming technique as you did in the task specific situation.

APPENDIX E

Tables containing performance data,
posttest and postexperiment questionnaire data.

1) Subject 1
2) Subject 2
3) Subject 3
4) Key for tables.

SUBJECT 1 -- RESULTS

PERFORMANCE DATA						POSTTEST QUESTIONNAIRE DATA							POSTEXPERIMENT QUESTIONNAIRE DATA	
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
DAY	DATE	CONDITION	TIME	POOL	CONCENTRATION	DISCOMFORT	PAIN	EXPECTATION	ASSESSMENT	SLEEP	POOL	FACTORS	PREFERENCE	EFFECTIVENESS
W	04/02/81	C	309	85	75	2	N	-	-	N	N	Y	A	(1) A
Th	05/02/81	B	296	85	75	5	Y	Y	Y	Y	N	N		(2) B
M	09/02/81	A	303	86	-	5	N	N	N	Y	N	N		(3) C
T	10/02/81	B	302	86	75	5	N	N	N	N	N	Y		
W	11/02/81	A	294	83	-	5	N	Y	Y	N	N	N		
Th	12/02/81	C	313	82	85	4	N	N	N	N	N	Y		
M	16/02/81	A	299	83	-	6	N	Y	Y	N	N	N		
T	17/02/81	C	303	82	85	5	N	N	N	N	N	Y		
W	18/02/81	B	305	82	80	5	N	N	N	N	N	Y		
Th	19/02/81	C	310	83	90	5	N	N	N	Y	N	N		
M	23/02/81	B	305	83	75	5	N	N	N	Y	N	Y		
T	24/02/81	A	307	83	-	5	Y	Y	Y	N	N	N		
W	25/02/81	B	306	82	85	4	N	N	N	N	N	N		
Th	26/02/81	A	304	84	-	5	N	N	Y	N	N	N		
M	02/03/81	C	297	85	85	6	Y	Y	Y	Y	N	N		
T	03/03/81	A	301	82	-	5	N	N	N	N	N	N		
W	04/03/81	C	307	84	90	5	N	N	N	Y	N	Y		
Th	05/03/81	B	299	83	75	4	Y	N	N	N	N	Y		
M	09/03/81	C	308	84	75	4	Y	Y	Y	Y	N	Y		
T	10/03/81	B	304	83	75	4	Y	N	N	Y	N	Y		
W	11/03/81	A	308	84	-	4	Y	N	N	N	N	Y		
Th	12/03/81	B	310	83	80	5	Y	N	N	N	N	Y		
M	16/03/81	A	303	85	-	5	Y	Y	Y	N	N	N		

SUBJECT 2 -- RESULTS

PERFORMANCE DATA						POSTTEST QUESTIONNAIRE DATA							POSTEXPERIMENT QUESTIONNAIRE DATA	
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
DAY	DATE	CONDITION	TIME	POOL	CONCENTRATION	DISCOMFORT	PAIN	EXPECTATION	ASSESSMENT	SLEEP	POOL	FACTORS	PREFERENCE	EFFECTIVENESS
W	11/02/81	B	345	83	65	9	Y	N	N	Y	N	Y	B	(1) B
Th	12/02/81	A	345	82	-	7	Y	Y	N	Y	N	Y		(2) A
M	16/02/81	C	342	83	90	8	Y	Y	N	Y	N	Y		(3) C
T	17/02/81	A	346	82	-	8	Y	Y	N	Y	N	Y		
W	18/02/81	C	347	82	85	9	Y	Y	N	Y	N	Y		
Th	19/02/81	B	344	83	75	6	Y	N	N	Y	N	Y		
M	23/02/81	C	353	83	85	8	Y	Y	N	Y	N	Y		
T	24/02/81	B	340	83	70	7	Y	N	N	Y	N	Y		
W	25/02/81	A	347	82	-	7	Y	N	N	Y	N	Y		
Th	26/02/81	B	339	84	80	7	Y	N	N	Y	N	Y		

SUBJECT 3 -- RESULTS

PERFORMANCE DATA					POSTTEST QUESTIONNAIRE DATA								POSTEXPERIMENT QUESTIONNAIRE DATA	
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
DAY	DATE	CONDITION	TIME	POOL	CONCENTRATION	DISCOMFORT	PAIN	EXPECTATION	ASSESSMENT	SLEEP	FOOD	FACTORS	PREFERENCE	EFFECTIVENESS
W	21/01/81	A	307*	86	-	-	-	-	-	-	-	Y	B	(1) B
M	26/01/81	C	296	83	100	1.5	N	-	-	N	N	N		(2) A
T	27/01/81	B	295	82	96	1.5	N	Y	Y	Y	N	N		(3) C
W	28/01/81	C	298	82	84	2.5	Y	N	N	Y	N	N		
T	03/02/81	B	292	82	76	1.5	Y	N	N	N	N	N		
W	04/02/81	A	310*	85	-	4.8	N	N	N	N	Y	Y		
Th	05/02/81	B	299	85	75	2.0	Y	N	N	Y	N	N		
M	09/02/81	A	301	86	-	2.0	Y	N	N	Y	N	N		
T	10/02/81	C	301	86	92	.5	Y	N	N	N	N	N		
W	11/02/81	A	301	83	-	3.0	Y	N	N	N	Y	N		
Th	12/02/81	C	306*	82	90	3.0	Y	N	N	Y	N	Y		
M	16/02/81	B	- **	83	90	2.0	Y	Y	Y	Y	N	N		
T	17/02/81	C	297	82	90	1.0	N	N	N	N	N	N		
W	18/02/81	B	296	82	90	1.5	Y	N	N	N	N	N		
Th	19/02/81	A	293	83	-	.5	N	Y	Y	Y	N	N		
T	24/02/81	B	289	83	95	2.0	Y	Y	Y	Y	N	N		
W	25/02/81	A	292	82	-	2.0	Y	Y	N	N	N	N		
Th	26/02/81	C	287	84	90	3.0	Y	Y	Y	Y	N	N		
M	02/03/81	A	288	85	-	2.5	Y	Y	Y	Y	N	N		
T	03/03/81	C	283	82	80	3.0	Y	Y	N	Y	N	N		
W	04/03/81	B	289	84	65	3.5	Y	Y	N	N	N	N		
Th	05/03/81	C	290	83	85	4.0	Y	N	N	N	Y	N		
M	09/03/81	B	287	84	90	3.0	Y	Y	Y	Y	N	N		

*Ill

**No time - due to timing error.

Key for Appendix E

Column	Explanation
A.	Day of the Week. M - Monday, T - Tuesday, W - Wednesday, Th - Thursday.
B.	Date of performance. Day/Month/Year.
C.	Treatment condition. A - Unaided, B - Task Specific C - Voluntary Distraction.
D.	Performance time. In seconds.
E.	Pool temperature. In ^{o}F.
F.	The subject's estimate of the percentage of the performance time that she was able to concentrate on the prepared strategy.
G.	The subject's estimate of the degree of discomfort experienced.
H.	The subject's interpretation of the discomfort as painful. Y - Yes, N - No.
I.	The subject's expectation for performance (i.e. did you expect to do better today than on your previous swim?). Y - Yes, N - No.
J.	The subject's assessment of performance (i.e. do you feel you did better today than on your previous swim?). Y - Yes, N - No.
K.	The subject's assessment of sufficiency of sleep. Y - Yes, N - No.
L.	The subject's assessment of appropriateness of eating habits (i.e. did you eat too much or too little before this performance?). Y - Yes, N - No.
M.	The subject's identification of factors which prevented best performance. Y - Yes, N - No.
N.	The subject's preferred treatment condition (see column C explanation for key).
O.	The subject's ranking of conditions according to effectiveness for improving performance. (1) Most effective, (3) Least effective.

APPENDIX F

Pilot study data and baseline data.

PILOT STUDY DATA

Date	Performance Time (sec.)
08/12/80	295
09/12/80	292
10/12/80	300
11/12/80	297
15/12/80	300
16/12/80	295
17/12/80	299
18/12/80	300

BASELINE DATA -- SUBJECT 1

Date	Performance Time (sec.)
06/01/81	293
07/01/81	299
12/01/81	299
13/01/81	303
14/01/81	305
15/01/81	294
26/01/81	296
27/01/81	299
28/01/81	293
03/02/81	295

BASELINE DATA -- SUBJECT 2

Date	Performance Time (sec.)
08/01/81	342
12/01/81	346
13/01/81	350
14/01/81	344
15/01/81	342
20/01/81	342
21/01/81	349
22/01/81	344
26/01/81	337
27/01/81	335
28/01/81	328
03/02/81	338
04/02/81	337
05/02/81	339
09/02/81	344
10/02/81	344

BASELINE DATA -- SUBJECT 3

Date	Performance Time (sec.)
06/01/81	301
07/01/81	295
12/01/81	298
13/01/81	298
14/01/81	297
15/01/81	296
20/01/81	297

APPENDIX G

Mean Performance Times According to Measured Factors

1) Pool temperature
2) Day of the week
3) Pain assessment
4) Sleep habits
5) Eating habits
6) Other factors

MEAN PERFORMANCE TIME ACCORDING TO POOL TEMPERATURE

Temperature	82°	83°	84°	85°	86°
Subject 1	305.6	303.5	306.8	301.3	302.5
Subject 2	346.3	344.8	339.0	--	--
Subject 3	293.3	293.8	287.7	293.5	301.0

MEAN PERFORMANCE TIME ACCORDING TO DAY OF THE WEEK

Day of the Week	M	T	W	Th
Subject 1	302.5	303.4	304.8	305.3
Subject 2	347.5	343.0	346.3	342.7
Subject 3	293.0	292.8	295.2	292.3

MEAN PERFORMANCE TIME ACCORDING TO PAIN ASSESSMENT

Painful	Yes	No
Subject 1	303.6	304.4
Subject 2	All performances considered painful.	
Subject 3	292.9	295.3

MEAN PERFORMANCE TIME ACCORDING TO SLEEP HABITS

Sleep	Enough Sleep	Not Enough Sleep
Subject 1	303.8	304.2
Subject 2	Enough sleep before all performances.	
Subject 3	292.0	294.9

MEAN PERFORMANCE TIME ACCORDING TO EATING HABITS

Eating Habits	Appropriate	Inappropriate
Subject 1	All eating habits appropriate.	
Subject 2	All eating habits appropriate.	
Subject 3	293.1	295.5

MEAN PERFORMANCE TIME ACCORDING TO OTHER FACTORS

Factors	Present	Not Present
Subject 1	306.2	301.8
Subject 2	Factors present on all trials.	
Subject 3	307.7	293.4